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Electro Optics

Photonics business, applications & technology

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Photonics West 2018

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Contents

LEADER
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The future of driving

The consumer world relies heavily on photonics technology, which was evident at the Consumer Electronics Show (CES) that took place in January in Las Vegas. A range of the latest automotive products was demonstrated, giving us a glimpse into how vehicles in years to come might look and function. There is no doubt that future car, whether fully autonomous or partially assisted, will be enabled by photonics – from the navigation and safety systems to the interior lighting and entertainment features.

Many of these innovative technologies, including lidar, displays and luminaires, will be present at the Photonics West show in San Francisco, which starts on 27 January. Of course automotive products are just a small part of what will be on display – the show preview starting on page 28 details more of what to expect at the exhibition and conference.

Electro Optics will be at the fair, so please stop by booth 2133 to say hello and pick up a copy of the magazine. I look forward to seeing you there!

@electrooptics

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FOCUS BUSINESS NEWS

Optoelectronics Research Centre to lead £6.1m project for next-gen optical fibres

- *Expertise from 25 industry partners and research organisations brought together*
- *Programme aims to put UK at the 'forefront of optical technology'*

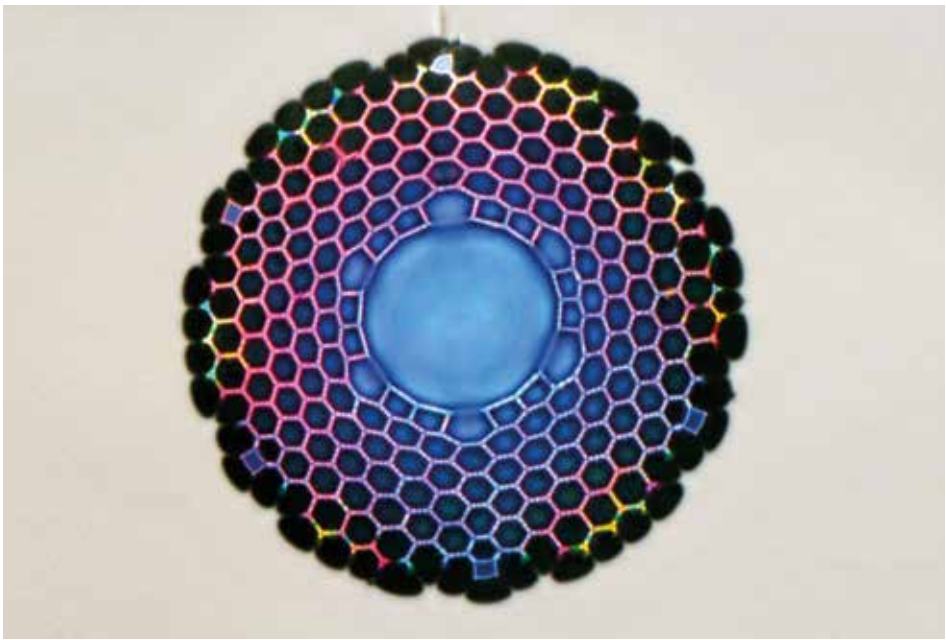
The Optoelectronics Research Centre (ORC), based at the University of Southampton, UK, is heading a £6.1 million programme aiming to produce fibre optics with increased bandwidth, lower latency, improved power handling and better overall quality of light transmission.

The 'AirGuide Photonics' programme, funded by the Engineering and Physical Sciences Research Council (EPSRC), will bring together expertise from more than 25 research organisations and industry partners, in order to transform future fibre networks and open up a broad range of applications, ranging from a faster, more responsive internet, to space exploration, laser-based manufacturing and bioengineering.

AirGuide Photonics aims to replace the glass core of today's conventional optical fibres – which are known to limit fibre performance by adversely affecting various propagation aspects of light, such as its speed – with either a vacuum or air to produce hollow-core 'light pipes'. By instead guiding the light through air rather than glass, these new optical fibres could offer increased bandwidth, lower latency, improved power handling and better overall quality of light transmission.

The new programme will also investigate and explore the performance limits of these hollow-core fibres, in addition to developing innovative means of manufacturing them and reliable methods of interconnecting them to more conventional fibre types and optical components such as lasers.

Bespoke application-specific fibres based on the particular interests of project partners will also be developed and demonstrated in real world uses of the technology, which will serve to showcase its unique and enabling properties.



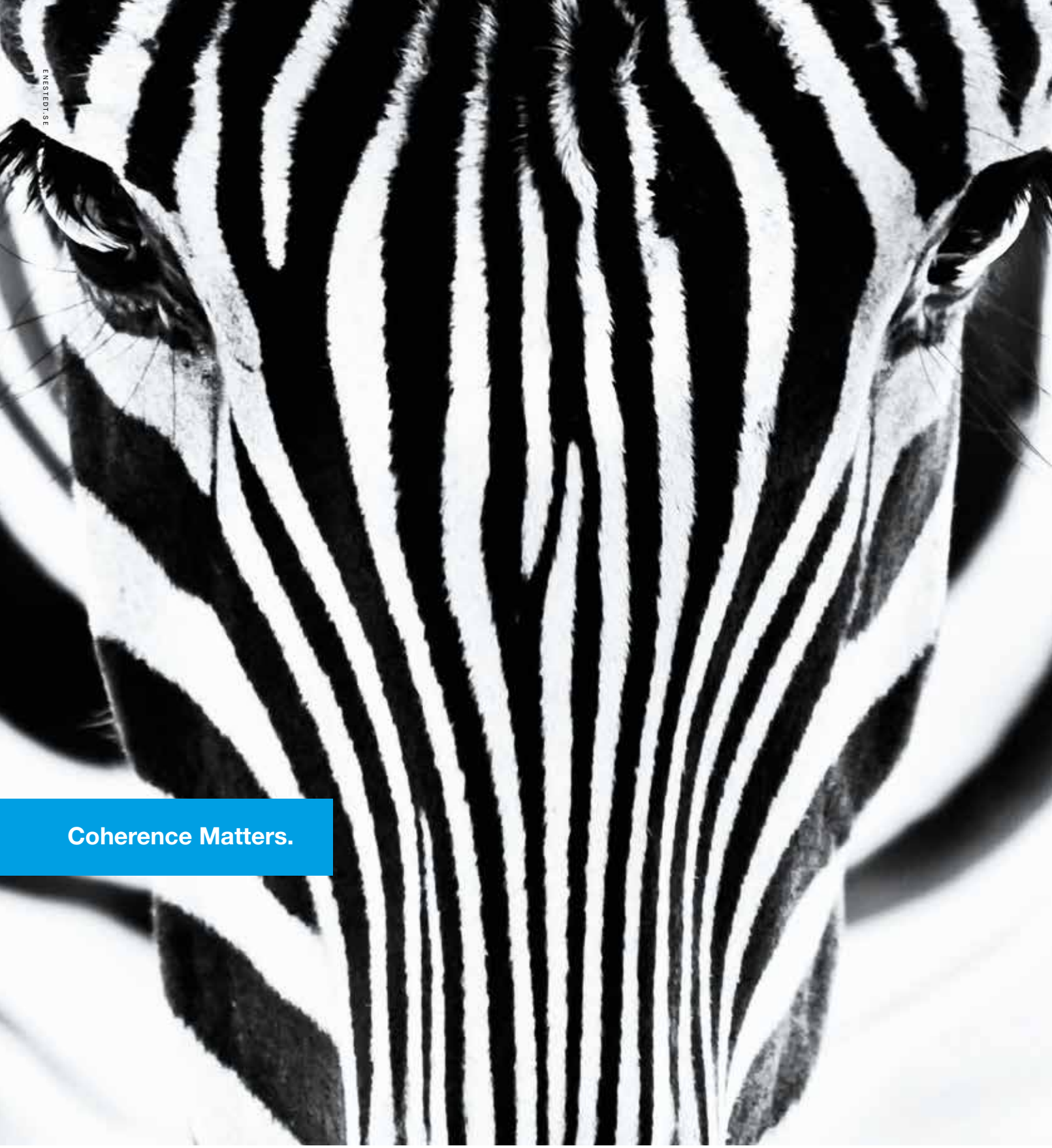
"EPSRC has consistently supported research at the ORC and the new AirGuide Photonics programme promises to push at the boundaries once more"

In December, more than 70 guests, including those from key industries such as telecommunications, sensing and data communications attended a launch event for the programme in Southampton.

'Our new AirGuide Photonics programme will continue to push the boundaries of what can be achieved with optical fibres and develop a disruptive technology that puts the UK at the forefront of optical technology,' said Professor David Richardson, programme lead for AirGuide Photonics, and deputy director of the university's Optoelectronics Research Centre.

Professor Tom Rodden, deputy chief executive of the EPSRC said: 'The ORC has been pioneering the development of fibre optics and advancing communications technology for many years and has an impressive record of using research funding to collaborate with academic and industry partners. EPSRC has consistently supported research at the ORC and the new AirGuide Photonics programme promises to push at the boundaries once more. We are confident the research will uncover more discoveries and lead to world-leading innovations.'

The ORC has built strong links with industry, research institutions and universities around the world, from informal collaborations to large-scale funding. In 2014 it launched The Photonics Institute with Nanyang Technological University in Singapore. Ten spin-out firms, including Fibercore, Fianium, SENSA, SPI Lasers and Stratophase have commercialised ORC research, while its extensive outreach programme has brought light technologies into schools across the UK.



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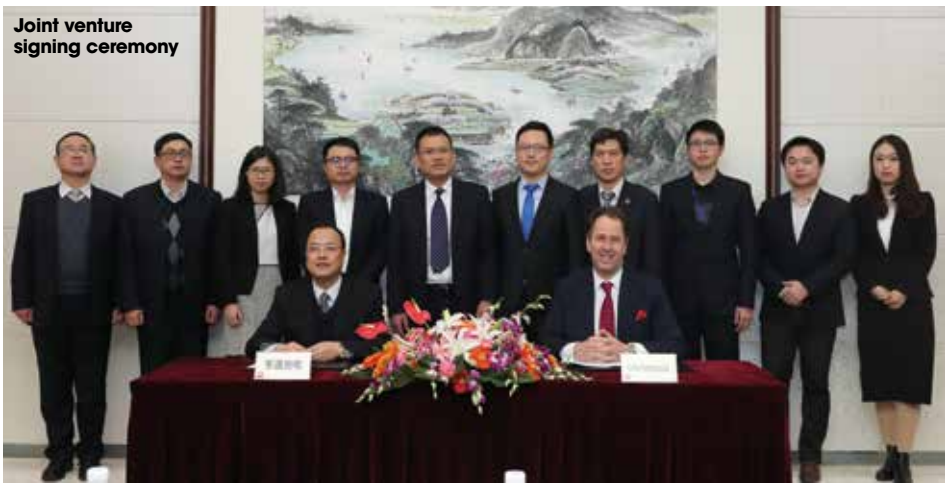
$42m joint venture to deliver silicon photonics optical modules

Silicon photonics firm Rockley Photonics has announced a joint venture with Chinese fibre optic cable manufacturer, Hengtong Optic-Electric, to produce optical transceiver modules based on its silicon photonics technology.

The joint venture was established based on a $42 million co-investment led by Hengtong Optic-Electric, and will commercialise Rockley Photonics' photonics technology for networking applications. The new partnership aims to manufacture and sell silicon photonics optical modules to meet the burgeoning market for high-speed data communication, including carrier networks, internet data centres, high performance computing and deep learning applications.

These products will employ Rockley Photonics' innovations for high-density optical integration with innovative monolithic fibre attach technologies and an all-CMOS electrical chipset to offer a new generation of photonic optical transceiver modules delivering lower power and high manufacturing efficiencies.

'Demand for high-speed optical interconnect is increasing at an unprecedented rate, and technology providers must demonstrate capacity to deliver solutions at high-volume scale,' said Dr Andrew Rickman, chief executive officer, Rockley Photonics. 'Hengtong Optic-Electric is a recognised manufacturing leader for fibre-optic technologies, and we are excited to partner with them in delivering our next generation solutions.'



Joint venture signing ceremony

Rockley Photonics

Weiming Shi, announcer of Hengtong Optic-Electric and general manager of Jiangsu Hengtong Optical Network Technology, added: 'Silicon photonic technology is reshaping the economic structure of the optical module market. The joint venture will employ Hengtong's advanced R&D of optical module and intelligent manufacturing technology, along with Rockley's worldwide first-class silicon photonic technology platform.'

The global optical network hardware market is forecast to grow to $24.99 billion by 2021, at a compound growth rate of close to 13 per cent, according to research published by Technavio. Growing mobile data traffic, high demand for data centres and development of 5G networks are just some of the leading drivers of demand for new optical network hardware.

Rockley Photonics' silicon photonics designs meet the increasing demands of higher speed and integration for more efficient data transmission, while satisfying customer requirements for low power and superior economics.

First ELT main mirror segments cast

The first six hexagonal segments for the main mirror of the European Southern Observatory's Extremely Large Telescope (ELT) have been cast by Schott at its facility in Mainz, Germany. These segments will form part of the ELT's 39-metre main mirror, which will have 798 segments in total when completed. The ELT will be the largest optical telescope in the world when it sees first light in 2024.

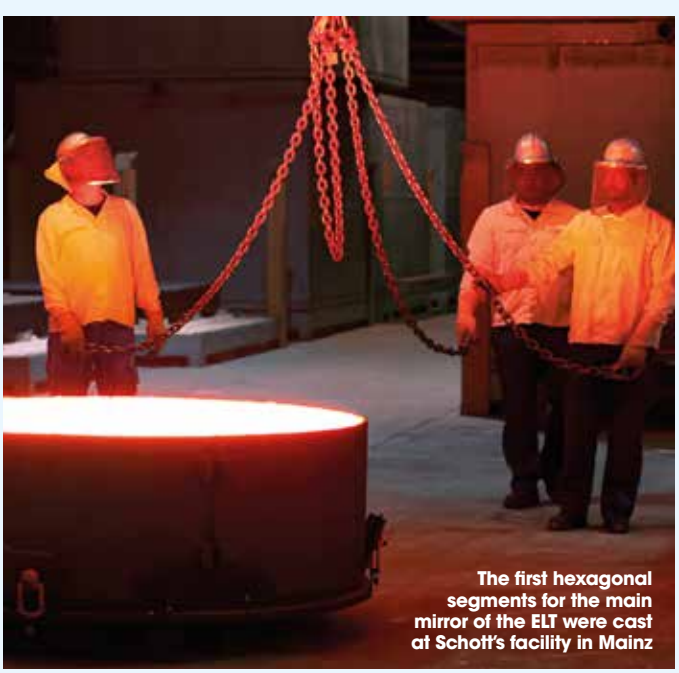
The 798 individual hexagonal segments, each measuring 1.4 metres across and about five centimetres thick, will work together as a single huge mirror to collect tens of millions of times as much light as the human eye.

The ELT main mirror segments are made from Schott's Zerodur low-expansion ceramic material. The firm has ESO contracts to manufacture the blanks of the first four ELT mirrors.

The first segment castings allow the engineers to validate and optimise the manufacturing process and the associated tools and procedures.

Although the casting of the first six segments is a major milestone, in total, more than 900 segments will need to be cast and polished (798 for the main mirror itself, plus a spare set of 133). When fully up to speed, the production rate will be about one segment per day.

After casting, the mirror segment blanks will go through a slow cooling and heat treatment sequence and will then be ground to the right shape and polished to a precision of 15 nanometres across the entire optical surface. The shaping and polishing will be performed by the French company Safran Reosc, which will also be responsible for additional testing.



The first hexagonal segments for the main mirror of the ELT were cast at Schott's facility in Mainz

Schott/ESO

Mellanox halts silicon photonics activities

Mellanox Technologies, a supplier of smart interconnect solutions for data centre servers and storage systems, has announced that it will discontinue its 1,550nm silicon photonics development activities, effective immediately, due to the business not growing as much as anticipated.

The move has led to Mellanox letting go its silicon photonics team of around 100 people.

The discontinuation is not expected to have an impact on fiscal 2018 revenues, the firm has said, and is projected to result in expected fiscal 2018 non-GAAP operating expense savings of $26 million to $28 million. Mellanox expects to recognise most of the restructuring charges in the first quarter of 2018.

'We [Mellanox board of directors and management team] began our review of the silicon photonics business in May of 2017, but as the business did not become accretive as we had hoped, we decided to discontinue our 1,550nm silicon photonics development activities,' said Eyal Waldman, president and CEO of Mellanox Technologies.

There will be no impact for its variable optical attenuators (VOA) product, with a minor one on the LinkX cables and transceivers product line. The firm plans to deliver 200 gigabit, 400 gigabit and beyond cables and transceiver solutions on schedule, using technologies such as Mellanox's IC designs. Mellanox intends to retain silicon photonics intellectual property.

Despite Mellanox's move, market firm Yole Développement's most recent forecast for the overall silicon photonics market is positive.

According to the firm's Silicon Photonics report released in January, Silicon photonics is still a small market today, with sales at die level estimated to be $30 million in 2016. However, it has big promise, with an anticipated 2025 market value of $560 million at chip level and almost $4 billion at transceiver level.

Silicon photonics technology will grow from a few per cent of total optical transceiver market value in 2016 to 35 per cent of the market in 2025, according to Yole, mostly for intra-data centre communication.

The strongest demand is for 400G. In parallel, 200G could be only an intermediate step between 100G and 400G. 'The next evolution is to develop a 400G optical port over a single fibre across 500m at less than $1 per gigabit and with power less than 5mW/Gb', explained Dr Eric Mounier, senior technology and market analyst at Yole. One terabit per second rates should follow.

Velodyne halves cost of lidar system

Automotive lidar manufacture Velodyne has halved the cost of its most popular sensor system, with the intention of making autonomous driving technology more accessible and to encourage its uptake into various markets.

The VLP-16 Puck lidar sensor was launched in 2016 and has since had been used in multiple applications, including automotive, freight, 3D mapping, unmanned aerial vehicles (UAVs), industry, and robotics. It offers small dimensions and real-time 3D vision with 100 metres of range and a 360° surround field-of-view.

Velodyne's systems are now produced autonomously thanks to the firm establishing a megafactory in San Jose, California, last year.

'Demand for our VLP-16s grew tremendously in 2017. As a result, we increased capacity and now can pass along savings as a cost reduction to our customers,' said David Hall, founder and CEO of Velodyne Lidar. 'With this cost reduction, we'll be able to get more Pucks into the hands of more customers, and support the growing number of autonomous vehicle development fleets.'

IN BRIEF

Edmund Optics has acquired ITOS, a producer of optical components based in Mainz, Germany. The acquisition was completed by 1 January 2018 and ITOS is now a 100 per cent subsidiary of Edmund Optics, functioning as 'ITOS - A Division of Edmund Optics'.

Jenoptik has opened an application centre in Fremont, in Silicon Valley, California, to enhance customer proximity and support growth in the United States.

German photonics firm Toptica has signed an updated contract with the European Southern Observatory (ESO) for the production of four more lasers to be used in the adaptive optics system of the European Extremely Large Telescope (E-ELT).

Elliot Scientific is now distributing, within the UK and Ireland, a range of products from precision positioning manufacturer Siskiyou.

NEWS FROM EPIC *By Carlos Lee, director general, EPIC*

Pace of innovation requires increased focus on short-term strategy

EPIC European Photonics Industry Consortium

I had the privilege of moderating a panel discussion during the 100th anniversary celebration of the Institut d'Optique, which is now known as the Institut d'Optique Graduate School (IOGS) and sometimes given the nickname 'SupOptique'.

My first question was how innovation differs today compared to 20 years ago. As expected, the answers addressed the increased pace of invention. The biggest surprise came when discussing the time frames for future innovation – I thought it would be 10 years plus, but the panel, made up of executives of large multinationals in the B2B sector, commented that it would only be three to five years. That came as a revelation to me, particularly after recently finished reading *Building a Long Lasting Organisation*, a book that focuses on how to build companies that will last more than 100 years.

That technology and innovation are reaching unprecedented levels of development is something that most consumers experience with all new gadgets and apps on the market every day – this is something I did not anticipate for the B2B sector. Paul Roberts, in his 2014 book, *The Impulse Society*, described a system 'so hostile to the notion of long-term investment, or commitment, or permanence, that it is becoming incapable of producing anything'. Accelerated technological developments, globalisation and increasing digitalisation fuel the growth of start-ups that introduce disruptive innovation and enable established industry players to test new ideas rapidly, with less risk in development cost, and possibly at a cheaper cost.

Looking at innovation from a short-term perspective has a lot of implications, and indeed we do see a lot of multinationals increasingly 'acquiring' innovation in addition to developing it in-house. When you work on developing a new technology, you need to think about the entire ecosystem, and all of the competing technologies. But you also need to consider that maybe your technology will be

> **"You also need to consider that maybe your technology will be obsolete in the short-term"**

obsolete in the short-term, and that you will need to recuperate your investment during this short window of opportunity. In light of these developments, companies need to redesign their strategic plans, and employees should become 'intrapreneurs', or inside entrepreneurs.

This then leads to the important role of schools: academic and personal development. Universities should focus not only in educating and stimulating academic learning, but also in developing the right mindset and soft skills competencies that will sustain the competitiveness of companies and help them cope with the accelerated pace of innovation.

European consortium to develop 'luminaire of the future'

A Horizon 2020 research project called Repro-light (reusable and reconfigurable parts for sustainable LED-based lighting systems) has been launched with the goal of developing the 'luminaire of the future'.

The new project aims to implement a new modular luminaire architecture, a smart production scheme, and also the development of a reconfigurable customised LED luminaires.

Repro-light brings together experts in light, manufacturing, industry, communication, social technology and sustainability from across Europe.

The first phase of the project is already underway, with the experts initially focusing on analysing customer needs and technical requirements. This information is vital for the following phases and will be gathered by March 2018.

Repro-light

With the LED market mid-transformation, shifting its focus to functionality, the Repro-light project is well-timed to lead this, changing the reputation of the LED luminaire from a disposable object to a customisable, sustainable product.

'Led by representatives and driving forces from the European lighting industry, as well as manufacturers, experts on lighting sustainability and the social sciences, the Repro-light consortium possesses the excellence and the influence to not only execute this project successfully, but also invoke a sustainable change in the European lighting industry beyond the lifetime of the project,' the project announced.

The consortium is made up of European lighting firms and research institutes Trilux, BJB, Bartenbach and Luger Research, as well as manufacturers Grado Zero Espace and Rohner Engineering, lighting sustainability and life cycle assessment expert IREC, and Mondragon University.

The need for projects such as Repro-light has been highlighted in several recent white papers, including *Serviceable Luminaires in a Circular Economy* published by The European Lighting Association. The white paper highlights the value of a circular economy, and it is just such an economy that Repro-light's 'luminaire of the future' is designed to be part of.

FOCUS RESEARCH NEWS

New heart-on-a-chip to boost drug testing

A fast method for manufacturing a heart-on-a-chip using a UV laser could pave the way for straightforward tests of how heart tissue reacts to clinical drugs.

The platform, developed by researchers at Harvard University, uses a UV micropatterning method to create features on a gel 60 per cent faster than traditional moulding techniques. The study was published in the journal *Biofabrication*.

Co-lead author Dr Lisa Scudder said: 'One of the major challenges... is failure at the clinical testing stage due to cardiac toxicity. A way to overcome this is to develop new preclinical tests for new drugs using engineered tissues that mimic the native organs of the human body, such as the heart.'

The heart-on-a-chip has to have tissue that is as contractile and organised as the human heart, so scientists can measure contractile force – a major determinant of heart pumping performance. The cardiac tissue and muscular thin films beat and contract in response to external stimuli like electrical pacing.

The chip adds to previous work, which established a platform using the miniaturised structural formation of cardiac muscle on a cantilever of hydrogel. The hydrogel has mechanical properties that are similar to the extracellular matrix of the heart. This pre-patterned substrate results in an organised growth of cardiac muscle. The end goal is to put these structures into a microfluidic environment where the flow of a drug being tested can be monitored.

However, for these chips to become a tool for drug development and biomedical research in industry, they need to be manufactured on a large scale, as opposed to producing small batches for academic research.

Dr Scudder said: 'The existing way of engineering cardiac tissues involves using photomasks, stamping and manually moulding gelatine to create patterns in the hydrogel for tissue alignment, but this was taking too long and was not practical for our chip manufacturing needs.

Disease Biophysics Group, Harvard University, Cambridge, MA

The method uses UV micropatterning to create features on a gel

'Our new fabrication method uses a UV laser to pattern the hydrogel, employing riboflavin to sensitise the gel for optical ablation. This patterning method then allows the cardiac cells to align into organised laminar tissue structures, like in the native heart. The UV micropatterning method creates features on the gel much faster, but with the same resolution and reproducibility as traditional moulding techniques.'

The process is scalable, gives great uniformity, doesn't alter the properties of the hydrogel, and is up to 60 per cent faster.

'It is another step towards the mass production of organs on a chip... essential if large pharmaceutical companies are going to utilise them,' said co-lead author Dr Janna Nawroth.

Scudder added: 'This method could be useful for manufacturing other organs-on-a-chip, such as a brain or skeletal muscle-on-a-chip.'

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Metalens focuses entire visible light spectrum onto single point

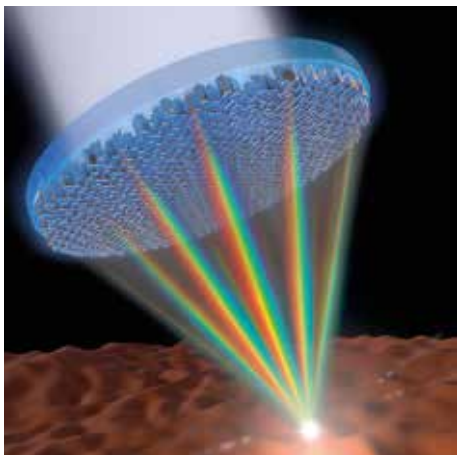
- ***Lens design uses multiple pairs of nanofins to create different time delays***
- ***Simple, flat surface replaces multiple lenses and reduces optical device bulk***

A single metalens capable of focusing the entire visible spectrum of light onto a single point and in high resolution has been developed by a team of researchers at the Harvard John A Paulson School of Engineering and Applied Sciences (SEAS).

According to the research team, the achievement, published in *Nature Nanotechnology*, has only occurred before by stacking multiple lenses together, and could open new possibilities in virtual and augmented reality.

Different wavelengths move through materials at different speeds – red wavelengths move through glass faster than the blue – resulting in varying foci that make focusing the entire visible spectrum at once particularly challenging. This creates image distortions known as chromatic aberrations.

Currently, cameras and optical instruments use multiple conventional curved lenses of different thicknesses and materials to correct these aberrations. However, Harvard's new single metalens instead features a simple, flat surface that uses nanostructures to focus light, allowing it to replace these multiple lenses and reduce the bulk of optical devices.



Jared Sisler/Harvard SEAS

The flat metalens uses arrays of titanium dioxide nanofins to equally focus wavelengths of light and eliminate chromatic aberration

'Metalenses are thin, easy to fabricate and cost effective,' said Federico Capasso, senior author of the research and a professor of applied physics at SEAS. 'This breakthrough extends those advantages across the whole visible range of light. This is the next big step.'

The metalens corrects chromatic aberrations using arrays of titanium dioxide nanofins, the dimensions and shape of which can be optimised to focus different wavelengths at varying distances. The lens design uses mutliple pairs of these nanofins, each tuned to create different time delays in the light passing through, allowing them to determine the refractive index of the metasurface and ensure all wavelengths reach the same focal spot at the same time.

'One of the biggest challenges in designing an achromatic broadband lens is making sure that the outgoing wavelengths from all the different points of the metalens arrive at the focal point at the same time,' said Wei Ting Chen, a postdoctoral fellow at SEAS and first author of the paper. 'By combining two nanofins into one element, we can tune the speed of light in the nanostructured material, to ensure that all wavelengths in the visible are focused in the same spot, using a single metalens. This dramatically reduces thickness and design complexity.'

'Using our achromatic lens, we are able to perform high quality, white-light imaging,' added Alexander Zhu, co-author of the study. 'This brings us one step closer to the goal of incorporating them into common optical devices such as cameras.'

The researchers are now looking to scale up the lens to about 1cm in diameter, which could lead to a range of new possibilities, such as virtual and augmented reality uses. In the meantime, the Harvard Office of Technology Development has licensed the intellectual property to a startup, in order to begin commercialisation of the new lens.

Ultra-fine OLED fibres to be woven into wearable displays

Researchers from the Korea Advanced Institute of Science and Technology (KAIST) have produced organic light-emitting diodes (OLEDs) on ultra-narrow fibres thinner than a human hair. The technology, which featured in *Nano Letters* last month, could be woven into textiles and knitted clothes for producing wearable displays.

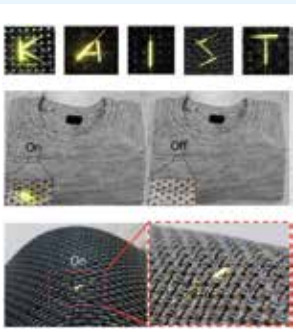
According to the KAIST team, existing fibre-based wearable displays' OLEDs demonstrate much lower performance compared to those fabricated on planar substrates, which limits their application. The research, led by Professor Kyung Cheol Choi from the School of Electrical Engineering and PhD candidate Seonil Kwon, resulted in the design of a structure of OLEDs compatible to fibre, and used a special dip-coating method in a 3D structure of fibres to develop efficient OLEDs designed to last a lifetime, with performance equivalent to those on planar substrates.

'This simple, low-cost process opens a way to commercialise fibre-based wearable displays,' commented Choi.

Exhibiting luminance and current efficiency values of over 10,000cd/m² (candela/square metre) and 11cd/A (candela/ampere), the researchers identified that their solution-processed planar OLEDs can be applied to fibres without any reduction in performance.

The team also verified that the fibre OLEDs withstood tensile strains of up to 4.3 per cent while retaining more than 90 per cent of their current efficiency. In addition, the OLEDs could be fabricated on fibres with diameters ranging from 300μm down to 90μm, thinner than a human hair, which attests to the scalability of the proposed fabrication scheme. The fibres can be woven into textiles and knitted clothes without causing any problems, according to the researchers.

Due to the researchers' process being carried out at relatively low temperatures – approximately 105°C – fibres vulnerable to high temperatures can also be used in this new fabrication scheme.



Kwon et al

The new fibre-based OLEDs can be woven into knitted clothes to produce wearable displays

This work was funded by the Engineering Research Centre of Excellence programme and the Nano-Material Technology development programme by the National Research Foundation of Korea and the Ministry of Science and ICT of Korea.

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Modernising the motorcar

Jessica Rowbury looks at how some of the technologies demonstrated at the Consumer Electronics Show in January will transform the driving experience

From adaptive laser headlights and lidar-controlled navigation, to interior lighting that fits your mood, cars of the future will not only be safer but will give drivers and passengers a personal and immersive experience.

The Consumer Electronics Show (CES 2018), which took place from 9 to 12 January in Las Vegas, had a number of futuristic vehicles on display, with much of the clever technology going into them relying on photonics.

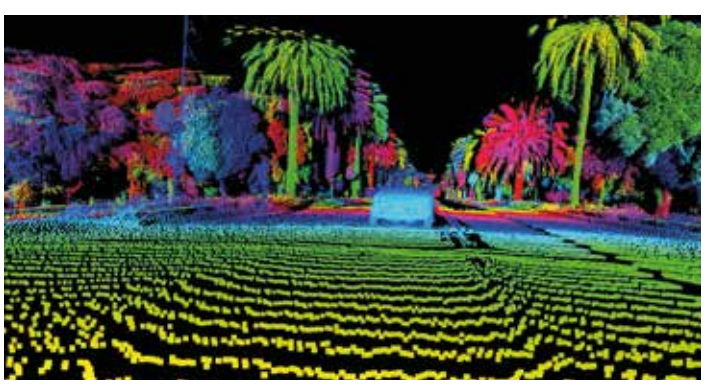
Navigating with lidar

With several of the demo autonomous cars containing multiple lidar systems – such as Aptiv's self-driving BMW that had nine units – lidar was out in full force in Las Vegas, with equipment ranging from $100 to more than $70,000 in value.

Velodyne, which has dominated the automotive lidar market in recent years, showed its new VLS-128 system, which features a wider field-of-view and improved resolution compared to previous models. It has 128 scanning channels and four times the data density of its predecessor. The instrument is also 70 per cent smaller in size than the HDL-64, with double the range and four times the resolution. The price of the new unit isn't widely advertised, but given the $70,000+ price tag on previous top-end models, it will probably cost more than most cars seen on the road today.

Luminar's 1.5µm lidar system stands out because of its 200-metre range and high resolution, which is made possible because of the longer wavelength of light. Operating at 1.5µm is deemed less damaging to the eyes and means higher power lasers can be used. The longer range allows for more reaction time in the case of any road incidents, increasing safety.

Luminar



A single frame captured with Luminar lidar

Compared to the cheaper 905nm wavelength used by Velodyne and many other lidar companies, 1.5µm lasers are relatively expensive, which limits how many can be integrated while still being competitive. Compared to Velodyne's new system, which uses 128 lasers and 128 photodetectors to capture the scene, Luminar's lidar has just two modules, each containing a single laser, detector and a mirror that sweeps the beam over the surrounding environment many times a second to create a 3D image.

These optomechanical scanners also increase the price of the overall system, and it has been suggested that the mirrors can be replaced with optical versions of phased-array antennas – common in radars and in mobile phones – to increase affordability. These arrays have slotted elements arranged side by side, controlled via electric signals rather than moving mirrors.

Toyota's latest self-driving research vehicle employs eight lidar systems, four of which come from Luminar.

California-based AEye also employs a 1,550nm laser in its lidar system, which the firm says will be available to OEMs and Tier-1s this summer. The AE100 MOEMS lidar includes a low-light HD video camera, distributed artificial intelligence, and software-definable and extensible hardware.

Quanergy's eight-line solid-state lidar instrument has a lower resolution and field-of-view than other brands; however, the firm's big advantage is that it has already started production – meaning that, if there are no delays, the systems could prove popular with automakers. The 905nm system contains no moving or vibrating parts on either macro or micro scales, the company says.

Byton

Byton's 49-inch LCD screen stretches across the entire dashboard

Velodyne now sells its cheapest 16-laser lidar for $4,000, after halving the price in January, but some companies are marketing systems at a fraction of that cost. LeddarTech presented its new LeddarCore LCA2 chipset for autonomous cars, which, according to the company, is the first 3D solid-state lidar integrated chip that can be manufactured at scale for under $100 apiece. The firm is geared toward mass production by Tier-1 manufacturers for deployment by automotive OEMs as early as 2020.

Dynamic displays

In a world where every surface inside a vehicle could become

a screen, cars of the future will make commuting feel like less of a chore – giving the same kind of interactive experiences of personal electronics and visuals comparable to a cinema.

Harman, a Samsung company, showed a concept dashboard featuring a range of organic LED (OLED) and quantum dot LED (QLED) screens. Built into

"Velodyne now sells its cheapest 16-laser lidar for $4,000, but some … systems [are] a fraction of that cost"

a Maserati GranCabrio, the displays project personalised information and customisable controls to the driver and passengers.

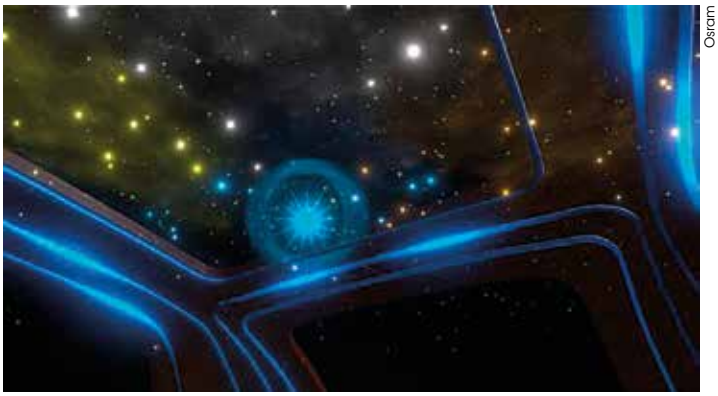
Taking advantage of the flexible nature of OLEDs, a display running through the centre of the car blends in so that it doesn't look like a screen, but presents touch controls that the driver can personable.

The QLEDs' direct-lit backlight technology gives improved power savings, which Harman has said can lead to increased range and efficiency in electric vehicles. The technology works in a similar manner to Samsung's QLED televisions.

The company also demonstrated its QLED 'mood roof', which presents a choice of immersive visual landscapes on the inside of the car's curved top, complemented by a range of environmental sounds played through the speakers.

The atmosphere inside the vehicle can also be enhanced by lighting, as shown with Osram's interior luminaires that can match, or boost, a passenger's mood. Through biometrics, the vehicle can measure stress levels and adjust the lighting colours and levels automatically to encourage relaxation and aid safe driving.

Harman's dashboard concept demonstration presents automotive OEMs with a cost-effective way of placing curved screens on any surface to give the driver useful information or immersive experiences.



Osram

Interior lighting from Osram can help enhance a driver's or passenger's mood, or even help alleviate jet lag

Chinese start-up Byton goes so far as to refer to the inside of its electric SUV concept car as a 'personal lounge'. The model has a 49-inch LCD screen that stretches across the entire dashboard, which can present health information, as well as being a communication and entertainment system. Through facial recognition, gesture control and touch screens, the display reacts intuitively to its passenger's needs and recognises faces to present tailored information to each person.

Toyota's autonomous shuttle vehicle, called e-Palette, features large screen-window displays on its exterior. The e-Palette has been designed to function for various applications, for example as an autonomous delivery unit or mobile market place, so the displays offer the opportunity for digital advertising.

Smarter and brighter

A range of smart headlight concepts were demonstrated at CES, including a unit containing a DLP chip from Texas Instruments that can alter how light is reflected in front of the car, reacting to pedestrians and the road ahead.

For autonomous vehicle applications, for example, the chip is able to track a pedestrian's location and angle the illumination above the person's head to avoid dazzling them.

In non-autonomous cars, the smart technology could prove useful by projecting directions onto the road in front of the car, or highlighting lane lines when it's dark.

SLD Laser, formerly SoraaLaser, showed its LaserLight source for automotive applications. According to the company, the sources deliver more than 10 times the luminance of LEDs, and can alter the beam pattern on the road. A SPIE Prism Award finalist in 2017, SLD Laser's light sources use patented semi-polar GaN laser diodes, incorporated with phosphor chip technology, and high luminance packaging. The technology was originally developed by SLD Laser co-founders and blue laser pioneers Shuji Nakamura, Steven Denbaars and James Speck at the University of California, Santa Barbara.

Osram presented its DMD laser light source, which is suitable for both light and symbol projection on the road ahead. The adaptive headlight has more than one million individually addressable pixels that can communicate with other drivers, passengers and road users, and even entertain by projecting the latest movies when the car is parked.

LEDs and lasers convert front and rear windows into information-rich screens for conveying marketing messages or communicating with the vehicle's surroundings. LED license plates can be customised with the driver's information to accommodate future car sharing regulations. **EO**

The backbone of smart cities

Matthew Dale discovers that smart lighting has a lot more to offer than the energy savings associated with LEDs

In the ongoing global effort to reduce energy consumption, entire cities have now committed to switching from using high-pressure sodium or metal halide street lighting to more efficient, more reliable white-light LED alternatives.

As part of the 'smartification' of infrastructure, intelligent street lighting solutions are now available offering complete control of a city's illumination from a central hub. The US city of Chicago has installed more than 18,000 smart LED lights along its major south and west side streets as part of a project to improve the safety and quality of its neighbourhoods. The Chicago smart lighting programme, launched last year, plans to replace 270,000 street, alley and viaduct lights within four years.

Meanwhile, Cardiff, in Wales, UK has installed 1,000 Luma LED street lights from Philips Lighting, with plans to install more than 14,000 in total, all controlled via Philips' CityTouch street light management system.

There's also work on the LED luminaires themselves – an EU Horizon 2020 research project called 'Re-usable and re-configurable parts for sustainable LED based lighting systems' was launched in January, with aims to implement a new modular luminaire architecture, a smart production scheme, and also the development of a reconfigurable customised LED luminaire.

But perhaps the most significant opportunity that smart street lighting presents is its ability to act as a backbone network for futuristic smart cities – conceptualised highly connected urban areas that use a multitude of sensors, monitoring systems and broadcasting equipment to optimise the efficiency of available operations and services. With many cities already making the switch to LEDs, now more than ever presents the perfect opportunity to incorporate this additional smart functionality into street lighting.

'Outdoor lighting being the backbone for smart cities is the future,' said Jeremy Ludyjan, senior director of global field marketing for lighting firm Fulham. 'Outdoor lights provide power for various sensors, are in most places you would need sensors, and provide you with a place to put the sensors; they are also tall enough to easily communicate with each other, to the gateway, and ultimately to the management software.'

Ludyjan will be at the LED show in Long Beach, California on 13-15 February presenting the session 'Intelligent outdoor lighting – empowering end users to utilise lighting as the backbone to smart cities'.

Such a backbone could offer sensing opportunities for applications such as weather monitoring or pollution

Osram

Around 3,000 lights in Bensheim, Germany have been converted to Siteco's Streetlight 10 LEDs to illuminate the main and side streets

Osram

Siteco's DL30 luminaires bathe parks in Balgheim, Germany with uniform white light

detection, as well as data collecting services such as traffic monitoring, people counting and noise detection, whose analysis could aid in the overall planning of a city.

'Smart lighting will be a part of the "smartification" of cities,' agreed Jörg Kupferschlaeger, specialist for outdoor lighting at Osram. 'In the future, sensors or cameras for movement detection and other purposes may also be included in the luminaires of city lights or attached to the mast to improve the lives of not only the public, but also the people who work with and maintain these systems.'

Such improvements have already been introduced in the town of Wipperfürth in Germany, where modern LED City Light pillars equipped with Osram's own Street Light Control system and Einstone beacon technology were installed as part of a smart city project. The luminaires transmit useful data via a Bluetooth signal that can be viewed by smartphone users around the town using an app, giving them access to a diversity of information about local companies, retailers, locations and landmarks.

'We also have projects working with cameras for parking and safety applications,' commented Kupferschlaeger. 'Retailers are interested in using this to find out when non-paying customers are using their car parking spaces for free. This could also help when customers are searching for parking.'

According to Kupferschlaeger, while this added opportunity of smart lighting is now one of its most promising aspects, it hasn't always been the case.

'We brought up the possibility of incorporating other functionality in lighting in the past, but this was something our customers were not interested in at the time,' he said. 'Now its generating a lot more interest, perhaps because the lighting industry is putting a lot more pressure on it and because we now have this 'smart city' term, so everyone wants to know what's behind it. We are getting lots of questions and pilot project requests to try out certain things. This is all still in the early stages though.'

"The efficiency of LED luminaires is improving at roughly one lumen per Watt per month"

Osram recently acquired a 47.5 per cent share of Dutch firm Tvilight, which specialises in the software of intelligent lighting and the potential for it to be used to communicate and interact with other systems. Through the partnership, Osram is able to work with Tvilight's additionally smart lighting technology such as CitySense – a sensor that can be attached to street lights in order to detect the presence of road traffic and enable responsive dimming in quiet periods.

Tvilight has also partnered with Fulham, which is integrating the firm's software and radio technology into its own smart lighting drivers, according to Ludyjan.

Partnerships in photonics

This increasing adoption of smart lighting bodes well for the photonics industry, as not only do the smart lights themselves contain luminaires, lenses and sensors, but so do the additional smart city sensing opportunities that are enabled through their installation.

'This work is all being done with various partners such as sensor and camera manufacturers,' said Kupferschlaeger. 'As well as the LEDs, smart lighting also contains a number of other photonic components. Tvilight's CitySense uses infrared sensors to detect movements – which, when coupled with software, specifies whether that movement is from a vehicle, human →

Osram

Norway's town of Horten uses Siteco's Streetlight 20 LEDs to illuminate its roads with white light

→ or animal. Lidar sensors, which are already used in autonomous cars, could also be included in a smart lighting system. The matrix LEDs used in the car industry could also be used in future lighting applications.'

Osram's own LED lighting solutions, such as its subsidiary Siteco's Streetlight 20 family, use efficient lens technology to redistribute the light of the luminaire more evenly compared to traditional street light sources, which often have bright spots under them and darker spaces between each installation – around 50 per cent of their light is directed inefficiently.

'LED lights are much better for light distribution in that they don't feature as much light directly under the luminaire and re-direct light out to the sides where it is also needed,' explained Kupferschlaeger. 'The success of LED luminaires is down to both the efficiency of the diodes as well as the optics involved, areas we are continuously working on. For area lighting it is very difficult to illuminate big areas uniformly with a traditional light source. With LEDs it's much easier.'

According to Kupferschlaeger, the efficiency of LED luminaires is improving at roughly one lumen per Watt per month, and currently stands at around 130 lumens per Watt.

Osram uses poly-methyl-methacrylate for its LED street light lenses; however, Kupferschlaeger said that silicon can also work well. 'Lots of companies develop their own lenses, while others obtain them from lens manufacturers,'

Telensa

Telensa's apple-sized telecells fit to the top of streetlights and enable full remote control of their operation

he added. 'There is no real standard lens. We have lenses for street lighting applications, and other lenses we use for area lighting. Different illuminations require different lenses.

'While we do purchase some of these lenses from manufacturers in the photonics industry, we also manufacture lenses ourselves as well.'

For additional smart light sensing applications, Osram will rely on other photonics companies for their sensor technology in the future, Kupferschlaeger noted, although Osram's own semiconductor branch will also research and develop sensors for these applications as well.

These partnerships, while being one of the beneficial trends of smart cities,

"While we do purchase lenses ... [from] the photonics industry, we also manufacture lenses ourselves"

according to Kupferschlaeger, could be one of its main challenges as well. 'There is not one company that can accomplish everything, and different companies have varying philosophies and techniques,' he said. 'Working out the right solution that is a good business case for everyone is a real challenge.'

For Fulham, its focus is not in the commodity lighting business – a race to the lowest price – rather the business of adding value to its components to create clever lighting. Smart cities will therefore benefit photonics firms such as Fulham as they 'create markets for lighting that extend beyond just price', →

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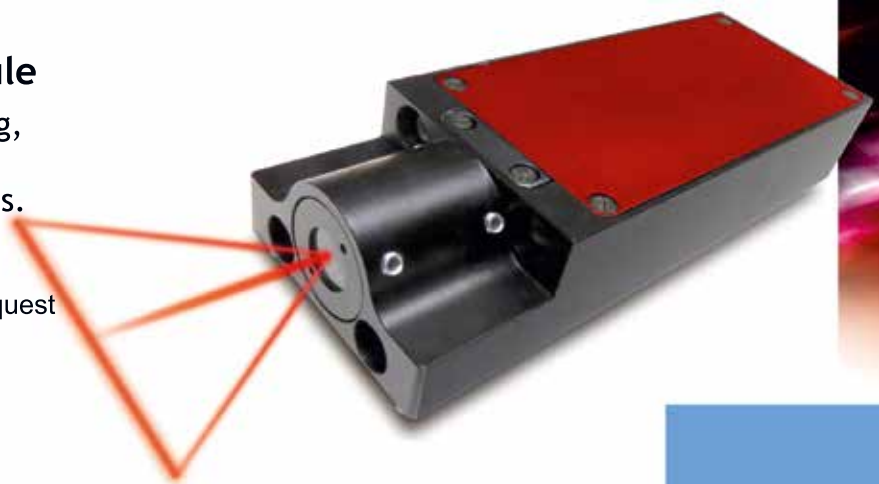

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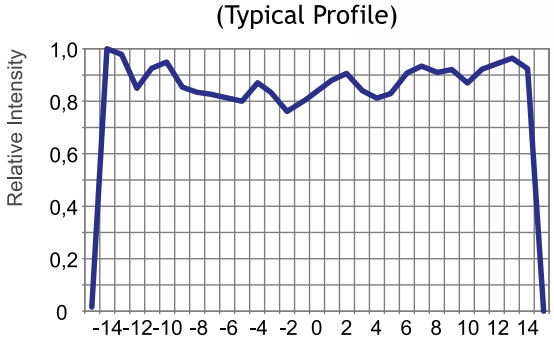

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→ according to Ludyjan. 'There will be new demands for smarter, tuneable, longer-lasting components.'

Kupferschlaeger explained that other sectors, such as the voltage protection industry, have gained a new branch of business from LED lighting. 'This is great for them because electronics are now very sensitive to over voltage and we have to protect the luminaires in a lot of applications. This positive effect will also be seen by sensor and electronics manufactures when additional functionalities such as LiFi get integrated into smart lighting.'

Light fidelity

The possibility of also using smart street lighting to broadcast internet, a technique known as LiFi, is also being discussed by lighting firms such as Osram.

LiFi, standing for light fidelity, promises much as a way of transmitting data. With speeds in excess of 100Gb/s conceived, all communicated through LED lighting, the technology seems to be superior in many ways to the slower WiFi networks based on radio frequency.

'This would lead to more photonics components being used in both the lighting involved and the smart devices receiving the data,' said Kupferschlaeger. 'LiFi could enable a faster and higher-quality internet connection for those within smart cities. This is still in the very early stages; however, it's important that we do not miss the point where this becomes industry standard, as it fits very well into what Osram is looking to achieve.'

Osram

Croatia's capital of Zagreb uses DL20 LEDs from Siteco and linear Liner XB LED strips from Osram's Traxon to illuminate a circular memorial in Park Bosnjaci

LiFi is already becoming a commercial reality, with Edinburgh-based firm, PureLiFi, offering a LiFi USB dongle and a LiFi-integrated luminaire, but there is still a long way to go until every LED light can be produced with LiFi capability.

'The lighting industry is in a competition for smartification with the automotive and mobile phone industries, and it could be that mankind has enough smartification already. However, with additional opportunities such as LiFi, weather, population and traffic sensing available, smart lighting could have a huge benefit to smart cities,' Kupferschlaeger concluded. **EO**

Smart savings

Automated lighting is of course nothing new; in an attempt to save energy cities already use photocells on top of their street lights to switch them on and off at appropriate times of the day. These, however, can be notoriously inaccurate, according to Keith Day, vice president of marketing at smart lighting firm Telensa, who explained that a smart light could provide a much more precise measure of when to turn on and off.

'Even if this only results in five minutes of extra downtime, across an entire city over the course of a year this results in huge energy savings,' said Day. 'The possibility of smart lighting is to make lights responsive, allowing them to provide the right level of illumination at the right time.'

Day explained that, using smart controls, energy savings of around 30 per cent can be achieved by ensuring that only the required level of light is being delivered at any one time. This is achieved by – in addition to responding to daylight levels using more sophisticated photosensors – using radar to monitor traffic flow on roads, which enables large portions of street lights to be dimmed at quieter times.

'When our systems use radar sensors to dim lights on a highway if a stretch goes quiet, it does so gradually over a period of time, so much so that if you had no prior knowledge of it you wouldn't know it was happening – the adjustment is made very gently so as not to distract anyone.'

While LEDs are more efficient and much less prone to faults than traditional street lights, they are known to decrease in brightness over time – by approximately 20 per cent over the course of 25 years, according to Day. Adding smart capability, rather than sending out crews to replace the degraded lights, enables street lights to alter their output to match this natural degradation. 'As a result, LED street lights often begin at 85 per cent power capacity, and as they degrade over the years their power usage is increased to maintain their brightness,' Day explained.

The multiple savings in energy and maintenance enabled by using a smart lighting system allow it to pay for itself in approximately four to six years, according to Day.

Telensa's own smart light offering, the Public Lighting Active Network (shortened to PLANet), consists of three components and offers complete control of a city's street lighting. The first component is the Telecell, a small, wireless node that fits onto the top of each street light and acts as an energy measuring and compute device that monitors and controls all the light's operations.

The second PLANet component is a laptop-sized base station that fits to the pole of a central street light and connects to up to 5,000 surrounding Telecells within a 10-mile radius. The third component is a cloud-hosted central management system that provides a complete map-based view of all the street lights in the smart network and enables complete remote control of them through functions such as manual dimming, automated timed dimming, activation time adjustment, fault reporting and faulty component flagging.

Currently Telensa's technology controls approximately 1.5 million lights worldwide, with its biggest project taking place in the US state of Georgia. 'That is the biggest smart street light system in the world,' commented Day. 'Telensa's systems are also in control of one in every 10 street lights in the UK. We cover entire counties and whole metropolitan boroughs, as well as some highways.'


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Raman healthcare vision

Mark Venables reports on the work being carried out to get Raman spectroscopy into clinical laboratories and operating rooms, where it could improve disease diagnosis

Raman spectroscopy is a non-destructive chemical analysis technique that is well-established in various fields such as pharmaceuticals, life sciences, carbon materials and geology and mineralogy.

Because it allows for label-free characterisation of biochemistry without damaging samples, it has enhanced many areas of biology research. However, Raman spectroscopy has not yet made its way into hospital laboratories, which, if made possible, could potentially transform clinical diagnostics.

Researchers from the Leibniz Institute of Photonic Technology (IPHT) in Jena, Germany, are developing tools that could allow human tissue to be analysed on a cellular level, without the need for a biopsy. This could provide surgeons with a means to distinguish between cancerous and non-cancerous tissue without having to wait for separate laboratory analysis of tissue sample. The instruments would complement existing pathological techniques, allowing for more reliable and faster disease diagnosis.

Getting Raman-based techniques into the clinic has many difficulties, including ease of use, sensitivity, standardisation and making sure the techniques can

be integrated with existing methods.

'Many of the techniques being employed in clinical applications today have been well-established in chemistry and physics circles for decades,' Dr Sarah Locknar, staff scientist and technical business development manager at Omega Filters, explained. 'The biggest barriers are familiarity with the techniques, which are not necessarily known by most biologists, and establishment of validated protocols that use the techniques and have been proven effective by comparison with known standards.'

Although the potential of Raman-based methods in clinical diagnostics has been proven in many studies, there needs to be more thorough research, added professor

"The biggest barriers are familiarity with the techniques, which are not necessarily known by most biologists"

Fiona Lyng, of the Centre for Radiation and Environmental Science (RESC) at Dublin Institute of Technology. 'Most of the studies published to date have used small sample sizes so these need to be increased to really show the potential for clinical diagnostics,' she said. 'Standardisation is important for sample preparation, spectral acquisition, data pre-processing and data analysis, so that multi-centre trials can be carried out.'

Lyng pointed to work by the European project, Raman4Clinics, addressing these standardisation issues for Raman spectroscopy. The programme is funded by Cost – European Cooperation in Science and Technology, a framework supporting trans-national cooperation among researchers, engineers and scholars across Europe.

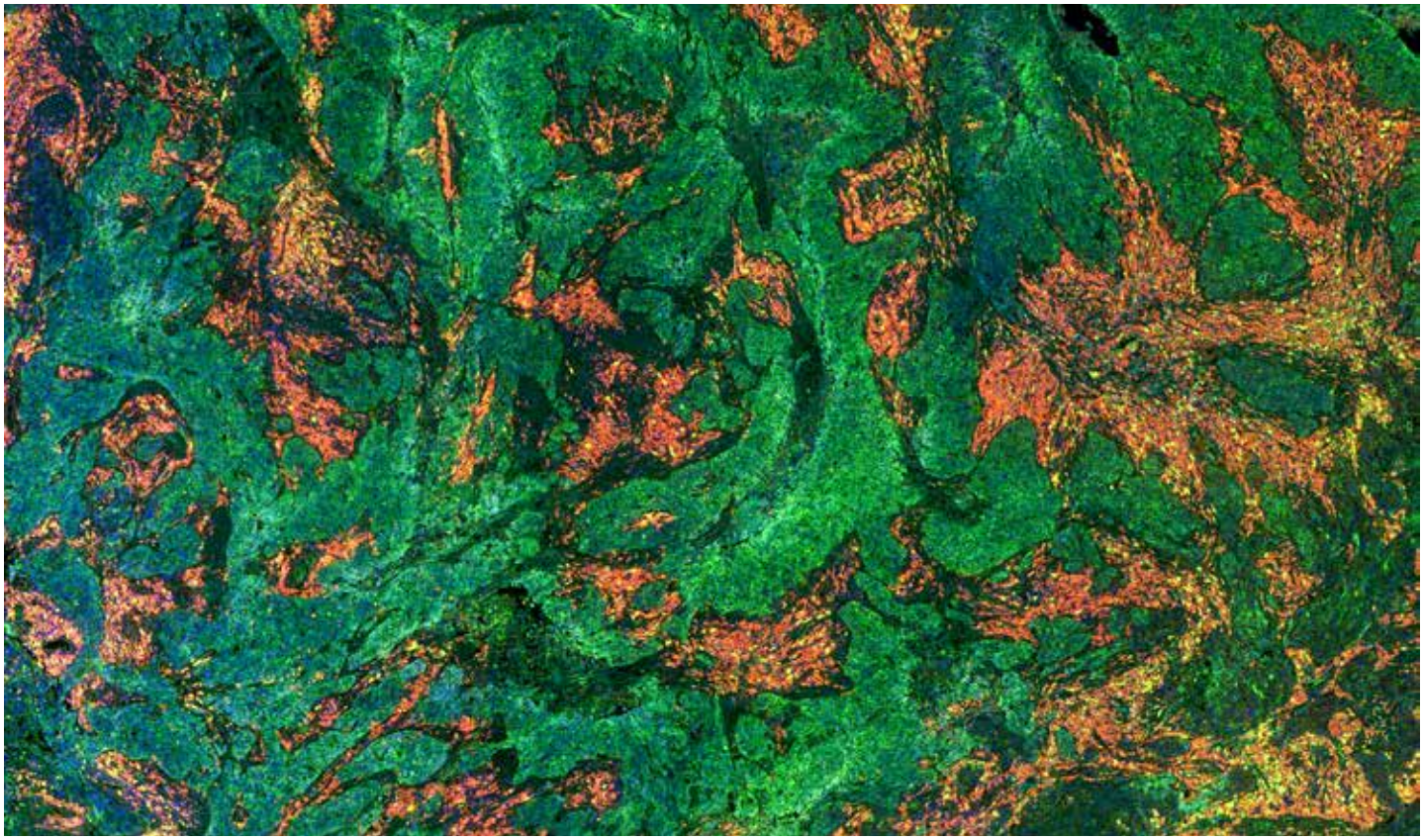
Raman4Clinics fosters collaboration between biophotonics research clusters and physicians or clinicians. 'It advances the conversion of scientific findings into clinically relevant, practicable and economically feasible diagnostic methods and systems, setting up a technology portfolio based on Raman spectroscopy,' Lyng said.

One of Raman4Clinic's research projects involved a clinical utility study of Raman spectroscopy for cervical cancer screening on Pap smear samples from 1,000 patients. This is funded by the Health Research Board in Ireland and carried out in partnership with the Coombe Women and Infants University Hospital.

'We are also extending this work on cytopathology to other cancers, such as oral, lung and thyroid cancer,' commented Lyng.

Raman in pathology

Researchers from IPHT, led by scientific director professor Jürgen Popp, are developing Raman approaches that could provide rapid, non-invasive →



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→ pathological analysis of cells and tissues as surgeons operate.

'We have developed a compact laser-scanning microscope aimed at the label-free and fast intraoperative online analysis of tissue sections for histopathologic assessment of disease-associated molecular changes,' said Popp.

For example, the spectroscopic method will allow tissue samples to be analysed to determine tumour type and grade, and provide reliable delineation of tumour margins.

Currently, pathological staining procedures represent the gold standard for the detection of tissue pathologies in biomedicine. However, tissue staining is constrained to *ex vivo* investigations only, and the imaging speed and number of molecular labels are limited. In this context, Raman spectroscopy could enable minimally invasive and label-free imaging of a wide range of specific molecular structures.

"CRS enables the label-free detection of changes in tissue composition and morphology based on virtually any molecular marker at high speed"

IPHT's work focuses on the development of sensitive spectroscopic technologies that will work with pathological staining protocols and can serve as a screening tool in future clinical routines, reducing the pathologist's workload.

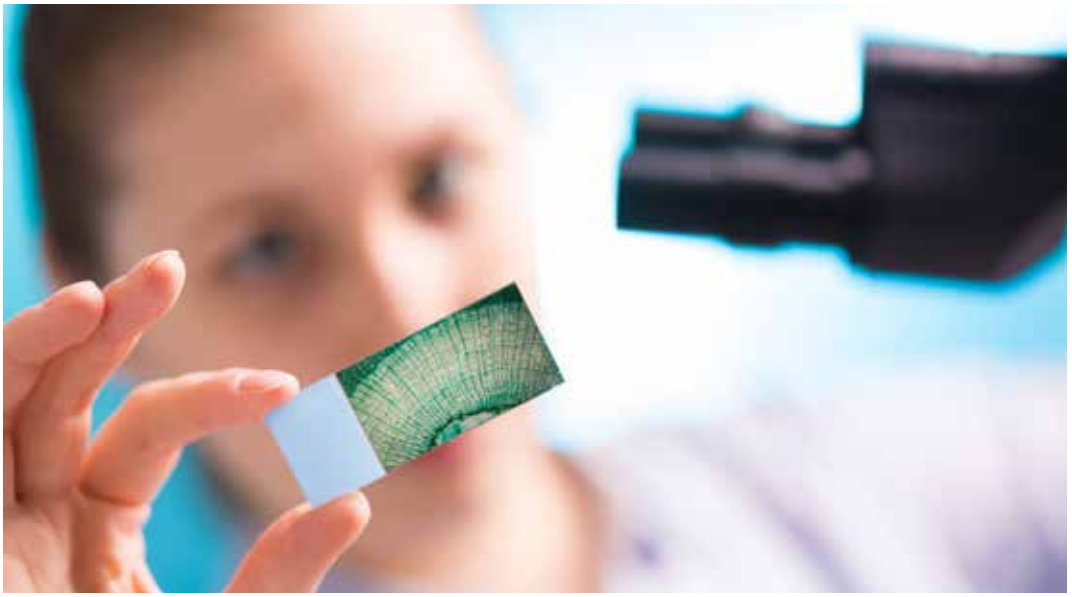
While the advantage of Raman spectroscopy is its high specificity, it suffers from its poor sensitivity, which can be overcome by using non-linear coherent Raman scattering (CRS), Popp explained: 'In particular, in combination with further non-linear spectroscopic imaging modalities [such as] two photon excited fluorescence (TPEF) and second harmonic generation (SHG), CRS enables the label-free detection of changes in tissue composition →

Confocal fluorescence imaging for breast cancer diagnosis

The translation of biophotonics technologies into clinical environments requires collaboration between research and industry. Optical filter manufacturer Omega Optical is working with the University of Vermont on testing the feasibility of confocal fluorescence imaging for diagnosing breast cancer.

'We are trying to determine if we can use intrinsic fluorescence to distinguish healthy from cancerous or precancerous tissues at the microscopic level,' said Dr Sarah Locknar, staff scientist and technical business development manager at Omega. 'The design of the system makes it ideal for imaging of fluorescently labelled tissue as well, although few fluorescent labels are FDA-approved at this time.'

The system uses a pulsed laser beam to excite the sample in a raster pattern, while the fluorescence and reflected laser signal are directed through a series of short wavelength reflectors positioned on the ends of optical fibre tips and then into a single high gain, high bandwidth PMT. This design allows for the detection of up to 14 channels (a combination of reflected and fluorescent channels) within 2.5 microseconds per pixel. 'We have also demonstrated the system as a detection scheme for flow cytometry,' Locknar continued. 'This would introduce a new method of imaging flow cytometry which would provide an alternative for the time-delay integration on a CCD detector already on the market. Our system provides a larger number of channels in a robust optical system that is relatively small, portable and resistant to vibration, given the reliance on optical fibres instead of free-space optics.'



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→ and morphology based on virtually any molecular marker at high speed, ideally suited for intraoperative histopathology.'

Traditionally, Raman techniques require complex, maintenance-intense and expensive instrumentation, which hinders the routine application of multimodal non-linear imaging in biomedicine.

Hence, to allow for clinical translation, IPHT's tool is a highly integrated, multi-contrast non-linear microscope, which involved the development of a novel high-power ultrashort fibre laser source that can be used for 24/7 maintenance-free operation.

The instrument's operation was intentionally kept simple for use by pathologists and surgeons. It can complete the results from established staining procedures by complementing images of the distribution of specific molecular targets in tissue, providing a label-free all-optical pathology of tissue specimen.

'This microscopic platform can be combined with laser tissue ablation for tissue-specific laser surgery,' Popp explained. 'The specific detection of malignant tissue during curative surgery is the most important precondition for complete tumour removal.

'To further extend the applicability of this multimodal imaging approach for *in vivo* tissue screening of difficult-to-access body regions, an imaging fibre probe has been recently developed.

"Optical spectroscopic approaches have proven their potential to certain diagnostic issues in numerous proof-of-principle tests; however, their actual effectiveness needs now to be tested under routine clinical conditions"

'Currently, we have achieved a stage of development beyond mere basic feasibility. However, we are far from being integrated into routine clinical diagnostics. We currently pursue this important goal – the translation of our approaches into clinical diagnostics.

'In other words, optical spectroscopic approaches have proven their potential to certain diagnostic issues in numerous proof-of-principle tests; however, their actual effectiveness needs now to be tested under routine clinical conditions in patients, or samples in the form of comparative studies.'

Popp added that the developed spectroscopic approaches need to be evaluated on a broader patient cohort in a multi-centre preclinical study to account for inter and intra patient variations with respect to the histopathological gold standard. In addition, the techniques need to be certified, which requires the support of industry or appropriate funding.

Finally, yet importantly, physicians, in particular pathologists, need to be convinced of the usefulness of the new approaches to complement their established gold standard devices. In parallel to clinical studies, negotiations with health insurance concerning reimbursement arrangements of costs are required.

Although it is clear that further research and development and industry support is needed before Raman-based approaches exist in clinics, the benefits are numerous.

With point-of-care diagnostics becoming ever more important to deal with global healthcare challenges, Raman methods provide a promising way of reducing the time and costs associated with current diagnostic techniques, whilst improving reliability. **EO**

Gateway to what's new at Golden City

San Francisco again hosts two major international exhibitions to start the year – the Bios Expo on 27 and 28 January, and the Photonics West exhibition from 30 January to 1 February – which will showcase the latest photonics components and systems. We preview some of what to expect at the event

Avantes will feature its expanded line of compact spectrometers at booth 1815, which includes the first-ever CMOS spectrometer with a 4,096 pixel detector. The Mini4096CL has both speed and sensitivity packed into a small footprint. Like all other AvaSpec instruments, the Mini4096CL is affordable, compact, and ideal for OEM integration. The spectrometer permits less than 0.2 per cent stray light and delivers a signal-to-noise ratio of 319:1.
www.avantes.com

At Photonics West the **Berliner Glas Group** will feature its entire line of solutions for various market segments at booth 1141 and Bios booth 8556. Key components such as aspheres and large cylinder lenses will be shown in addition to beam splitters, lenses and other optical systems.

One highlight will be a new RGB LED light source module that provides bright light through small light guides. Up to 40 lumens can be emitted from one fibre with a diameter of 0.7mm. This development is therefore suitable for ophthalmology and other diagnostic procedures for which clear, bright, and high-contrast illumination is essential.
www.berlinerglasgroup.com

Crystalline Mirror Solutions merges compound semiconductor materials with super-polished optics to create semiconductor supermirrors.

Via MBE, the highest-quality GaAs/AlGaAs Bragg reflectors are grown. The epilayers are then extracted from their native GaAs growth wafers and transferred to bulk optical substrates.

Crystalline's direct-bonding process enables single-crystal multilayers to be combined with a variety of dissimilar materials and geometries – including substrates with a radius of curvature >1cm for diameters up to 20cm. The result is the best mirror possible on the ideal substrate, with centre wavelengths spanning 0.9µm and reflectivities >99.99 per cent.

In the near-IR, scattering and absorption losses can be <5ppm and Brownian noise is reduced by up to a factor of 10. When paired with thermally-optimised substrates (e.g. SiC and diamond), the superior thermal conductivity of the coatings – 30 times greater than traditional sputtered films – redefines the performance metrics of optics for high-power laser systems
www.crystallinemirrors.com

A new laser attenuator has been developed, which utilises an ultra-hard coated, Laser Optical Multilayer Attenuator (LOMA) filter from **Delta Optical Thin Film**.

The laser attenuator enables computer-controlled attenuation of a monochromatic light source from 1 to 99 per cent within the wavelength region of ~ 550-1,000nm. It provides the user with safe, repeatable, and real-time control over the attenuation by combining the LOMA filter with a linear drive, controlled electronics, and dedicated software.

This filter is based on an optical thin film coating that works on reflection, unlike other filters that work on absorption. This feature allows the LOMA filters to withstand high laser power, as it attenuates the laser with no absorption of the input power.

The laser beam is transmitted without distortion of the beam profile, and no extra optics are required. No pulse broadening is observed, even with short laser pulses down to 70fs. The optical coating works independently of polarisation, and it is designed for a wide range of laser wavelengths between 550 and 1,000nm.
www.deltaopticalthinfilm.com

Dover Motion will be at booth 4030 showcasing its low-cost, direct drive technology for optical imaging and precision

Cobolt, a part of Hübner Photonics, will highlight new wavelengths of 457nm, 473nm, 515nm, 660nm and 1,064nm on its 08-01 series, complementing the already available wavelengths of 405nm, 532nm, 561nm and 785nm. The 08-01 series of single frequency and narrow linewidth lasers are ideal for Raman spectroscopy.

The 08-01 series consists of high performance, ultra-compact, single longitudinal mode (SLM) diode pumped lasers (08-DPL) up to 400mW and narrow linewidth diode lasers (08-NLD) up to 500mW, all having very good wavelength stability and spectral purity. With integrated electronics, an integrated optional optical isolator and clean up filter, the lasers from the 08-01 series are easily integrated into high-end, Raman-based systems or other analytical instrumentation.

All Cobolt lasers are manufactured using proprietary HTCure technology, and the resulting compact hermetically sealed package provides a very high level of immunity to varying environmental conditions along with excellent reliability.
www.coboltlasers.com

focusing instruments, such as the new DOF-5 objective focusing stage. The firm's direct drive stages offer high-precision, high-reliability and smooth operation for applications including microscopy, metrology, and digital imaging.
https://dovermotion.com

Edmund Optics will be exhibiting at booth 823 with a strong focus on laser optics, showcasing its new Nd:YAG laser line mirrors at UV wavelengths, divergence adjustable beam expanders and monolithic reflective beam expanders, in addition to a selection of its regular portfolio.

Also at the booth will be product expos on a UV laser materials processing system, drone-based imaging for analysing the health of crops, well-plate inspection for advanced medical diagnostics and an exhibit visualising the firm's manufacturing capabilities.

The company will also be at Bios, booth 8620, where it will present products specifically addressing the life science market.
www.edmundoptics.eu

Emberion (booth 4365) will show new nanotechnology-based infrared detectors for the visible to shortwave infrared (VIS-SWIR) wavelength range. It will present a linear array for spectroscopy and a single pixel detector module with digital output.

The company is developing a VGA imager suitable for night and machine vision as well as hyperspectral imaging, and a linear array (1 x 512 pixels) detector for spectroscopy. These VIS-SWIR arrays have a competitive cost structure compared to existing products, thus enabling wider adoption of sensor and imaging technologies in existing and emerging application areas.

Additionally, Emberion is developing an ultra-sensitive uncooled bolometer array for thermal imaging, which has a competitive thermal resolution and sensitivity comparable to current cooled detector performance.

Emberion's nanotechnology-based uncooled single-pixel VIS-SWIR detectors provide superior responsivity with low noise over a broad spectral range (initially 400-1,600nm) on a single detector chip. The sensors are suitable for various applications including chemical and gas sensing, portable material analysis solutions, and optical power meters.
www.emberion.com

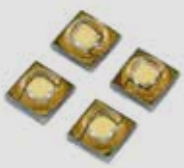
The laser diode module for 3D vision systems to be showcased by **Frankfurt Laser Company** from its HAML-F series is compact, reliable and delivers a highly uniform and stable line output beam. It comes in visible and IR wavelengths with up to 100mW power output and is graded at IP67 for industrial protection. Available with special features such as digital and analogue modulation, different beam shapes and power adjustments, the HAML-F can be used in a wide range of applications.
www.frlaserco.com

At booth 4629-27 **Fraunhofer ILT** will be exhibiting new laser optics with diamond lenses that have enabled the institute to produce a laser cutting head that is 90 per cent lighter than comparable components using glass lenses. Used with a 1kW fibre laser, the diamond lenses allowed 1.5mm stainless steel to be cut without any difficulties in a 2017 trial.

Fraunhofer ILT will also present the Future Laser System, or FULAS for short, which it intends to act as a foundation platform for future laser and optical systems for the aerospace industry. FULAS not only features space-grade components, it also comes with semi-automated assembly technology. The FULAS demonstrator passed environmental qualification tests conducted →

At booth 1031, **Excelitas Technologies** will show several new optoelectronics products, including the new ApoLED customisable single-chip LED package for surgical and dental lighting. ApoLED allows customers to select a specific white colour temperature while achieving high colour rendering index (CRI) for improved visualisation of tissue during surgery or other medical procedures.

Its customisable LED package can be used with any LED chip commercially available (monochromatic colours from 395 to 1,050nm or white from 2,500 to 7,000K), and is small enough to enable high-quality colour mixing for surgical lighting. Users can achieve high-colour rendering with tunable colour correlated temperature (CCT) from 3,300 to 6,000K.



ApoLED's high CRI offers the widest colour spectrum possible, allowing surgeons and dentists to select the optimal white color for their needs. Lens or no-lens options support optical engineering design choices to optimise light capture.
www.excelitas.com

→ in Airbus Defence and Space's climate chamber. Researchers are now developing and building the beam source for the Merlin satellite mission.

Lastly, the institute's new diode laser technology for energy-efficient materials processing developed in the 2016 Bridle project will be shown. The institute built a demonstrator that successfully coupled five wavelengths from different emitters on one bar into one 35µm fibre. Its output power is 46W, but various options allow for further scaling. Another system with around 800W output from a fibre with a core diameter of 100µm has also proven its merits in cutting tests.
www.ilt.fraunhofer.de

Gentec-EO's product line, some of which will be on display at the show, includes a complete range of laser power and energy meters, photo detectors, broadband pyroelectric detectors, terahertz detectors, OEM detectors and beam diagnostics. This year the company introduced new wireless laser power detectors, M^2 beam diagnostics, and Pronto HP power meters.

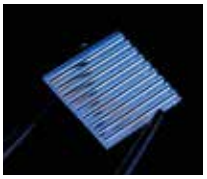
www.gentec-eo.com

Holoeye will showcase its GAEA-2 phase modulator models that are based on reflective LCOS microdisplays with a maximum resolution of 4,160 x 2,464 pixels and small 3.74µm pixel pitch.

It offers a display size of 0.7 inches (15.32 x 9.22mm), a fill factor of 90 per cent, a maximum spatial resolution of 133.5lp/mm, an input frame rate of 60Hz at 3,840 x 2,160 pixels or 4,000 x 2,160 pixels, and an input frame rate of 58Hz at 4,160 x 2,464 pixels.

The GAEA phase modulator series covers different versions optimised for different applications and wavelength ranges. Currently the GAEA-2 series includes a version for the visible (420-650nm), a version for the NIR (650-1,100nm) and a version for the typical telecommunication wavelength between 1,400-1,700nm (e.g. C-Band 1,550nm).
www.holoeye.com

Ingeneric will for the first time present its new micro-optics module 'C-SMDB', developed for the collimation of single-mode diode bars. The new monolithic cylindrical lens array achieves high degrees of collimation and is effectively double-sided, as the entry side collimates the slow axis of the emitted light, and the exit side collimates the fast axis.



The new array has a design wavelength of 970nm. The effective focal length of the fast-axis collimation is 600µm with a numerical aperture of 0.8, the effective focal length of the slow-axis collimation is 190µm, and the pitch of the slow-axis collimation is 48µm. There are 200 lens elements on each part. The result is a back focal length of 179µm.

Ingeneric is also exhibiting its BeamProp 200 beam-shaping optics, a lens array that adjusts the beam parameter product of the fast and slow axis of high-power diode lasers. It is a key component for the fibre coupling of diode bars and for dense wavelength multiplexing.
www.ingeneric.com

Irisiome Solutions will exhibit a Manny laser for STED microscopy (depletion laser) at the French pavilion booth number 431. Staff members will be happy to demonstrate how easy it is to control the pulse duration, power and repetition rate through external electrical signals.

At Bios, Irisiome will exhibit on the shared Bordeaux laser cluster booth, La Route des Lasers et Hyperfréquences, at stand number 8440.
www.irisiome-solutions.com

Jenoptik will present its solutions for the digital world, healthcare and Industry 4.0 at Photonics West booth 1023 and Bios booth 8513.

Four new completely fused silica F-Theta objective lenses, a fused silica beam expander for high-power laser applications, and three new standard F-Theta lenses will be on display. The new designs boast improved VIS performance for monitoring manufacturing processes in the range of 1,030-1,080nm. In the 500-680nm range, lens transmission measures over 85 per cent and enables direct process monitoring through a simple combination of image sensor and filter. With a coating for 900-1,100nm instead of the previous 1,030-1,080nm, Jenoptik's new Silverline lenses for the NIR range are especially suitable for the broader spectra that are typical of diode lasers.

Also on display will be the firm's new 1x-8x motorised beam expander, which simplifies production steps in laser material processing. The expander is offered for wavelengths 355nm or 1,030–1,080nm. The expansion can be continuously adjusted from 1x to 8x using software commands.

The Jenoptik 25mm f/2, 400–1,700nm hyperspectral lens will also be shown, which maximizes the performance of many popular SWIR and hyperspectral cameras. A broad spectral range of 400–1,700nm combined with an adjustable diaphragm makes the new lens very versatile.

Lastly, Jenoptik will exhibit its range of enhanced diffractive optical elements (DOEs). Thanks to high uniformity, precise control of the diffraction orders, and reduction of the zeroth diffraction order, Jenoptik's beam shapers and splitters are key elements for boosting welding, dicing, ablating and drilling →

Startup Challenge

The SPIE Startup Challenge, which takes place every year at Photonics West, invites new entrepreneurs to pitch their light-based technology business plan to a team of business development experts and venture capitalists.

The first-place winner will receive a cash prize of $10,000 provided by founding partner Jenoptik and $5,000 in products from lead sponsor Edmund Optics. Jenoptik also provides $5,000 for second place and $2,500 for third place, while supporting Sponsors Trumpf and Luminar fund other prizes in the competition.

Applicants selected to pitch at Photonics West are invited to attend an entrepreneur boot camp for training, networking, and refining their business plan. The best pitch presenters receive cash prizes and are provided support to attend additional entrepreneurship training to continue refining ideas and make further contacts with experts.

All applicants will have their written application evaluated by a team of expert judges, which select around 20 semi-final pitches that will enter the live pitch round of the competition from the initial pool of applicants. The applicants are divided among three tracks.

The semi-final round will take place on Tuesday 30 January and is open to all Photonics West attendees. A panel of judges, different from the initial pool, will select the top six presenters – two from each track – who will go on to the final competition on Wednesday afternoon.

The final round will occur in public on Wednesday, 31 January, in Room 21 of Moscone Center North. Judges will decide the top three pitches and announce the winners shortly after the last presenter has finished.

Winning projects in the 2017 SPIE Startup Challenge were:

- A laser-activated nanodevice to deliver gene therapies to cells to cure viral or genetic diseases that affect the blood, from Cellino Biotech,
- A device enabling blind or visually impaired people to "see" by translation of visual information captured by a camera to spatial tactile stimulation of the cornea, from IC Touch,
- High-performance, low-cost OCT imaging devices for use by independent healthcare providers, from Lumedica.

New White Papers now available online

Challenging the Limit of Detection of Compact Spectrometers

By Wasatch Photonics

Traditional thinking is that compact spectrometers do not offer the sensitivity or speed needed to compete with benchtop fluorimeters for many fluorescence measurements. We explain how limit of detection (LOD) and limit of quantitation (LOQ) are defined and measured, and challenge that preconception by demonstrating picomolar LOD for fluorescein with a compact, cost-effective spectrometer capable of capturing 50 ms scans with ease.

Mission Impossible? Measuring Signals Below the Noise Floor with a Lock-In Amplifier

By Ophir

Measuring optical signals in the femtowatt (10-15) to nanowatt (10-9) range can be a daunting task. In order to achieve significant improvements in noise rejection we need to turn to a lock-in amplifier, which can improve noise rejection by 3 orders of magnitude or more.

Monitoring water quality with fluorescence spectroscopy

By Edinburgh Instruments

Fluorescence spectroscopy has been used to characterise natural organic matter (NOM) in water. Excitation-emission maps reveal the nature and concentration of NOM in river water and can be used as a routine analysis technique in water treatment facilities.

Tunable lasers at work with trapped ions

By Hübner Photonics

Professor Tobias Schaetz from the Amo Research Group at the University of Freiburg, Germany describes the group's experimental work with trapped ion systems. Coulomb crystals consisting of isotopically pure Magnesium ions are built employing a new tunable continuous-wave (cw) laser light source: Mg atoms are isotope-selective ionized by resonant two-photon excitation at a wavelength of 285.3 nm.

*Registration required

Electro Optics

www.electrooptics.com/whitepapers

→ processes. Customised DOEs are available in small to high volumes, from UV to IR and from low to high power applications.
www.jenoptik.com

Safety experts **Lasermet** will be on the UK Pavilion (booth 5137 to 5145) to discuss any client laser safety needs. Ask about the company's modular 'Laser Castle' laser safety cabin, its 'Laser Jailer' active laser guarding, the latest laser safety interlock control systems – conforming to laser safety standards Z136.1 and IEC 60825 – personnel laser protection and laser safety calculation software. Lasermet also manufactures laser blocking curtains, screens and roller blinds, laser warning LED Signs, and designs and install complete laser safety systems.
www.lasermet.com

The venteon ultra laser system from **Laser Quantum** provides an integrated DPSS pump laser in a novel monolithic housing. It is designed and optimised to offer the shortest available pulse durations, delivering >240mW of sub-5.5fs short laser pulses directly out of the box (>3nJ at 80MHz repetition rate), with a spectral bandwidth ranging from 600nm to 1,200nm (at -10dBc) translating to sub-5fs FTL. Due to this octave spanning output spectrum, the venteon ultra can be used for direct CEP stabilisation without any additional spectral broadening.

The venteon ultra is an ideal laser for two photon microscopy due to its ultra-short pulses and broad spectral output, making it able to excite multiple fluorophores without tuning.

Visit Laser Quantum on the Novanta booth 731 to find out more about the venteon ultra.
www.laserquantum.com

Lasos Lasertechnik will showcase its entire range of light source solutions – from single components to flexible systems at booth 1315 and Bios booth 8542. The firm's wide product portfolio includes gas lasers, diode-pumped solid-state lasers and laser diode modules.

Particular product highlights include: the Lasos System series of flexible and modular multi-laser-solutions, featuring new compact field-upgradeable MultiColorSystems for life science applications; the compact, stable and long living Lasos XT laser series, featuring new solid-state lasers with modulation capability for applications in biophotonics; and the Lasos He-Ne laser series, featuring He-Ne laser modules and tubes for ultra-precise metrology.

The modular design of Lasos lasers and systems guarantee a rapid and simple integration into OEM instruments as well as flexible laboratory operation.
www.lasos.com

Industrial and scientific metal laser mirror manufacturer **LBP Optics**, together with its new owners ULO Optics, will be exhibiting at booth 5137.

LBP Optics will be exhibiting a range of precision metal mirrors, including gold coated copper and aluminium. LBP mirrors are chemically polished to a super-smooth finish, and examples of these fully tested, super-polished metal substrates ready for coating will be on display at the booth.

ULO Optics will be showcasing its new Compact2 range of CO_2 beam delivery equipment in addition to the first of its range of fused silica collimators for fibre lasers. Compact2 is a cost-effective, low maintenance, modular solution to CO_2 beam delivery. Offering twice the power handling of the existing Compact range, the Compact2 range is suited to lasers up to 1kW with beam sizes up to 38mm.
www.lbp.co.uk
www.ulooptics.com

Lew Techniques will be showing its capabilities in the precision custom manufacture of submounts and carriers for laser diodes, laser bars, laser stacks and photodiodes.

Product types include tungsten/copper (WCu) submounts with super-sharp edges (<5µm radius), allowing precise mount-edge positioning of laser diodes. WCu inserts brazed to solid copper bodies maximise heat-sinking, while minimising expansion mismatch between carrier and laser die.

Submounts in aluminium nitride (AlN) with photo-patterned metallisation provide high-precision circuits. Metal structures can be tailored to meet individual requirements for soldering, wire bonding, electrical and thermal performance.

WCu- and AlN-style mounts selectively coated with a thin layer of AuSn solder allow accurate and consistent mounting of the laser die. Strict maintenance of metal coatings and solder alloy consistency ensure optimum reflow results.

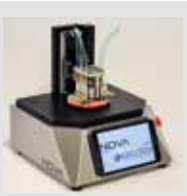
Mounts for photodiodes on ceramics with wrap-over conductors are also available. Circuits can be defined on multiple faces allowing greater interconnect flexibility, and ceramic can be precision-machined for the greatest functionality.
www.lewtec.co.uk

KrellTech will be exhibiting its line of fibre optic and photonic polishing equipment at Photonic West (booth 4322) and introducing the Nova system.

Maximum flexibility for optical surface processing is now available with Nova. KrellTech has integrated the proven performance and features of its Scepter, Trig and FLex polishers into this configurable and cost-effective system.

Nova supports a variety of polishing applications from connectors to waveguides, and bare fibres to custom components. Nova is scalable for R&D projects, high-volume production, and the rigours of high-reliability field installation.

Wireless tablet control with a familiar Android interface provides the programming flexibility required for research, as well as simplified step-by-step operation for manufacturing technicians. Workholder fixtures are easily interchangeable for each task, and optional videoscopes are available for real-time process monitoring and in-line surface inspection.



Whether developing new optical devices, improving component performance or manufacturing Telcordia-compliant cable assemblies, Nova is the ideal polishing system.
https://krelltech.com

LightPath develops, designs and manufactures infrared optics made from moulded BD6 chalcogenide glass, which is ideal for use in MWIR and LWIR thermal imaging systems.

Advantages of LightPath's BD6 include high transmission, low cost and weight, optical athermalisation, as well as being able to be moulded, polished or diamond-turned, and featuring no germanium content.

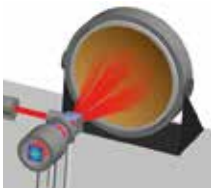
LightPath's high volume production experience brings expertise and knowledge

to customer projects as quantities for infrared optics continue to grow.
www.lightpath.com

Ondax will be exhibiting its new Mini-BT series wavelength stabilised lasers that are ultra-compact, easy to use benchtop solutions for the lab. Incorporating an Ondax SureLock VHG-stabilised laser diode, the Mini-BT delivers steady, high-power, spectrum-narrowed performance. Featuring both a touchscreen and easy-to-adjust manual power controls, the fibre-coupled output delivers better than 1 per cent power stability and less than one minute warm-up. Delivering extreme temperature insensitivity, these lasers are perfect for lab users or OEMs doing Raman spectroscopy, metrology, or other optical analysis where stabilised wavelength performance is needed. They are available in wavelengths from 405nm to 1,064nm.
www.ondax.com

Ophir will be displaying the BeamSquared, an M^2 laser beam propagation system designed to help users optimise laser performance. A robust, portable device, BeamSquared automatically measures the propagation characteristics of CW and pulsed lasers in less than a minute. It can optionally measure wavelengths above 1.8µm in manual mode, including CO_2 and terahertz. BeamSquared is designed for continuous use applications, from scientific research to rapid prototyping, fabrication and machining.

The system includes BeamSquared M^2 software and an optical train. The software measures beam propagation characteristics on both the X and Y axes, including waist diameters, full angle divergences, waist locations, Rayleigh lengths, M^2 or K and BPP factors, astigmatism and asymmetry. The system displays 2D or 3D beam profiles for visual verification of beam behaviour through focus.
www.ophiropt.com



Photon Engineering will be debuting 'FRED MPC', the new version of its FRED optimum optical engineering Software that offers exceptional capability in optical design and analysis.

FRED MPC enables users to predict performance with a higher level of confidence by tracing orders of magnitude more rays through optical systems. It also allows users to experiment by varying more parameters to find their optimum hardware configuration, as well as investigate a larger trade space in a fraction of the time, and run more analyses at higher fidelity than before.
www.photonengr.com

PicoQuant will be showcasing its latest innovations in picosecond pulsed diode lasers for single photon counting, microscopy and spectroscopy applications at booths 306, 4853 and 4859. The highlights at the exhibition will include the high-power pulsed laser VisIR/VisUV platform with the new wavelengths 266, 280, 295, 532, 560 and 590nm, as well as PicoQuant's new quantum correlation analysis software QuCoa. →

At booth 723, **Ocean Optics'** Ocean FX versatile spectrometer will be on show, distinguished by an acquisition speed of up to 4,500 scans per second, onboard processing for favourable SNR and reduced transfer time, and robust communications via USB, Gigabit Ethernet and Wi-Fi. The Ocean FX is an ideal choice for high-speed process applications, measurement of transient events and reaction monitoring.

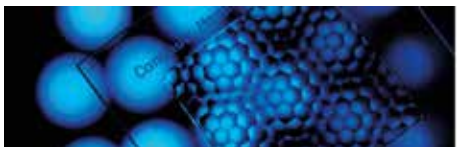
The Ocean FX is available in application-ready, custom and OEM spectrometer configurations. The spectrometer can be integrated into other devices as a component, subassembly or turnkey solution. It is well suited for environments where fast sampling rates are necessary, such as monitoring sample colour, quality and other characteristics on a process line.

In addition, the Ocean FX's integration periods can be as brief as 10µs, effectively managing saturation intensity when measuring high-intensity sources and plasmas. The Ocean FX acquires spectra with such speed that short-lived events can be measured confidently and otherwise undetected spectral effects made evident.
www.oceanoptics.com

→ The company will also be sponsoring presentations in the field of single molecule spectroscopy and super resolution imaging at the conference session BO503, where Nobel Prize winner Stefan Hell will also hold a talk focused on his most recent research.
www.picoquant.com

PowerPhotonic will be at booth 5137 presenting its range of high-precision micro optics.

PowerPhotonic manufactures a wide variety of freeform optics in UV-fused silica that exceed the demanding performance requirements of existing and emerging applications of laser systems. These applications include DUV illumination,



industrial metal cutting and welding, single mode telecommunications, skin and eye treatment and directed energy. PowerPhotonic's fabrication technology produces diffraction limited freeform optical surfaces that are able to handle very high power, whether CW or pulsed.
www.powerphotonic.com

Precision Glass & Optics, a provider of optical thin film coatings and custom optical solutions for a wide variety of life science and biomedical applications, will present a wide range of biomedical optical products at BiOS in booth 8648 and at Photonics West in booth 4867. Products will include plano optics, beamsplitters,

prisms, optical assemblies, windows, hot and cold mirrors, indium tin oxide, maximum reflectors, anti-reflection coatings, and customised optical solutions utilising a variety of shapes and substrate materials.
www.pgo.com

Princeton Instruments will introduce its Blaze spectroscopy CCD cameras at the show, featuring advanced new sensors with up to three times higher NIR sensitivity and low dark current, which make the camera exceptional for demanding applications such as Raman spectroscopy, fluorescence or photoluminescence. Blaze provides spectral rates of up to thousands of spectra per second. For low light applications, Blaze delivers true -100°C cooling for ultra-low dark current, ideal for long exposures.
www.princetoninstruments.com

Visitors to **Quantel**'s and **Keopsys**' booths (8742 and 417) will be able to see both groups' range of diode modules and laser solutions. Quantel and Keopsys groups are merging their resources into a new laser group to offer an extended product portfolio in addition to their existing laser solutions for a variety of application fields such as: biotech and medical, material processing, defence, scientific instrumentation, LIBS, laser pumping and fluid dynamics.

LIDAR de Dumont d'Urville © C. FRESSER-IPEV

Quantel and Keopsys are also consolidating their activities in the lidar application space, with a full range of solutions including: integrated high-power diode solutions for automotive and surveillance needs; ultra-compact fibre lasers for wind sensing, range finding and 3D scanning; high energy flash or diode-pumped solid-state lasers for atmospheric lidar and environmental measurements; and various customised solutions for defence, space and high-end applications.
www.quantel-laser.com

Ross Optical, a provider of precision OEM lenses and engineering services, will discuss the company's new super-polishing capability at booth 2541.

Ross Optical provides a wide range of catalogue optics above 100mm and down to 1.0mm, sourced through a global network of optical manufacturers. The company can also create custom lenses for a variety of OEM applications, from biomedical to machine vision and consumer electronics.

Ross now offers super-polishing of windows, mirrors, and other flat optics. This

Conference details

Talks by two Nobel Laureates will be among more than 5,200 technical presentations held alongside the Photonics West exhibition in San Francisco. The symposium is expected to attract an international audience of more than 20,000.

Conferences are organised into tracks on biomedical optics (BiOS), industrial laser sources and applications (LASE) and optoelectronics and photonic materials and devices (OPTO).

Stefan Hell (Max-Planck-Institut Göttingen) and William Moerner (Stanford University), who shared the 2014 Nobel Prize in Chemistry with Eric Betzig (Janelia Research Campus) for their work in ultrahigh-resolution fluorescence microscopy, will give details on the latest advances in the field.

A comprehensive training programme is set to offer more than 70 courses in lasers and applications, sensors, imaging, IR systems, and optical and optomechanical engineering, plus professional development seminars and industry workshops.

Receptions and other networking events will provide many opportunities to share ideas, connect around community issues such as diversity and inclusion, or to meet new potential collaborators.

HIGHLIGHTS

New among this year's 44 BiOS conferences – comprising 2,400 presentations – is the theme, 'Photonic Diagnosis and Treatment of Infections and Inflammatory Diseases'.

Nine talks in the popular BiOS Hot Topics session will cover topics such as biophotonics for low-resource settings (Katarina Svanberg, Lund University and Sune Svanberg, South China Normal University) and near-future developments in photodynamic therapy (Tayyaba Hasan, Wellman Centre for Photomedicine).

"A multi-speaker Neurotechnologies plenary session will include topics such as strategies for observing and controlling neural circuits and in-vivo imaging of the brain"

A multi-speaker Neurotechnologies plenary session will include topics such as strategies for observing and controlling neural circuits (Ed Boyden, MIT) and in-vivo imaging of the brain (Na Ji, University of California, Berkeley). Track chairs are David Boas (Martinos Centre, Massachusetts General Hospital, Harvard Medical School) and Raphael Yuste (Columbia University).

A Nano/Biophotonics plenary talk on shaped light will be presented by Kishan Dholakia (University of St Andrews, Scotland).

The Translational Research forum will present outcomes-based studies on technologies, tools and techniques with high potential to change the lives of patients. Organisers are Bruce Tromberg (Beckman Laser Institute and Medical Centre, University of California, Irvine) and Gabriela Apiou (Wellman Centre for Photomedicine, Massachusetts General Hospital, Harvard Medical School).

BiOS symposium chairs are James Fujimoto (MIT) and Rox Anderson (Wellman Centre for Photomedicine, Massachusetts General Hospital, Harvard Medical School).

technology can achieve extremely smooth surfaces on optics of various sizes (5 to 300mm in diameter) and materials (fused silica, silicon, Zerodur, and visible materials). Surface quality of 10^{-5} and surface roughness of less than 1 angstrom (0.1nm) are attainable.

Super-polished optics can help reduce light scattering in medical imaging, as well as in other applications and instruments.

www.rossoptical.com

F-Theta lenses are important in material processing applications like cutting, welding, ablation and many more. They are designed to focus laser beams down on a plane scan area with a consistent spot size. Additionally they are available at various focal lengths from UV to IR, and some even with telecentricity. **Sill Optics** presents the S4LFT4125/075 for UV lasers. The scan area has been improved from 35 x 35mm up to 50.5 x 50.5mm. Despite the higher focal length, a focal diameter of 8µm ($1/e^2$) can be reached inside the whole scan area with a 10mm input beam diameter. The lens is made of fused silica and is without internal or external back reflection focus points.

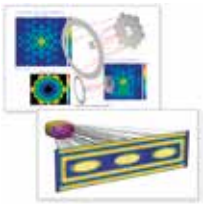
www.silloptics.de

Scanlab will be featuring its soon-to-be available intelliScanse 20 and 30 scan head systems, with 20mm and 30mm apertures for a larger working field. Their integrated digital encoder technology ensures the highest dynamics along with high resolution and long-term stability. These factors make the systems especially interesting for demanding applications such as 3D printing, micro-structuring and micro-processing. An attractive price/performance ratio also underscores the systems' suitability for efficient industrial usage.

The intelliScanse 20 and 30, both equipped with high-performance dynAxisse L galvanometer scanners, can fulfil the market's demand for large-aperture systems. These are designed to enable larger working volumes with unchanged spot sizes. The integrated digital se-encoder technology guarantees outstanding precision and dynamics, while enabling maximum throughput.

Scanlab will be located in the south hall, at booth number 2025.

www.scanlab-america.com



Synopsys' Optical Solutions Group (OSG) is a developer of optical design and analysis tools, with Code V imaging design software, LightTools illumination design software, LucidShape products for automotive lighting, and RSoft products for photonic and optical network design. →

Among the 900 presentations in the LASE conference will be plenary talks on laser frequency combs and dual-comb spectroscopy (Ursula Keller, ETH Zurich), optical lattice clocks (Hidetoshi Katori, University of Tokyo and Riken), and industrial laser systems and applications (Berthold Schmidt, Trumpf Photonics).

LASE symposium chairs are Koji Sugioka (Riken) and Reinhart Poprawe (Fraunhofer Institute for Laser Technology).

Highlighting 2,000 presentations in OPTO, plenary talks will cover silicon photonics (Andrew Rickman, Rockley Photonics), nanowire LEDs and diode lasers (Pallab Bhattacharya, University of Michigan), and photonics beyond the diffraction limit (Min Gu, RMIT University). There are three new conferences, on 2D Photonic Materials and Devices, Optical Data Science, and UltraHigh-Definition Imaging Systems.

OPTO symposium chairs are Connie Chang-Hasnain (University of California, Berkeley) and Graham Reed (Optoelectronics Research Centre, University of Southampton).

INDUSTRY FOCUS

Market trends and business opportunities will be explored in a variety industry-focused sessions, including: a conference on virtual, augmented and mixed reality technology challenges and successes, featuring Bernard Kress (Microsoft/Hololens) and Leo Baldwin (Amazon Functional Photonics); panel discussions on silicon photonics and photonic integrated circuits, 3D printing and other hot technology topics; updated SPIE analysis on the size of the core photonics market; tips on navigating the innovation ecosystem; the annual SPIE Startup Challenge pitch competition for pre-revenue companies; a Fast Pitch Lunch connecting entrepreneurs with potential investors and mentors; and a gala awards banquet where industry leaders will announce winners of the 2018 Prism Awards for Photonics Innovation.

Recruiters from more than 30 companies are expected at the SPIE Career Centre Job Fair (30-31 January).

→ At Photonics West, Synopsys will exhibit Code V, LightTools, and RSoft software solutions. Code V has powerful capabilities for lens optimisation, analysis, tolerancing, beam propagation and coupling efficiency.

LightTools is a 3D optical engineering and design software product that supports virtual prototyping, simulation, optimisation and photorealistic renderings of illumination applications.

RSoft products provide a full range of design, optimisation and planning tools for optical communications, as well as award-winning solutions for optoelectronics components and subsystems.

OSG is also an independent supplier of optical systems design services, with more than 5,000 completed projects in imaging, illumination, and optical systems engineering.

www.synopsys.com/optical-solutions

Visit Thorlabs (booth 807) to see a display of new products and manufacturing capabilities from across its portfolio of optomechanics, motion control, light sources, optoelectronics, optics, fibre, instrumentation, and imaging product lines.

Highlights from the mid infrared (MIR) selection include Thorlabs' supercontinuum source, winner of the 2017 Prism Award for Scientific Lasers. This first-to-market femtosecond-pumped supercontinuum source spans a wavelength range from approximately 1.3 to 4.5µm and emits more than 300mW of average power in a collimated beam. Additionally, the output noise is less than 0.025 per cent RMS. The low noise, high brightness, and laser-like beam performance of the supercontinuum source makes it ideal for environmental sensing, biological and chemical threat identification, absorption spectroscopy, and ultrafast spectroscopy.

www.thorlabs.com

Toptica Photonics will be at Photonics West (booth 4645), and at Bios (booth 8508) presenting its laser solutions for biophotonics.

With its broad product portfolio, Toptica offers all wavelengths, from deep-UV (190nm) to terahertz radiation (0.1THz, corresponding to 3mm). These lasers support a multitude of applications in microscopy, materials metrology and quantum technology.

One product on show will be the multi-laser engine iChrome CLE for biophotonics, providing 405, 488, 561 and 640nm with 20mW at the end of the fibre. The CLE is a cost-effective system for multi-colour microscopy applications. Even the 561nm light is generated by a laser diode instead of a solid-state laser, allowing this system to be directly modulated at high speed (1MHz) while maintaining complete-off, i.e. zero photons, in the dark state. The iChrome CLE is the latest member of Toptica's iChrome product line that also includes the powerful iChrome MLE (up to 100mW and four laser lines). All iChrome systems have a unified user interface, innnovative modulation features and Coolac, Toptica's automated beam alignment algorithm guaranteeing consistent power out of the fibre.

Advanced material inspection like near-field spectroscopy is possible with the FemtoFiber dichro midIR. This tunable, broadband mid-infrared laser (5-15µm) is suited to mid-infrared spectroscopy and near-field studies. It provides tunable broadband pulses with more than 400cm^{-1} bandwidth at 80MHz repetition rate. The FemtoFiber dichro midIR is the perfect tool for the chemical analysis of materials with nanoscale resolution.

www.toptica.com

Veeco's Spector-HT Advanced Ion Beam Sputtering System will be on show, offering excellent layer thickness control, enhanced process stability and the lowest published optical losses in the industry.

For cutting-edge optical interference coating applications ranging from bandpass filters to beam splitters and laser passives, the Spector-HT has been engineered to improve key production parameters. The Spector-HT gives manufacturers the qualitative advantages of ion beam sputtering technology in a more robust package.

www.veeco.com

Visitors to **VPIphotonics**' booth can learn about library extensions to VPIcomponentMaker Photonic Circuits, which provide circuit-level support of a Process Design Kit (PDK) for various integrated photonics technologies.

These pluggable toolkits support a cost-effective generic foundry approach for application-specific photonic integrated circuits design. Within this approach, the designer can choose photonic devices from a fixed list of so-called building blocks (BBs) supported by the individual foundry.

The seamless integration with photonic layout design tools allows users to specify physical locations and orientations of BBs of standardised PDKs on the final layout. Designers can gradually elaborate its layout, easily incorporating requirements such as adequate layout connectivity, packaging, and functional specifications.

VPIphotonics' integrated design solutions allow users to combine graphical schematic capture, including automated parameter sweeps and optimisation, as well as automated waveguide routing of PICs utilising any combination of different technology platforms.

http://vpiphotonics.com

S I Howard Glass, a supplier of glass substrates and fabrication services for the precision optics industry, will be exhibiting flat glass wafers, filters, windows and substrates at booth 4669.

The company is distinguished for its wide variety, large volume, and extensive selection of sizes and thicknesses of raw materials from prime glass manufacturer brands. These include Schott, Hoya, Corning, Pilkington, Glaverbel, Guardian, Saint-Gobain, and Euroglas. Howard Glass is able to deliver custom flat glass products, instruments, and parts with competitive pricing and short lead times.

In-house services available include glass fabrication, such as computer numerical control (CNC) milling and edging using Haas Automation and Blanchard equipment;

grinding and polishing with SpeedFam's double- and single-sided machines (up to 15 inches); scribe and break using TLC's Phoenix scribing machines; precision dicing utilising Kulicke & Soffa (K&S) and Disco equipment; frosting and sandblasting employing SpeedFam's single-sided lapping machines and large sandblast cabinet; drilling with Branson's ultrasonic drill; bevelling by hand and using ultra-precise CNC machinery; and tempering.

www.howardglass.com

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EOS NEWS

All the latest news from the European Optical Society
www.myeos.org

In memoriam: Professor Ionel Valentin Vlad

It was with great sadness that we learned of the passing of our dear colleague and friend Professor Valentin Vlad on 24 December 2017, in Bucharest.

Valentin was the president of the Romanian Academy of Science. He achieved international recognition for his research on information processing, holography and interferometry.

Valentin performed his studies in Bucharest and Paris from 1961 to 1970. After graduating, he started his research at the Institute of Atomic Physics in Bucharest, in the 'Optical Methods in Nuclear Physics' laboratory, where he developed the first solid active laser in Romania in 1968 (together with G Nemes) and was certified as a scientific researcher. He maintained positions as professor at several universities, set up and led several laboratories, and upheld a wide network of colleagues around the world.

Valentin had an endearing personality and was very approachable, which was facilitated by his perfect knowledge of Romanian, English, French, German, Russian and Italian. Conversations with him often included cultural references, demonstrating his sincere interest in the country of his interlocutor. He used his social and scientific skills in promoting the Romanian science culture with a spirit of collaboration and exchange. Valentin indeed travelled a lot, and spent multiple research stays in laboratories.

Valentin was also deeply involved in the European Optical Society and contributed to its development. He was the bridge between EOS and the Romanian Optical Society, holding a position on the board representing the Romanian Optical Society – a position he held until he passed away. In 2011, he became chair of the EOS scientific advisory committee, and entered the executive committee; two duties he carried out until last year. He also contributed to the revival of EOS' industrial advisory committee.

"He achieved international recognition for his research on information processing, holography and interferometry"

As part of his support of EOS, Valentin acted as an editorial member of its first journal, the *Journal of Optics A: Pure and Applied Optics*, from 1998 to 2006. In 2006, he became part of the editorial board for the *Journal of EOS: Rapid Publication*.

Valentin was an ambassador for Romanian culture and a dedicated promoter of EOS. We miss him.

A third way for hyperspectral imaging

Continuously variable bandpass filters offer a good middle ground for building hyperspectral imaging solutions, says Delta Optical Thin Film's Oliver Pust

Hyperspectral imaging has been used for a couple of decades in applications such as satellite imaging, air reconnaissance and other not overly price-sensitive markets. Classical hyperspectral cameras with gratings and prisms achieve the highest spectral resolution and are well suited for demanding applications in research.

An alternative approach comprises sensors that are coated at wafer-level with fixed wavelength bandpass filters. These sensors provide compact cameras, offer total flexibility with respect to filter pattern, and are readily suited for snapshot imaging.

A third approach is cameras based on continuously variable bandpass filters (CVBPFs),

"Filter designs are under development that cover 450nm to 950nm"

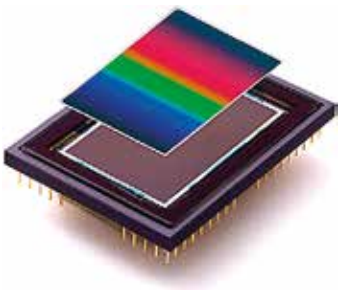
which combine high light efficiency, high signal-to-noise ratio and high spectral resolution with compactness and robustness.

Delta Optical Thin Film manufactures custom CVBPFs for mid-size and full-frame CCD and CMOS sensors. These filters offer very high transmission levels and are fully blocked in the light-sensitive wavelength range of silicon-based detectors (200nm to 1,150nm or higher).

The first filter from Delta that was used for hyperspectral imaging was a linear variable bandpass filter with a centre wavelength range from 400nm to 700nm. It was actually designed for a non-imaging application in an absorbance reader. Although it was not fully blocked in the silicon range and was rather large, customers saw its potential for HSI and used it to build prototypes and products. A second LVBPF extending the wavelength range to 1,000nm was developed and produced on customer request.

As a result of further customer projects, standard filters are available covering 450nm to 880nm and 796nm to 1,084nm, transmission is up to 90 per cent in some models, a blocking level of OD4, and sensor sizes range from 19 x 8mm to 32 x 18mm.

Delta's CVBPFs are thin film filters that are coated with silicon dioxide and metal oxides on a single fused silica substrate without the use of glue, colour glasses or thin metal layers. The resulting filters are very robust against environmental conditions like temperature and humidity, and are spectrally and mechanically stable. The



filters are ideally suited for long-term use in airborne or space applications without any degradation.

The filters can be mounted directly on top of, or close to, the sensor. Options include gluing onto the sensor surface, replacing the cover glass with the filter or a mechanical holder. The optical design does not require the use of a slit and light is collected through the full aperture of the lens. The deep broad-band blocking of the filter ensures a high signal-to-noise ratio and eliminates spectral crosstalk.

Without a slit, every acquired image shows the complete scene. This makes it possible to arbitrarily image the scene from different positions without the need for precise synchronisation of lateral movement and image acquisition, such as with the push broom technique. In addition, it is possible to construct a hyperspectral data cube using image pattern recognition techniques.

Filters that cover a larger wavelength range over a shorter length are desirable. Currently, filter designs are under development that, for example, cover 450nm to 950nm over 36mm with an exponential dispersion function.

www.deltaopticalthinfilm.com

Latest product releases

Midwest Optical Systems has designed two new triple bandpass filters for imaging vegetation from the air. The TB550/660/850 filter adds green to traditional red and NIR measurements.

Green, red and NIR wavelengths are used for applications where chlorophyll vegetation index (CVI), normalised green (NG) and other vegetative index monitoring is needed.

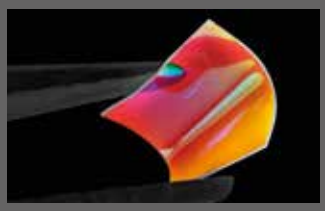
The TB475/550/850 gives blue, green and NIR, which is recognised as the enhanced normalised difference vegetation index (ENDVI), a technique that can provide more detailed information. ENDVI may better isolate plant health indicators and can generate results and false colour mapping to indicate values at the pixel level.

MidOpt triple bandpass filters are offered in various standard threaded mounts and custom mounts that are cut to fit any lens or camera size. Standard material thicknesses include 0.5mm, 1.1mm and 2mm.

www.midopt.com

Edmund Optics has introduced flexible longpass filters. These versatile cut-on filters offer deep blocking and excellent transmission over a large spectral range from 400-1,600nm to accommodate a wide variety of applications. The filters are constructed using ultra-thin flexible polymers and dyes. They are scratch insensitive and provide equivalent durability to most industry hard-oxide coatings, making them extremely robust.

The filters are made of



hundreds to thousands of polymeric and dyed sub-layers. Using these stacked materials allows them to be ultra-thin, measuring only 200-500µm thick. The filters are manufactured using a process combining features from plastic extrusion and fibre drawing processes. Able to conform to both flat and curved surfaces, the filters can be cut into complex shapes and small dimensions down to 0.5mm by the customer using scissors, blades, or lasers.

www.edmundoptics.eu

LATEST PRODUCT UPDATE

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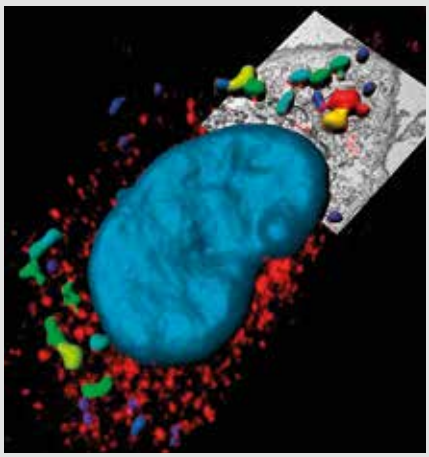
www.electrooptics.com/products

SOFTWARE



Imaris version 9.1 and Imaris Stitcher

Bitplane has recently launched Imaris version 9.1 along with the newest member of the Imaris family, Imaris Stitcher.

Imaris 9.1 offers the ability to visualise multiple 2D, 3D or 4D images with differing spatial or temporal dimensions and resolutions simultaneously. Imaris' object-based analysis tools are available for all images, and this functionality, along with alignment tools to rotate and translate the images relative to one another, provide a solution for researchers performing correlative microscopy across multiple imaging modalities.

Fast and precise stitching of multiple tiles in the XYZ is also now possible through the easy to use interface of the Imaris Stitcher. Imaris Stitcher reads image stage coordinates automatically, correcting for rotation of the camera relative to the microscope stage. Subsequent alignment of neighbouring tiles is based on best signal overlap in a selected channel.

The latest release includes improvements to the positioning and rotation of the reference frame object for flexible measurements relative to a specific location within an image. New file readers for Dicom, Leica XLEF and LOF formats, and an updated reader for the Olympus VSI format, are available within the Imaris 9.1 release as well. In addition, Imaris File Converter offers an ease-of-use and time saving improvement for users who require individual Imaris (IMS) files from a series of images.
www.imaris.com/newrelease

GL Spectrosoft Pro

GL Optic's light analytic software GL Spectrosoft Pro is now able to calculate equivalent melanopic lux (EML) and the melanopic-photopic ratio (M/P Ratio) in order to determine the melanopic effect of light – the temporal change in intensity and spectral composition of light that determines the circadian rhythm of organisms.

The light spectrum varies to the time of day and has different effects on the circadian rhythm. This means artificial light, such as very bright workplace illumination with lots of blue light and high colour temperature, can prevent tiredness in the morning and afternoon, but can also have a negative influence in terms of sleep at night and at home.

In order to detect the melanopic effect of light – especially regarding LED light sources with different light spectrum and colour temperatures – suitable measurement devices and analytic software are required. The GL Spectrosoft Pro therefore provides the necessary parameters.
www.gloptic.com

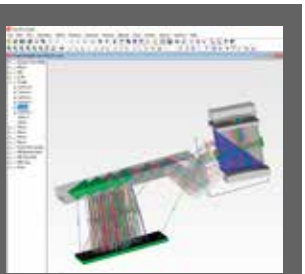
TracePro 7.8.3

Lambda Research has announced the release of TracePro 7.8.3 and the early visibility release of its TracePro 2018 software.

Some of the new features and enhancements in TracePro 7.8.3 include: Monte Carlo Tolerancing added to the 3D interactive modeler; new 3D modeler capabilities, such as an advanced sweep body editor, a measurement tool and new path selections including helical, square spiral and free helix; a rounding radius added to periodic and Fresnel segments to accurately model optics with chamfers and fillets; new photorealistic rendering options with the ability to save luminance data; and a new utility: the surface property generator.

Some of the new features and enhancements in TracePro 2018 EV include: ACIS release R28 with improved optional STEP and IGES translators; an upgraded HOOPS graphic engine for improved system visualisation; and an improved RepTile coincident surface algorithm for TracePro Expert users.

TracePro streamlines the



prototype-to-manufacturing process by combining an intuitive 3D CAD interface, superior ray tracing performance, advanced utilities, and seamless interoperability with other mechanical design programs.
www.lambdares.com

SPECTROSCOPY

FluoTime 300 with double monochromators

PicoQuant's FluoTime 300 fluorescence lifetime spectrometer is now available with double monochromators in excitation and emission. Due to the high stray light rejection of these monochromators, the signal to noise ratio of the spectrometer is increased to more than 29,000:1 (RMS) using the standard water Raman test.

Both monochromators are supplied with special features. For the excitation monochromator, an additional motorised filter wheel is installed to suppress the second order that could lead to parasitic signals. The emission monochromator on the other hand can be used in two modes: additive and subtractive.

The additive mode is suited to applications that require an extremely high spectral resolution. Values as high as 0.15nm can be reached, enabling measurements of complex molecular systems, organic semiconductor hybrids, or up conversion materials.

www.picoquant.com

ASOPS time-domain spectroscopy system

Laser Quantum has released the ASOPS Engine, an advanced time-domain spectroscopy system that offers extremely fast acquisition speeds of up to 20kHz and excellent time-resolution; significantly below 60fs for 1GHz lasers, and 100fs for 84MHz lasers.

The ASynchronous OPtical Sampling (ASOPS) technique enables fast scan rates and long measurement windows whilst maintaining excellent time resolution, ideal for ultrafast time domain spectroscopy and high-resolution terahertz spectroscopy.

The ASOPS engine is comprised of two femtosecond lasers, a TL-1000 ASOPS for offset frequency stabilisation, an optical trigger unit, a high-speed balanced optical photo receiver, a PC housing the data acquisition card, and HASSP-Scope software for measurement of time-domain data.

www.laserquantum.com

Triple monochromator

McPherson, a manufacturer of precision optical systems for spectroscopy and science applications, has announced a new triple monochromator ideal for making Raman, photoluminescence and Thomson scattering measurements in a variety of ways.

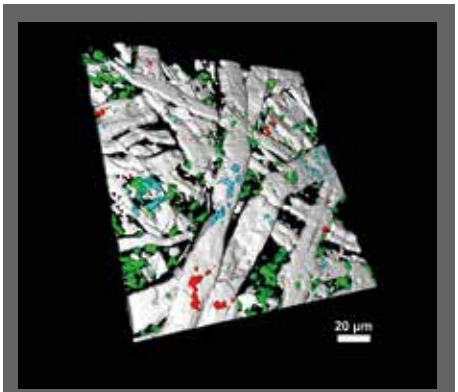
The triple configuration allows users to create a bandpass 'notch' of select wavelengths and disperse them onto a sensitive CCD or another array detector. The width and slope of the notches' edges can be tailored for the user's application.

The McPherson triple monochromator uses exclusively reflective optics and is capable of working deep into the ultraviolet, below 190nm if necessary. The triple can be equipped with many different diffraction gratings and works fast as f/5.

For ultimate throughput, McPherson also offers the triple monochromator with astigmatic optics for point-to-point imaging.

www.mcphersoninc.com

MICROSCOPY



Suite Five

WITec, a manufacturer of Raman imaging and correlative microscopy systems, has started shipping its Suite Five data acquisition, evaluation and processing software with the new ability of being able to compensate for thermal and mechanical variations during long-term measurements.

Confocal Raman microscopy investigations performed on delicate samples often require lower excitation power and a corresponding increase in acquisition time. Active focus stabilisation ensures that the ideal focus between the microscope objective and sample is maintained and that signal collection is unaffected while temperature or humidity changes. This is accomplished by an automatic routine that uses a reference point to optimise the Raman signal.

www.witec.de

Lext OLS5000 3D measuring laser microscope

Olympus' Lext OLS5000 3D measuring laser microscope helps users reach a higher level of metrology. With dedicated objectives, an improved scanning algorithm and a 210mm extension frame, the new Lext can accommodate and measure a larger range of samples – as well as improve productivity.

Acquiring highly accurate data in less time, the OLS5000 microscope incorporates a Peak algorithm for 3D data construction. This algorithm, combined with an intelligent Skip Scan function, has reduced data acquisition times by 75 per cent.

With the new extension frame of the OLS5000, samples of up to 210mm can be analysed. Furthermore, with an ultra-long working distance objective it is possible to measure dents of up to 25mm and carry out comprehensive inspection of even the most challenging samples.

To capture any surface at any angle, the OLS5000 is equipped with 4K scanning technology that can capture steep slopes of up to 87.5°. Olympus has also designed dedicated objectives for the OLS5000 that perform uniform measurements across the entire field of view.

www.olympus-ims.com

SENSORS AND DETECTORS

PowerMax-Pro kW laser detector

Coherent has extended its series of large area, high speed, PowerMax-Pro laser detectors to enable power measurement of continuous-wave modulated laser beams of 3kW and 5kW peak power.

PowerMax-Pro detectors combine the broad wavelength sensitivity, dynamic range and laser damage resistance of a thermopile with the response speed of a semiconductor photodiode.

The new PowerMax-Pro kW models will be particularly useful for materials processing applications based on high power fibre lasers, CO_2 lasers and solid-state lasers, including welding, cutting, drilling, and engraving.

PowerMax-Pro delivers a stable kilowatt power reading within microseconds with no overshoot.

The PowerMax-Pro kW sensor's innovative optical design also traps more than 99 per cent of the incident light inside the enclosure, eliminating the problem of back reflection. When used with a direct QBH fibre adapter option, 100 per cent of the incident light is captured, resulting in a Class 1 measurement system.

www.coherent.com

WeCat3D profile sensor

The new performance class for Wenglor's WeCat3D profile sensor MLSL2 includes a total of 10 models, each providing more options for 3D object measurement. In particular they permit large visual field widths of up to 1,350mm in the X direction, as well as increased laser power and even more extensive and faster profile detection.

The 2D/3D sensors project a laser line onto the object to be measured and then record it by means of an integrated camera. Two and three-dimensional surface and volume profiles can thus be calculated with the help of point clouds – quickly and accurately.

With the new additions, a

total of 81 different variants now exist in the WeCat3D series. Diverse applications such as bin picking, pick-and-place, gap measurement, object counting and 3D sealant bead monitoring are enabled with this technology.

With dimensions of just 200 x 67 x 38mm, the 10 new models represent a successful mixture of performance and compact design. Variants with different laser classes including 2M, 3R and 3B and red or blue light also provide customers with maximum diversity for product selection.

www.wenglor.com

CAMERAS AND IMAGING

OQ LabScope

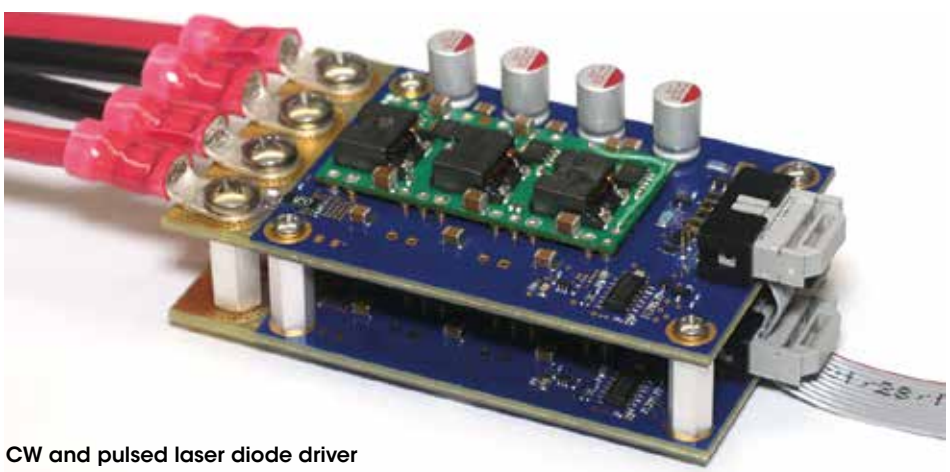
Edmund Optics now supplies the OQ LabScope, a new all-in-one, high-resolution optical coherence tomography (OCT) imaging system from Lumedica. With an affordable price below $10,000, the system is designed as an affordable alternative to more expensive and complex OCT systems.

The OQ LabScope is a tabletop device that provides competitive resolution, frame-rate, and power specifications. Featureing a laser centred at 840nm, the system is ideal for inspection at depths of up to 2.8mm in air and up to 2mm in tissue.

The new OCT system matches the performance of much more expensive units, with axial resolutions of 5µm and lateral resolutions of 15µm. Its small size, combined with an integrated computer and an intuitive graphical user interface, makes it perfect for both laboratory or field use.

An optional workstation package is available.
www.edmundoptics.eu

LASERS AND DIODES



CW and pulsed laser diode driver

Analog Modules has released the stackable CW and pulsed laser diode driver, model 787, a highly efficient, current-regulated and low-ripple triphase laser diode driver designed to power pulsed and CW high-current laser diode stacks.

AMI offers a 50A, 5.0V driver with an efficiency of 96 per cent in a compact footprint. Multiple drivers can be stacked together to achieve output currents of 200A or higher. The driver includes open circuit, short circuit, over-temperature and under voltage lockout protection.
http://analogmodules.com

A4 series of APC laser diodes

The new 'A4' series of compact APC laser diodes from Laser Components offers additional protective functionality for applications in which an eye-safe source of radiation is required.

The 'automatic power control' (APC) will shut down the laser once a specific operating current is exceeded.

The A4 laser diodes are insensitive to electrostatic discharges up to 10kV and a stable output power is guaranteed for supply voltages of 2.5-6VDC. As was the case for the device's predecessor, the APC is located at an ASIC on the same chip as the photodiode and the emitting laser diode, and is integrated in compact TO housings (3.3mm or 5.6mm). Diodes from this series are available at wavelengths between 635nm and 850nm and lend themselves well to applications in high precision measurement.
www.lasercomponents.com/uk/

Ushio red laser diodes

The Optoelectronics Company has announced that Ushio's new high-power laser diodes are now in mass production. As laser projection equipment and laser TVs get smaller and smaller, these two new diodes offer manufacturers the massive optical power output they need to enable better image quality, more vivid colour and greater clarity.

The HL63283HD is a visible wavelength laser diode in a 9mm-diameter CAN package with high heat dissipation and high wall plug efficiency of 40 per cent. It offers an impressive 1.2W optical output power at a typical centre lasing wavelength of 637nm at 25°C. Its operating temperature range is -10°C to +45°C, its typical operating voltage is 2.3V and its LD reverse voltage is 2V, with a typical threshold current of 340mA and an operating current of 1,300mA. The typical beam divergence parallel to the junction is 10°, and 33° perpendicular to the junction.

The HL63290HD is also a visible wavelength laser diode in a 9mm-diameter CAN package with high heat dissipation and high wall plug efficiency of 40 per cent. However, it offers even more optical output power of 2.2W CW at a typical centre lasing wavelength of 638nm at 25°C. Its operating temperature range is -10 to +55°C, its typical operating voltage is 2.4V and its LD reverse voltage is 2V, with a typical threshold current of 600mA and an operating current of 2.4A. The typical beam divergence parallel to the junction is 10°, and 33° perpendicular to the junction.
www.oe-company.com

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US government funds wireless laser-powered 'bat' drones

Drones that can be charged wirelessly by a laser are being sought after by the department of defence

The US government's department of defence (DoD) has put forward a $6 million (£4.4 million) grant to support the development of a new generation of self-navigating bat-like drones that can be powered remotely by lasers, even while in dust storms or when undergoing electromagnetic interference.

Announced in January by the Defense Enterprise Science Initiative (DESI), the 'FY 2018 DESI BAA' scheme is designed to support technology proposals from industry-academia collaborations that 'devise new paradigms for autonomous flight', and 'develop and demonstrate new concepts for wireless power transmission'.

'The biological study of agile organisms such as bats and flying insects has yielded new insights into complex flight kinematics of systems with a large number of degrees of freedom, and the use of multi-functional flight surface materials,' the DoD said. 'Progress in sensors, optimisation and miniaturisation of processors, and advances in flight control algorithms have also made it feasible to enable real-time autonomy in a miniature robotic system.'

The department has identified the potential for a generation of autonomous biomimetic drones that offer significant improvements in manoeuvrability, survivability and stealth over quadcopter or fixed-wing designs.

'The ultimate vision of this basic research programme is to yield advances that will enable the next generation of UAV platforms capable of autonomous operation,' it stated. 'These platforms should effectively navigate a battlespace and respond to obstacles with minimal human intervention.'

Caltech engineers demonstrated a drone capable of mimicking bat-like flight last year

Caltech

An ideal solution, according to the DoD, would therefore incorporate the required mechanical, electronic, power and sensory subsystems in a small robust package that can withstand strong accelerations and changes in thermal environment – such as those encountered on a battlefield. The system should also feature self-contained algorithms and/or hardware architectures for autonomous flight control with a large number of degrees of freedom, obstacle recognition and avoidance, real-time decision making and mission planning.

To power the biomimetic drones, the DoD envisions using laser, microwave or other electromagnetic frequencies to transmit energy remotely, even in inclement conditions such as dust storms, other poor weather, or in the presence of electromagnetic or other interference.

'The goal of this effort is to identify, develop and demonstrate new concepts for wireless power transmission... at the core of these applications is the need for new and scalable technologies for sending, receiving, directing and converting power across ground/air/space platforms.'

> "The goal of this effort is to identify, develop and demonstrate new concepts for wireless power transmission"

Such concepts could resemble small but highly efficient devices that incorporate metamaterials and adaptive optics for dynamic beam redirection and focusing onto a moving receiver, all while minimising the system's detectable signature and maximising the safety of local ground crews. If swarm applications are also to be considered with the biomimetic drones, new concepts for communications, data fusion and distributed control should also be considered, the DoD proposed.

The DoD said that, in order to enable the required high-tempo all-terrain agility in the drones, the idea of an intelligent system having to be a rigid multi-body platform optimised for quasi-static and steady-state motion should be avoided.

'To achieve robust, resilient, and energetically versatile agility and dexterity rivalling biological systems, robotic systems require breakthrough components featuring locally tuneable material properties with embedded sensing and actuation,' it explained.

A type of newly controllable smart material is therefore needed that, rather than having its control be extrinsic and centralised with fixed material properties and mechanics, instead features dynamic materials-based energy management that is intrinsic, modular, and distributed.

This will require advances in novel materials fabrication, for example active liquid-crystal elastomers, liquid metals, hyperelastic light-emitting capacitors and next-generation shape memory alloys/polymers, as well as techniques for wireless sensing and self-sensing, muscle-mimetic actuation, says the DoD. **EO**

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EPIC Executive Run at Photonics West
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Paris, France

15–16 February 2018 — **EPIC Meeting on Testing of Optoelectronics**
Belfast, Ireland

21–22 February 2018 — **EPIC Tech Watch at W3+FAIR**
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14 March 2018 — **EPIC Networking Event on Assembly & Packaging of PICs at OFC**
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10 April 2018 — **EPIC VIP Party at PIC International**
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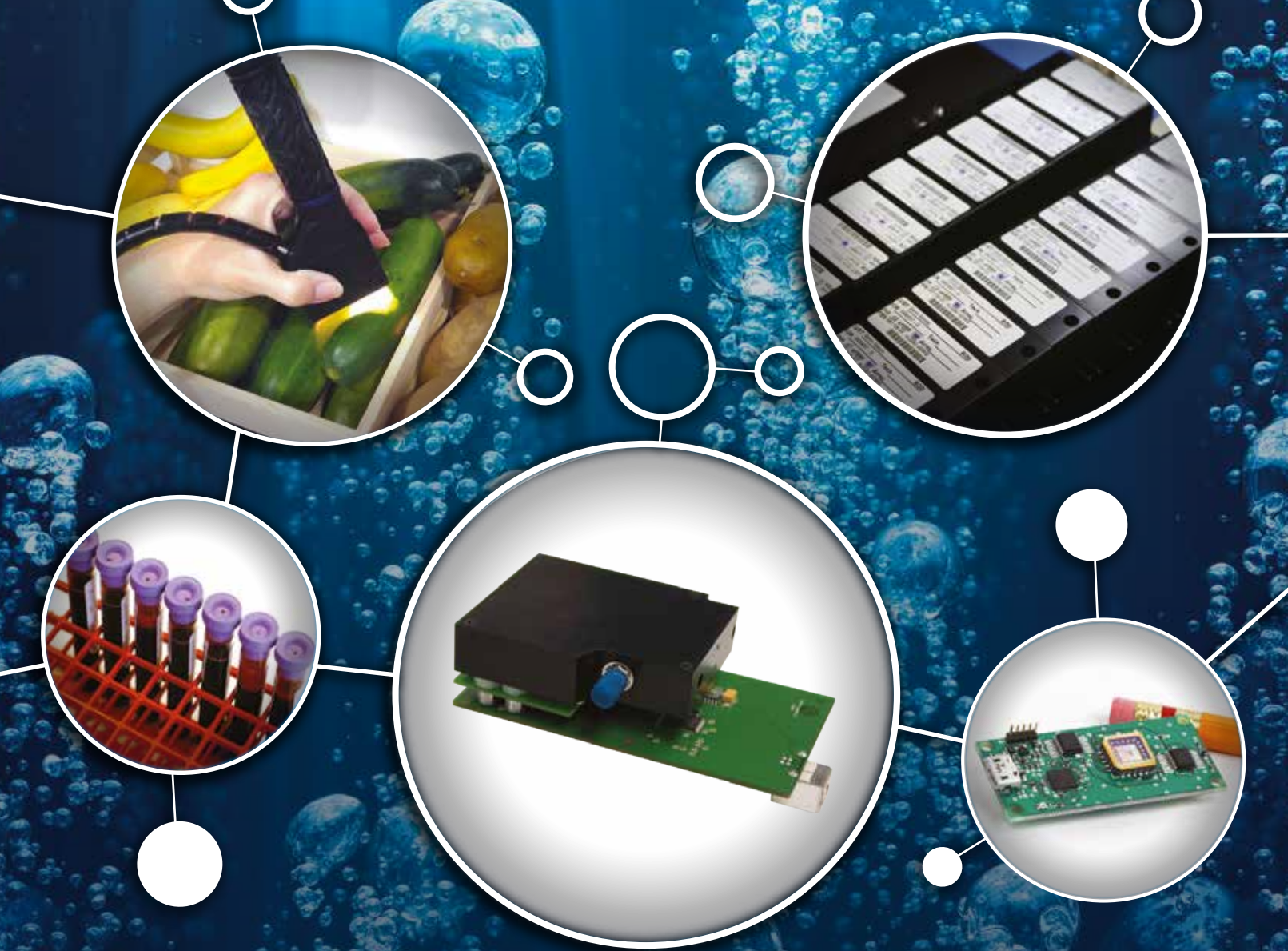

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