optics & laser europe

February 2007 Issue 147 The European magazine for photonics professionals optics.org

OPTICAL TWEEZERS

New interface gives optical tweezers a helping hand

PROJECTORS

Finnish start-up targets compact projector engines

INSIDE EOS NEWSLETTER

Focus on Norway

LASER SAFETY

EXPERT ADVICE SIMPLIFIES LASER EYEWEAR CHOICE

4 in 1

Smart Head to USB interface: USBI-4

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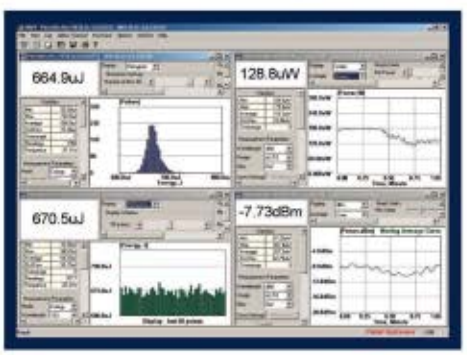

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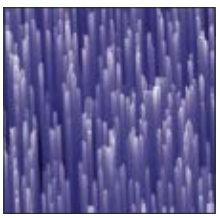
Plastic Logic secures cash for flexible displays p5



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PLASTIC ELECTRONICS

Portable 'read-anywhere' display is now ready for mass production

Plastic Logic is to build the first factory designed for commercial-scale manufacture of flexible active-matrix display modules for portable read-anywhere plastic electronic products.

The facility, to be based in Dresden, Germany, will utilize the firm's process to fabricate active-matrix displays that are thin, light and robust, which will give users a reading experience closer to paper than any other technology. The volume manufacturing facility is planned to ramp up in 2008.

To fund this development, the company has just raised $100 m (€77 m) of equity finance in a round led by Oak Investment Partners and Tudor Investment Corporation. The financing is believed to be one of the largest in the history of European venture capital.

The facility will produce display modules for portable electronic reader devices – a product category that the firm expects to grow to 41.6 million units in 2010. It will have an initial capacity of more than one million display modules per year and production will start in 2008. Dresden, in the "Silicon Saxony" region of eastern Germany, has been chosen as the facility location following an extensive worldwide site-selection process.

Plastic Logic

Just the beginning: Plastic Logic plans to develop A5-sized colour displays by 2010.

"Our displays will enable electronic reader products that are as comfortable and natural to read as paper whether you're on a beach, in a train or at home," said John Mills, Plastic Logic's chief operating officer. "Wireless connectivity will allow users to purchase and download a book, or pick up the latest edition of a newspaper, wherever you are and whenever you need it. The battery will last for thousands of pages so you can leave your charger at home."

The firm's patented technology lies in the backplane of the display, which is laminated together with display materials from US-based company E Ink. Charged particles of the ink are arranged by a remotely controlled, locally delivered electric field to create text documents. The bistable nature of the display means that images retain their form until the content is updated.

"Overall, the laminate has the thickness and feel of a credit card, perhaps more flexible," marketing executive Anusha Nirmalananthan told *OLE*. "We expect that the eventual products will find applications such as office documents, newspapers and literature. The US is likely to be an early market but the electronic readers will ultimately find markets worldwide."

The pace of development of the technology at the company, based in Cambridge, UK, has been dramatic from the first 2-inch 50 ppi display at the end of 2004 to today's SVGA display at 150 ppi. The company's roadmap shows that it plans to develop high-resolution A5-sized colour displays by 2010 and flexible 10-inch video displays by 2012.

Simon Jones, vice-president of product development at Plastic Logic, added: "Even in this age of pervasive digital content, our research shows that consumers are very reluctant to read on laptops, phones and PDAs. We still carry around enormous amounts of paper. However, we believe that there is a substantial unfulfilled need that we can meet by making digital reading a comfortable experience."

FIBRE LASERS

SPI's £7 m revenue in 2006 doubles previous year's

SPI Lasers has announced revenue figures of £7 m (€10.6 m) for 2006, which represents 100% growth on 2005's revenue.

The figures were revealed in a trading update on 9 January, published ahead of the company's preliminary results due on 9 March.

As well as the fixed orders of over $2 m (€1.5 m) announced in November 2006, the firm has received further orders totalling over $6 m in the medical, marking and micron-scale (micro) sectors.

In Q4 2006 the company began shipping its new 200 W fibre lasers intended specifically for micro applications and it is anticipating further revenue growth in this sector.

During the whole of 2006, order inflow was strong across SPI's product portfolio. The company entered new market verticals such as diamond processing and power cells. Its prospects are underpinned by a growing order book and product pipeline.

In a separate assessment of SPI, Panmure Gordon, which acts as corporate broker and adviser to the company, forecasts that the speciality fibre and laser manufacturer could see revenues rise to £20 m during 2007.

"It is encouraging that SPI's visibility is building," Panmure Gordon stated. "£3 m is already on the order book for Q1 07 and more than £5 m for H1 07 (compared with £4 m in H2 06). This bodes well for 2007, and supports our £20 m forecast for the coming year."

Panmure Gordon warned that due to the expansion of SPI's business, operating costs are increasing, which is perhaps unsurprising as the firm expands and establishes itself in the US and Asia. This will take about £3 m off its projections for the next two years.

SPI's expected loss before tax will therefore widen in 2006 from £10 m to £11.1 m, and in 2007 from £2.7 m to £6.3 m. However, the business is set to break even by the end of 2007, and 2008 should be a full year of profitability, with a pre-tax profit forecast of £3.2 m.

PHOTONICS WEST IN BRIEF

MEDICAL IMAGING

According to Joseph Izatt of Duke University, US, optical coherence tomography (OCT) has now passed the tipping point for technology transfer, with significant momentum towards commercialization. Companies like Thorlabs, Bioptigen and Novacam Technologies are all selling OCT systems for research applications. Equally, the number of vendors offering clinical OCT systems has gone from one (Carl Zeiss Meditec) to at least seven over the past 12 months.

FIBRE LASERS

Newport has formed a fibre laser business group within its Spectra-Physics Lasers Division to develop fibre-laser and amplifier technology. Newport's chief executive officer Robert Deuster revealed that the company has been working in this development area for some time and is already in discussions with key customers on products for several new applications.

SOLAR CELLS

Revenues from photovoltaic modules alone are predicted to grow from around $8 bn (€6 bn) in 2006 to $18 bn by 2010, says John Dexheimer, founder of equity firm LightWave Advisors, US. What's more, associated services, such as installation and other components, could bring the total value of the solar market to $35 bn by the end of the decade.

For more views and analysis on this year's event see optics.org/blog/.

ULTRAFAST FIBRE LASERS

Fianium awarded £1.4 m to develop 'next-generation' fibre lasers

A consortium led by Fianium, a UK developer of ultrafast fibre lasers, has received £1.4 m (€2.1 m) from the UK Government's Department of Trade and Industry (DTI) to develop next-generation fibre lasers for industrial and imaging applications.

The DTI-funded Ultrafast project is a collaborative effort involving Fianium as lead partner, together with Lairdside Laser Engineering Centre (LLLC) at the University of Liverpool and the Centre for Photonics and Photonic Materials (CPPM) based at the University of Bath.

As *OLE* goes to press, the LLLC is set to take delivery of a new picosecond fibre-laser system from Fianium for materials processing characterization trials as part of Ultrafast. The laser will be one of Fianium's FemtoPower devices operating at a wavelength of 1064 nm with a maximum pulse energy of 4 μJ. The source has a built-in pulse-picker that allows an end user to change the laser repetition rate step-wise from 20 to 1 MHz.

On show: Fianium was one of over 1000 exhibitors at this year's Photonics West.

CPPM's role in Ultrafast is to develop new types of photonic crystal fibres tailored for use within ultrafast fibre lasers to enable the delivery of femtosecond pulses with high peak powers.

"The Ultrafast project gives us access to state-of-the-art fibre lasers and allows us to carry out investigations in photonic materials using high-energy and linearly polarized clean ultrashort optical pulses from a compact and user-friendly fibre-laser source," said William Wadsworth of CPPM. "This will undoubtedly lead to the discovery of exciting effects in photonic crystal fibres."

LASER PROCESSING

Oerlikon acquires leading laser specialist Exitech

Oerlikon, based in Pfäffikon, Liechtenstein, has acquired in an asset deal the laser technology, staff and equipment of Exitech, UK, a provider of nano- and micro-laser systems. Financial details were not disclosed.

Lasers play a key role in the production of minute surface structures measuring a few nanometres and suit applications such as the scribing of solar cells, which is particularly significant for Oerlikon. Thanks to the cutting properties of lasers, solar cells can be formed into functioning modules without having to be specially assembled. Before the Exitech acquisition, Oerlikon had to purchase external technology for this important process.

"With the integration of Exitech's expertise, we will be able to control the full-value adding process in the solar segment," said Thomas Limberger, Oerlikon's chief executive officer.

Exitech will be integrated into the Oerlikon optics business unit, but other divisions are also likely to benefit from the acquisition. Fields such as the manufacturing and structuring of colour filters, the provision of optical sensors and the production of semiconductors will gain from Exitech's laser know-how.

Hands-on photonics

"Photonics West's upbeat atmosphere heralds good times ahead."

Jacqueline Hewett

I'm writing this editorial having just returned from Photonics West, which was held in San Jose, California, US, on 20–25 January. As a now seven-time veteran of the show, I can't help but think that the upbeat atmosphere in the technical conferences and exhibition halls heralds good times for the industry.

The online "ShowBlog", put together by the *OLE* and *optics.org* editorial team (http://optics.org/blog/) was certainly full of clever technical innovations and positive market analysis from the event. The blog was a first for us and we would be interested to hear your thoughts on it. We also welcome and encourage you to add comments to any of the topics our blog entries touched on.

Following up on the interview with Robert Deuster that appeared on p17 of the January issue, it is intriguing to note that Newport has now formed a fibre-laser group and is expecting to launch products this year. Fibre-laser technology was a hot topic at Photonics West, and although it remains to be seen exactly where Newport will enter the market, this only goes to show how much confidence large players have in the technology and its prospects.

Turning to the February issue of *OLE*, the optical tweezers feature starting on p17 describes what the researchers call a "natural interface". Here, the position of the user's fingertips defines the position of optical traps. The user then controls the traps at will and can pick up and move objects on the microscale. The researchers hope that this sort of interface will help to transfer optical tweezers into the wider scientific community. One added benefit is that the system works with opaque particles, which could not be tweezed by conventional means.

The emergence of commercial instruments that use laser speckle to image blood flow in real time is the topic under discussion on p15. "If you shine the laser beam at the back of your hand and look at the screen, you can even see the blood pulsing in your veins – it's an incredible thing to observe," laser-speckle pioneer David Briers told *OLE*.

Enjoy the issue.

Jacqueline Hewett, editor
E-mail jacqueline.hewett@iop.org

MOBILE DISPLAYS

DeCIBELs set for projection debut

By Jacqueline Hewett

Finnish start-up EpiCrystals believes that its DeCIBEL semiconductor laser platform has all the characteristics to enable the production of compact projector engines. Power scalable and with no need for free-space optics, the lasers are inexpensive, easily mass produced and suit projection applications ranging from handheld to home theatre.

"We think that we have the most suitable technology for handheld projectors when you compare it to other approaches," EpiCrystals' chief executive officer Tomi Jouhti told *OLE*. "Not many competing technologies can be fitted into handheld devices."

The RGB DeCIBEL platform uses frequency-doubled semiconductor diode lasers that are based on GaAs. Although the three colours use the same laser architecture, specific quantum-well regions generate light at 465 (blue), 532 (green) and 625 nm (red). The sources can be sold individually or combined to produce a compact RGB module.

"We are aiming at 50 mW per colour per emitter," said Jouhti. "We have a fully power-scalable design and a large array could go up to 5 W for home theatre or office projectors for example. Our aim is to provide the laser sources – we are not interested in manufacturing the overall projection engine."

Jouhti adds that EpiCrystals' core competences are in laser design and generating red light. "We use a novel semiconductor material for the red, and conventional materials for the blue and green," he said. "We have combined several pieces of laser technology in a new way and this is what we have patented."

An RGB module is said to be on the millimetre scale. The good emitted beam quality means that free-space optics are not required. "There is also no need for speckle-reduction components as the speckle is within acceptable levels," added Jouhti. "Both of these factors are reflected in the price of the whole module."

EpiCrystals

Tom Jouhti (left), chief executive officer of EpiCrystals, is pictured after winning the 2006 European Venture contest.

"For low-power devices for handheld projectors in mobile phones we are looking at chip prices of $1 to a few dollars per colour in large volumes in the millions per year mark," Jouhti continued. "This mark is certainly something we can go after."

The firm is providing samples to selected customers this year and hopes to make the devices commercially available in 2008.

Having spun-out of Tampere University of Technology's Optoelectronics Research Centre in 2003, the company secured seed-funding the following year. The firm is now looking to close its first round of funding this quarter.

EpiCrystals beat 484 other hopefuls from across the region to win the 2006 European Venture contest – said to be the only pan-European competition with an exclusive focus on top technology ventures showing "the ambition and potential to reshape their industry and conquer the international market".

LASER TV

Optical technologies feature in future Sony displays

Sony's future range of televisions is likely to contain laser diodes, revealed the Japanese firm at the annual Consumer Electronics Show (CES) in Las Vegas, US, (8–11 January). The electronics firm, which describes itself as "transforming into an entertainment powerhouse", demonstrated a 55-inch television that uses a laser-projection system.

The company also unveiled an 82-inch television with an LED backlight. Sony first incorporated LED technology into its high-end televisions more than two years ago but, in general, LED television backlighting has yet to take off in a big way.

Sony also exhibited a prototype slimline 27-inch display that uses organic LEDs instead of III-V components. According to the company, mass production of similar 11-inch screens is close to being cleared, although the larger-area products are still under development.

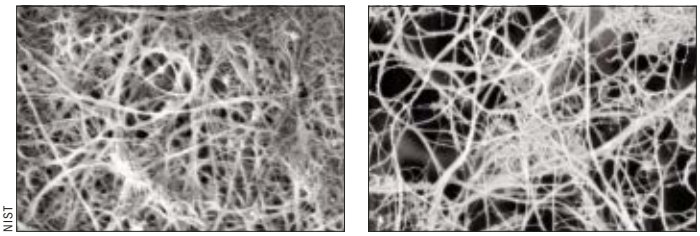
With the rival Blu-ray and high-definition DVD camps also out in force at CES, Sony was keen to point out that its US shipments of PlayStation 3 games consoles – each featuring a blue–violet GaN laser diode – were on track over the recent holiday period.

Despite reports of shortages of consoles, Peter Dille, senior vice-president of marketing for Sony Computer Entertainment America, says that up to the end of 2006, one million PlayStation 3s had been shipped to the US. The firm previously admitted that problems with GaN laser manufacturing had forced it to scale back the global launch of the the console in November 2006.

MATERIALS PROCESSING

Excimer laser cleans up nanotubes

A point-and-shoot laser-cleaning method could help to speed up the commercialization of carbon nanotubes (CNTs), according to researchers from the National Institute of Standards and Technology (NIST) and the National Renewable Energy Laboratory (NREL), both the US.



NIST

Carbon nanotube detectors before (left) and after exposure to an excimer laser.

CNTs have a range of unique properties that suit applications such as optical sources, detectors and displays. However, the cost-effective removal of performance-degrading contaminants remains an issue (*Chem. Phys. Lett.* **433** 301).

"We needed a quantitative measure of damage, but soon realized that we were also purifying the CNTs," John Lehman of NIST's sources, detectors and displays group told *OLE*. "The detector material was visibly blacker after the measurement, which suggested an increase in porosity."

An electron microscope image taken before and after processing confirmed that exposure to the excimer source had eliminated defective carbon in the sample, but left the CNTs intact. Lasers have been used in the past to selectively destroy CNTs in bulk, but here the NIST/NREL team is using much shorter wavelengths.

The group's set-up uses a 248 nm excimer laser that delivers 20 ns pulses at a repetition rate of 10 Hz. CNTs are placed in the beam path for 30 s by opening and then closing a manual shutter. Data indicate that tube diameters as small as 0.8 nm can withstand the cleaning process up to a fluence of 700 mW/cm^2.

Pleased with its result, the team has turned its attention to finding out more about the cleaning mechanism. "Although we can't say for sure, we believe that it is the combination of exciting the π plasmons in the presence of ozone that facilitates oxidation of carbon impurities," Lehman said. He thinks that the purification treatment could be taken a step further and used to not only clean, but also fine-tune the performance of CNTs. "We plan to scale the treatment down to the individual tube as well as scaling up to manage bulk quantities," Lehman revealed.

SURVEILLANCE

Security cameras to get a FoV boost

By A L Narayan

Researchers in South Korea have developed an inexpensive wide-angle lens that rivals the field-of-view (FoV) of conventional fish-eye lenses and does not add distortion. Designed by a team at Honam University, the lens costs around $100 (€77) and could improve the quality of indoor security cameras and CCTV systems (*Appl. Opt.* **45** 8659).

Gyeong-il Kweon

This picture of a book store was taken with a ceiling-mounted wide-angle lens.

Speaking to *OLE*, researcher Gyeong-il Kweon said: "We have successfully designed a wide-angle lens that can provide a FoV of more than 150° with less than 1% distortion, and are very excited about its potential in the security arena."

Dubbed a catadioptric wide-angle lens, it is made up of a mirror that reflects the light from a wide area (catoptric) and lenses that focus this light on the sensor of a small camera (dioptric).

The set-up consists of a cone-shaped mirror fixed inside a hemispherical glass dome. At the top of the dome are a series of lenses leading up to a slot for connecting a small camera. Light entering from the dome strikes the mirror and is directed toward the lens where it is focused to form a sharp image at the exact location of the camera's sensor. Like conventional wide-angle lenses, this design produces images that exaggerate nearby objects.

The FoV of the new lens is 151.8°, and the team believes that it can be pushed up to 160° with some enhancements. Unlike fish-eye lenses, which render straight lines that do not run through the centre of the frame as curved, the new lens depicts shapes and relative dimensions of imaged objects.

One problem still to overcome is the small black spot at the centre of every picture. This phenomenon, called central obscuration, is a reflection of the camera appearing on the mirror. Kweon and his research partner say that they have designed a purely dioptric lens that does not suffer from this problem and has a FoV of 120°.

"We are looking forward to licensing this design to interested companies, and reaching out to potential customers in Europe and America," said Kweon, who has already established a company called Nanophotonics to produce and market these lenses.

A L Narayan is a freelance writer based in Singapore.

LEDS

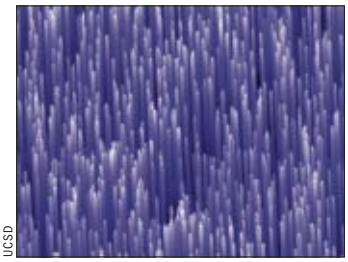
ZnO nanowires promise better LEDs

By A L Narayan

Scientists at the University of California, San Diego, US (UCSD), and Peking University in China have reported a low-cost technique for fabricating p-type zinc-oxide (ZnO) nanowires (*Nano Letters* **6** 2768).

According to UCSD researcher Deli Wang, the nanowires could be used in a new generation of LEDs that can emit light from ultraviolet (UV) wavelengths to the visible part of the spectrum.

ZnO is a very good light emitter with a band gap of 3.37 eV, and scientists have long been interested in its potential for producing highly efficient LEDs. However, engineers have found it difficult to achieve p-type doping in wide-bandgap semiconductors such as ZnO, which has limited its use in electronic applications.



UCSD

Pillar shaped: ZnO nanowires would provide a large junction area for LEDs.

More recently, p-type conductivity has been demonstrated in ZnO thin films, allowing ZnO-based LEDs to be fabricated for the first time. For example, US start-up MOXtronics has produced a ZnO LED with a range spanning from UV to visible light.

The project is the first time that p-type conduction has been replicated at the nanoscale. Using a simple form of chemical vapour deposition, the team doped the ZnO with phosphorous (P) to make p-type ZnO-P nanowires.

"In our process, zinc and phosphor vapours travel down to the substrate and condense to form the nanowires of desired dimensions," said Wang. Because of its simplicity, the method could be cheaper than the metal-organic chemical vapour deposition process that is used to fabricate GaN semiconductors.

Nanowires made in this way resemble a thick patch of grass, composed of pillar-shaped structures projecting up like spikes. Such a geometry would provide any LED with a large junction area, which in turn translates into higher efficiency.

A L Narayan is a freelance writer based in Singapore.

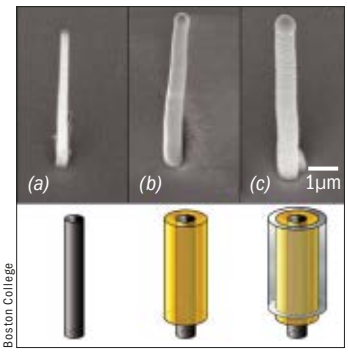
MATERIALS

Light squeezes through nano coax

By Hamish Johnston

Operating like the coaxial cables used to distribute television and radio signals, nanoscale cables can transmit light with wavelengths nearly four times their 200 nm diameter. The researchers claim that the ability to control light over sub-wavelength distances could lead to better optical microscopes, smaller computer chips and more efficient solar panels (*Appl. Phys. Lett.* **90** 021104).

Coaxial cables comprise an inner and outer conductor separated by an insulating dielectric layer and are used to transmit all manner of electromagnetic waves, from radio to microwave. They are extremely useful because they can transmit waves with wavelengths much greater than their diameter, making cable television and other technologies possible. Light is an electromagnetic wave so there is no reason why it cannot be transmitted in a similar manner via a coaxial cable – but conventional wisdom had held that light cannot travel through a cable of a diameter less than its wavelength. Boston College's Jakub Rybczynski, Mike Naughton and colleagues have now shown that a coaxial cable could carry sub-wavelength light waves if it were miniaturized.



Boston College

The cable is formed by coating a carbon nanotube (*a*) with Al_2O_3 (*b*) and Cr (*c*).

Their coaxial cable is based on a carbon nanotube, which forms the central conductor. The nanotube is surrounded by a concentric ring of transparent aluminium oxide, which acts as the dielectric layer, and a concentric metal ring acts as the outer conductor. The separation between the inner and outer conductors is about 100 nm.

Some of the central conductor protrudes from the cable and acts like an antenna, gathering light and sending it down the cable. The cable works exactly like a conventional coax, constraining the transverse electric and magnetic fields of the light wave between the two conductors, thereby guiding the light along the cable for distances of up to 50 μm. While this is not very far, it could allow the structures to be exploited in a number of ways.

Naughton and Rybczynski say that the cable's ability to control light over sub-wavelength distances could be exploited to solve a wide range of technological problems – the dielectric material could be replaced by a photovoltaic material like silicon, which would convert the light to electricity. This could be used to create better solar cells that exploit the cable's ability to constrain the light wave into an area smaller than its wavelength, thereby boosting the efficiency of the conversion process.

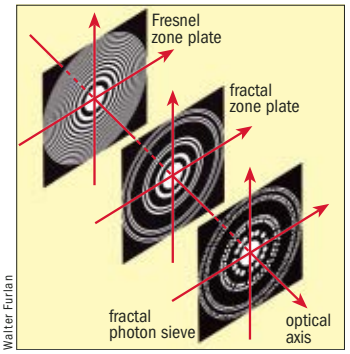
Hamish Johnston is editor of PhysicsWeb *(physicsweb.org).*

DIFFRACTIVE OPTICS

Fractals improve imaging performance

A fractal photon sieve (FPS) offering improved focusing and image-forming properties is set to make an impact on applications including X-ray microscopy, terahertz (THz) tomography and astronomy. That's according to researchers in Spain who say that their FPS has an extended depth of field and reduced chromatic aberration compared with Fresnel zone plates (*Optics Express* **14** 11958).

Just like Fresnel and fractal zone plates, an FPS is a diffractive lens. A Fresnel zone plate consists of periodic concentric circles, whereas a fractal zone plate comprises circles following a fractal pattern. In an FPS, the transparent circular regions of a zone plate are replaced by a high density of discrete holes.



Walter Furlan

Schematic view: the performance of fractal photon sieves was judged to be considerably better than conventional zone plates in a series of imaging tests.

"Compared with a fractal zone plate, the distribution of the holes is a degree of freedom that can be exploited to perform apodization, particularly to nearly suppress the higher-order foci," Walter Furlan of the University of Valencia told *OLE*. There are also advantages when it comes to fabricating FPSs. "FPSs can be manufactured using the same technology as conventional zone plates," he explained. "However, an FPS can be constructed from a single structure without any supporting substrate. We printed the diffractive lenses using a conventional laser printer and then reduced them photographically onto 35 mm slides."

Furlan and colleagues designed their FPSs to work in the visible using white-light illumination. They compared the performance of an FPS and a Fresnel photon sieve using a chart containing letters decreasing in size, such as those used by an optician. Images recorded using the FPS were judged to be considerably better. FPSs can also be designed to operate at short (extreme ultraviolet) wavelengths right through to long (microwave and terahertz) wavelengths.

"A broad range of polychromatic imaging applications where conventional Fresnel zone plates are used could benefit," said Furlan. "This includes X-ray microscopy where narrowband sources are limited; imaging and tomography using terahertz for an efficient projection of line spots onto the object; and also astronomy, where diffractive lenses can be implemented in large-aperture telescopes."

MATERIALS

Tropical beetle is brightest white

By Jon Cartwright

The secret behind the brilliant white shell of a peculiar tropical beetle is an unusual, aperiodic structure, according to physicists from the UK. Electron microscopy revealed that a random network of protein filaments allows the shell to scatter light with high efficiency. The protein structure, which is at least two orders of magnitude thinner than man-made materials of equivalent whiteness, could be imitated in future synthetic systems (*Science* **315** 348).

The bright colours of certain insects are normally down to a strong pigmentation or a highly periodic structure. But these properties cannot be responsible for insects with brilliant white shells, because white light needs a scattering process that covers all the visible wavelengths.

This mystery encouraged Pete Vukusic and his colleagues from Exeter University to investigate *Cyphochilus*, a species of beetle renowned in entomological circles for its unusually bright white shell. After examining electron microscope images of the shell's interior, they discovered a network of nanoscale protein filaments that were completely devoid of any periodicity. These unordered filaments have a very different refractive index from the air that surrounds them, meaning they can scatter light over the entire visible spectrum.

The physicists now think that their discovery could lead to a new generation of bright white materials, which cannot currently be made as thin as the beetle's 5 µm shell. "Synthetic materials can already produce spectacularly white light," explained Vukusic. "It's not that nature is doing something much better than we can, it is just doing something much thinner."

Jon Cartwright is a reporter for PhysicsWeb *(physicsweb.org).*

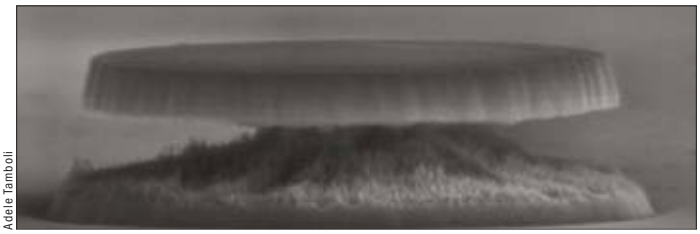
MICRODISK LASERS

Processing enhances GaN microdisk statistics

Researchers have reported an eye-catching leap in performance from blue-emitting gallium nitride (GaN) microdisk lasers. The team, from the University of California at Santa Barbara (UCSB), US, and the University of Oxford, UK, says that it has observed the first room-temperature continuous-wave lasing from a GaN microdisk and also the lowest threshold (*Nature Photonics* **1** 61).

"The threshold of about 300 W/cm^2 is the lowest reported for GaN-based microdisks by several orders of magnitude," said the authors. "Our threshold is also many of orders of magnitude lower than current optically pumped GaN-based vertical-cavity, surface-emitting lasers."

According to researcher Adele Tamboli from UCSB, several key factors have had a huge effect on device performance. "The first is the size of the microdisk," Tamboli told *OLE*. "Previous reports have focused on larger microdisks about 4 μm in diameter and ours are significantly smaller.



Adele Tamboli

A 1.2 μm-diameter microdisk emits at 428 nm at room temperature.

"Sidewall roughness and the circularity of the disk are important to performance," she continued. "We have improved these factors considerably by using electron-beam lithography coupled with resist reflow."

Unlike standard in-plane lasers, where the cavity is formed by two parallel mirrors, the resonant cavity in a microdisk laser is circular. This means that light travels round the periphery of the microdisk and is reflected at the air-semiconductor interface creating standing waves in the material known as whispering gallery modes (WGMs). Because the WGMs are concentrated close to the surface, especially in small disks, sidewall smoothness is crucial to producing low-loss modes.

The team fabricated a range of microdisks from 1.2–8 μm in diameter. Optical pumping of a 1.2 μm microdisk with a 3 mW helium cadmium laser emitting at 325 nm resulted in a lasing mode at 428 nm at room temperature. The threshold for this disk was 300 W/cm^2 and the researchers say that this should be considered as an upper limit. "We have not measured the total output power. It is difficult to measure this because the disks emit radially in all directions," added Tamboli. "The input power for these lasers to reach threshold is very low. The fabrication is very simple compared to other designs for blue lasers. It takes 10–12 h for one chip and we can generally pack several hundred microdisks per chip."

The team is now working on an electrically pumped microdisk. "The emission wavelength is determined by the material growth and the cavity size so we have control over that. In terms of performance, some minor improvements can be made but the structure is already close to optimal for optically pumped devices."

PATENTS

LITIGATION

IMRA America launches legal suit against IPG Photonics

IMRA America has filed a lawsuit against fibre-laser maker IPG Photonics "to stop misuse of IMRA intellectual property". According to an IMRA statement, IPG recently terminated licence negotiations after months of discussion. The technology in question is used to obtain high power and high-pulse energies from fibre lasers. IMRA says that it has licensed it to others in the field, such as Nufern, SPI Lasers and Aculight.

Initial ruling goes in favour of Lumileds in dispute with Epistar

An initial ruling by the US International Trade Commission (USITC) has decided that Taiwan-based Epistar is infringing a patent owned by Philips Lumileds. USITC judge Sydney Harris ruled that the metal-bond (MB) LEDs made by United Epitaxy Company, which is now part of Epistar, infringe Lumileds' 5,008,718 patent.

Lumileds is still seeking an order from the USITC to prohibit imports of both the LEDs in question, and any products featuring them, to the US. Epistar says that the MB products are a legacy of the merger and that it is about to produce a new generation of MB-based LEDs that overcome the issues relating to the '718 patent.

LICENSING

Coherent and Osram team up on laser projection applications

Coherent has signed a licensing agreement with Osram that permits the use of Coherent's optically pumped semiconductor lasers for consumer laser-based projection displays. The licence allows Osram to develop and deploy red, green and blue lasers based on Coherent's intellectual property in consumer applications, such as projection televisions and projectors for hand-held devices.

Aculight and US university sign optical neural stimulator deal

Aculight has signed a licence agreement with Vanderbilt University, US, for intellectual property related to the optical stimulation of neural tissue. The technology forms the basis of Aculight's first medical research product, the Capella R-1850 Infrared Neural Stimulator (INS).

The INS product is a fibre-coupled laser that emits pulses of mid-infrared light. Compared with electrical stimulation, Aculight says that the INS creates no electrical artefact, allows greater spatial selectivity and is non-contact – avoiding any cell damage that may result from physical contact with a metal electrode.

AWARD

Bookham tunable laser design now protected by US patent

Bookham has been awarded US patent number 7,145,923 for its DS-DBR laser. The patent is said to be one of several that covers Bookham's tunable laser portfolio and specifically protects the company's monolithic, widely tunable laser design.

"Using the technology detailed in this patent, Bookham has developed wideband, InP-based tunable lasers for both C-band and L-band operation with fast tuning times, excellent output powers, spectral purity and reliability," said Andy Carter, vice-president of R&D at Bookham.

To search for recently published applications, visit http://www.wipo.int/pct/en/ and http://ep.espacenet.com.

Video capability revives interest in laser method

Plastic surgery, neuroscience and dermatology could all benefit from the release of the first commercial instrument to image blood flow in real time, at up to 25 frames per second. **James Tyrrell** speaks to David Briers, one of the pioneers of laser speckle contrast analysis, to discover more about the technique that was first conceived over 25 years ago.

In the 1980s, when Adolf Fercher and David Briers came up with the idea of using laser speckle to monitor blood flow, their dream was to have an instrument that could operate in real time. After 25 years, the technology has caught up in the form of a full-field laser profusion imager (FLPI) from Moor Instruments, UK, and is set to take the medical sector by storm.

"I'm not aware of any other instrument on the market, or even in development, that can give a real-time video image of blood flow over an area," an excited Briers told *OLE* upon hearing the news. "If you shine the laser beam on the back of your hand and look at the screen, you can even see the blood pulsing in your veins – it's an incredible thing to observe."

Moor Instruments

Team effort: Xiabing Huang (left) technical manager at Moor Instruments, uses the full-field laser profusion imager (FLPI) to image the hand of Stewart Lillington, senior engineer for the FLPI project.

Now emeritus professor in applied optics at Kingston University, UK, Briers is pleased to see his original discoveries underpinning the work of Moor Instruments and others. "When our project ran out of funding in 1999, I offered the laser speckle contrast analysis method to anyone who wanted to run with it," said Briers. "Today, I know of more than 30 groups, in at least 17 countries, which are using or developing the technique."

For example, neuroscientists at the Harvard Medical School in Boston, US, are using the technique to monitor cerebral blood flow. Other up-and-coming areas include dermatology, diabetes, wound assessment and plastic surgery.

Video-frame-rate (25 images per second) performance opens up many opportunities for research into blood-flow mechanisms. Importantly, it allows scientists to track the changes in microcirculation that occur during a cardiac cycle.

Principle of operation

The technique works by illuminating an area of tissue with laser light to produce a high contrast random interference effect known as a speckle pattern. Blood cells flowing through the region of interest cause the speckle pattern to change and appear blurred, which leads to a reduction in local contrast. High flow rates show up as areas of low contrast and conversely, low flow rates are defined by regions of high contrast.

"A very simple way of capturing this [flow rate] information is to image the speckle pattern," said Briers. "Velocity distributions are coded as variations in speckle contrast." For convenience, scientists typically convert the contrast variations into an intensity map, which is much easier for the human eye to perceive.

The early days

When Fercher and Briers began their work in the 1980s at the University of Essen, Germany, suitable digital techniques were unavailable. "It was a two-stage process and nothing like real time, which meant that the medical profession was not particularly interested," commented Briers. "We've had to wait 25 years for [digital] technology to catch up."

In the early days, Fercher and Briers used a film camera to photograph the flowfield and then applied a form of optical-image processing to capture blood flow in the human retina. In the 1990s, Briers and his team at Kingston University, UK, came up with a digital version of the technique that bypassed the need for a two-stage approach and involved manipulating data directly from a charge-coupled device (CCD).

"About 10 years ago we could do this whole process in about one second," said Briers. "What Moor Instruments has done is to reduce the processing time down to one-twentyfifth of a second, which means that you can operate at video frame rates and actually see the blood flow changing."

Moor Instruments' FLPI system uses a near-infrared laser diode (785 nm) and a 576 × 768 pixel CCD camera to capture blood flow over an area of up to 80 × 120 mm. When operated in zoom mode, the system can deliver a maximum resolution of around 50 µm. The firm is now working on a version that can resolve down to 5 µm. Changes in contrast are colour coded to give a false colour map of velocity distribution.

To make the instrument more accessible and affordable to its customers, the

company is keen to use off-the-shelf PC technology wherever possible. The firm's Windows-based software is compatible with standard USB and FireWire interfaces, which eliminates the need for dedicated internal frame grabbers, and enables it to be used with laptop computers.

Ease of use and suitability for studies in the clinic and in the ward are key issues for the design team. "The company has packaged the laser delivery system to achieve Class 1 operation," revealed Briers. "It's completely eye safe, so you don't need to wear protective goggles."

The firm has applied for Food and Drug Administration pre-market approval for its device and is confident that users looking for video-frame-rate performance will appreciate the instrument's benefits. Rival techniques, such as laser Doppler imaging, may offer greater sampling depth, but they are based on a single-point measurement and require scanning. "The main problem is the time taken for the scan to be carried out," said Briers. "What laser speckle contrast analysis offers is a full-field technique that produces a map of velocity from a single shot."

Moor Instruments

Live video: the full-field laser profusion imager from Moor Instruments can map blood flow in real time.

"I'm not aware of any other instrument on the market that can give a real-time video image of blood flow."

David Briers

Market value

Moor Instruments anticipates that sales of its FLPI over the next five years could be worth about £3 m (€4.5 m) in the research market alone. Over the same period, the clinical sector could deliver around £10 m in sales, but this figure will require a substantial investment in clinical trials.

"It's really the medical side that has caught the imagination, but there are many other potential applications out there," commented Briers. "The technique can even be used to watch paint dry by determining when the painted surface has hardened." □

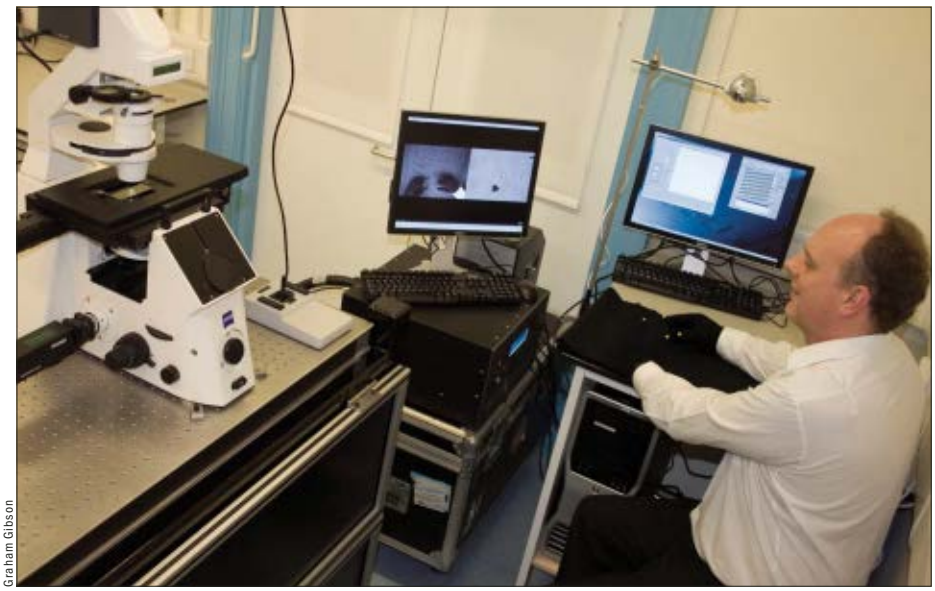
Microhand is a perfect fit for optical tweezers

A user-friendly set of optical tweezers that uses the position of the operator's hands to move trapped particles is broadening the appeal of the technology. **Jacqueline Hewett** reports.

Help really is now "at hand" to transfer optical tweezers into the wider scientific community. This is thanks to work being carried out in the UK to create a user-friendly set of optical tweezers with a range of simple interfaces.

Graham Gibson and Miles Padgett of the University of Glasgow are part of the research effort. In their system, the position of the user's fingertips defines the x, y and z location of the optical traps that make up a microhand capable of manipulating micron-sized objects, ranging from metallic particles to red blood cells (*Optics Express* **14** 12497).

"We wanted to create an intuitive and natural interface," Gibson told *OLE*. "The microhand is our first attempt at developing this completely new type of interface. The novelty of this system is that the trap locations are controlled by the position of the operator's fingertips."



Graham Gibson

Graham Gibson demonstrating the microhand system. Optical traps are generated using the position of the operator's fingertips. Software updates the position of each trap 10 times per second.

All about holograms

Basic optical tweezers pass a laser beam through an objective lens to form a tight focus on a microscope coverslip. Particles held in a solution on the coverslip are then attracted and trapped in the high intensity part of the beam. Holographic optical tweezers use a diffractive optical element, in this case a programmable spatial light modular (SLM), to shape the incident beam and generate multiple optical traps that can be moved independently and simultaneously.

As Padgett explains, the microhand uses some clever software, written in-house, to recreate the position of the user's fingertips as optical traps on the microscale.

"The user puts on a pair of black gloves with white beads attached to the fingertips," Padgett told *OLE*. "A webcam looks down on the gloves and we use LabView's pattern-recognition software to assess where the four beads are. We then use an algorithm to design holograms and pass this information on to the SLM to produce the optical traps."

The hologram-designing algorithm essentially adds up the phase holograms of basic optical elements to produce a hologram that defines an individual trap. For example, a diffraction grating produces a lateral shift and a lens causes an axial shift.

"One way of imagining it is, if our program said 'if I want to make a hologram that puts a trap where the first bead is then it's this diffraction grating' and it goes through beads one to four, adds them and displays the result on the SLM," explained Padgett. "One laser beam hits the SLM and four beams leave it giving four traps."

This is where the processing power of modern computers comes into play. "We can calculate 8–10 frames per second so we can see where the fingers are, calculate the four gratings, add them together and display it 10 times per second – enough to follow what is happening in real time," continued Padgett. "Our holograms have 512 × 512 pixels."

Multidisciplinary potential

The team's system is built around an inverted microscope with a 1.3 NA objective lens. A diode-pumped, Yb:YAG laser emitting 3 W at 515 nm is expanded to fill the SLM's aperture, which is then imaged onto the back aperture of the objective lens to produce the traps.

On the coverslip, one 5 µm-diameter silica bead is drawn into each of the four optical traps and can be moved at will by the user. One facet of the microhand is that it can be used to manipulate objects that cannot be tweezed by traditional means such as opaque particles. For example, the researchers have successfully used the microhand to control chrome particles measuring 8 µm.

It's not just metallic particles that can be moved by the microhand. The technique is also ideal for picking up particles such as red blood cells. The fragile nature of this biological material means careful consideration has to be given to the size of the silica beads and the trapping laser.

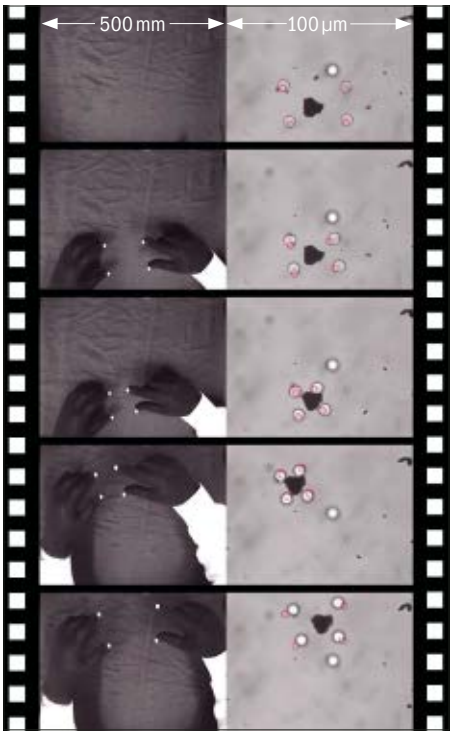
"5 µm beads are a good compromise," explained Gibson. "2 µm beads are easier to trap but the beam is closer to the trapped object. You isolate the trapped object better as the bead gets bigger. You would like to use 10 µm beads, but they become too difficult to trap. We have also switched to a Ti:sapphire laser emitting between 810 and 830 nm because there is less absorp-

tion by the cells."

The team is also interested in introducing a level of feedback either to the glove or to the images shown on screen. "One of the things we have tried, but haven't succeeded in, is squashing a red blood cell," said Padgett. "Making the system tactile is something we are interested in."

Having ironed out all the teething problems with the microhand, the technology will be transferred to the University of Bristol where researchers Mervyn Miles and Daniel Robert have a number of applications in mind. One idea is to use it to assemble even smaller tools. "It might simply be a set of chopsticks that you could build something smaller with," commented Miles.

Other assembly tasks could include building a photonic crystal lattice structure, or electronic devices such as LEDs. "We could introduce a defect in the photonic structure exactly where we want it," said Miles. "We'll do this with the microhand first to learn how to manipulate things, and then we need to automate the process. One of the big challenges is to develop algorithms that allow you to assemble larger structures. In terms of an LED, each trap could contain a component and you could use the microhand to pick them up and assemble them in the right order."



Graham Gibson

These images show how the position of the user's fingertips defines the location of the optical traps that make up the microhand. An additional feature of the control software limits the speed at which the traps can be translated to less than 5 µm/s.

According to Miles, biological applications are also on the agenda. "If you trap a particle and put it inside a cell, gel, or other 3D structure, you can watch its random walk as it explores its environment," he said. "This is called a photonic force microscope. Increasing the number of traps, we could have many particles and track their behaviour in real time. The trapped particle could also contain an enzyme to trigger events. You could have a tool to dissolve something when the beam is turned off, for example."

Changing the interface

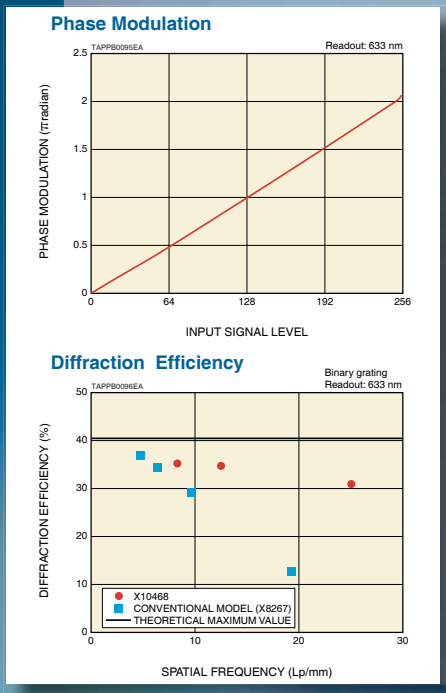
Having successfully demonstrated the microhand, the Glasgow team is also putting the finishing touches to an interface that uses a joystick to manipulate the traps. Described in an article to be published in the *New Journal of Physics*, the optically controlled gripper uses the fire button on the joystick as a means of positioning the silica spheres around the trapped particle.

Given the simplicity of both of the tweezers, scientists who are unfamiliar with the technology may now be willing to look at it in a different light. Handing direct control back to the user could be just the change that scientists are looking for. □

PRODUCT & TECHNOLOGY

Spatial Light Modulators

News



For more than 50 years, Hamamatsu Photonics has pushed the boundaries of Photonics technology and has developed a wide variety of state-of-the-art components. Our products offer solutions for many medical, industrial and analytical applications, such as the use of our Spatial Light Modulators in the development of Optical Tweezers by Professor Miles Padgett's Research Group at the Department of Physics, University of Glasgow.

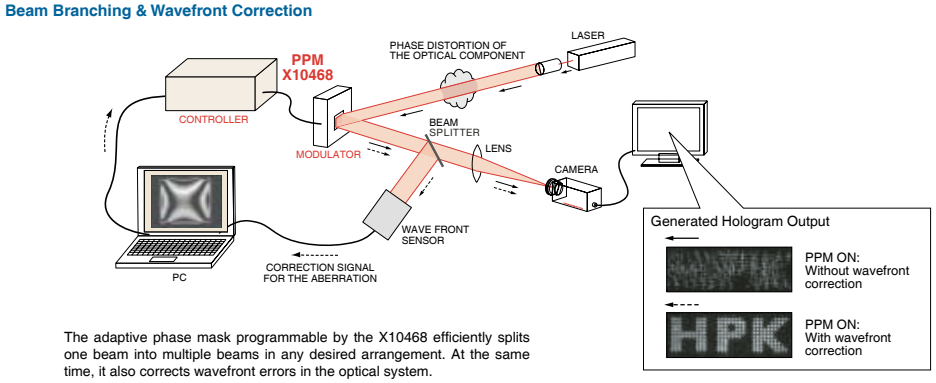
Hamamatsu is now developing a Liquid Crystal on Silicon Spatial Light Modulator (LCoS-SLM) the X10468.

Features:

- Each device optimised to meet individual application requirements
- Wide wavelength ranges will be available
- High diffraction efficiency
- Compact
- High precision phase modulation
- Linear phase modulation characteristics
- Higher frame rate compared to conventional parallel-aligned nematic liquid crystal SLMs

Applications:

- Optical Tweezers
- Wavefront correction
- Optical Correlation
- Laser machining



The adaptive phase mask programmable by the X10468 efficiently splits one beam into multiple beams in any desired arrangement. At the same time, it also corrects wavefront errors in the optical system.

Parameter		X10468
Array Size		16 mm × 12 mm
Format		800 × 600
Fill Factor		95%
Spatial Resolution		25 Lp/mm
Phase Stroke		More than 2 π radian
Dynamic Range		8 bit
Response Time (per rad)	Rise	10 ms
	Fall	30 ms
Frame Rate		60 Hz

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Extended VCSEL wavelengt

Markus Ortsiefer from Vertilas explains why long-wavelength tunable VCSELs are a better option for gas sensing than the lead-salt, quantum-cascade and diode-pumped solid-state lasers that are used today.

Vertilas is currently developing singlemode versions of its 2.3 µm produced by car engines. The firm believes that its BTJ design is

Gas sensors are employed for numerous applications, including detecting moisture; monitoring gas leaks and greenhouse gas emissions; searching for toxic and hazardous species; and optimizing combustion processes. Although many of these tasks can be carried out with chemical detectors, there is now a growing interest in optical systems that have several inherent advantages. These include rapid data collection and a non-contact approach that is more suited to the awkward measurement conditions in power stations and chemically reactive environments. In contrast to chemical sensors, which only detect gases at a fixed location, optical techniques can monitor target molecules anywhere within the detection path of the measurement system.

At Vertilas, in Garching, Germany, we have been developing a unique VCSEL structure that can provide the source for a modern sensing technique – tunable diode laser spectroscopy (TDLS). Our lasers cover the 1300–2300 nm wavelength range and have been used to determine the presence of numerous gases. With the tunable laser as a source, individual gases are identified by their unique optical absorption fingerprint. By focusing on a specific wavelength where a gas has a characteristic absorption, the amount of light absorbed reveals the concentration of the gas.

TDLS has frequently been applied to wavelengths outside the range covered by our lasers. By analysing the strong absorption lines in the mid-infrared region (2.5–50 µm) the technique can determine the concentration of common gases such as water vapour, carbon dioxide and ammonia. These lines are associated with so-called rovibronic ground energy transitions, a term that describes the combination of molecular rotations and oscillations. The absorption strength of these transitions enables detection of gas concentrations even in the parts per billion range.

However, the various lasers that are used to probe these gases at mid-infrared wavelengths, including lead-salt, quantum-cascade and diode-pumped solid-state lasers, tend to be either expensive or inconvenient to use. This can be avoided by focusing on alternative transitions in the near-infrared (800–2500 nm). The absorption strength of these transitions is one to two orders of magnitude weaker than that of the rovibronic transitions. However, more reliable, cost-effective and easy-to-use sources are available that draw on the technology associated with lasers used for telecommunications or data storage. Sensing in this spectral range is also an advantage because uncooled high-sensitivity detectors are available that can partly offset the weaker absorption strength of the higher order transitions.

VCSELs versus edge emitters

The first TDLS systems operating in the near-infrared used conventional edge-emitting distributed feedback (DFB) lasers, but improvements to the performance of VCSELs operating at 1.3 µm and above have made a better source for gas sensing (see table for the benefits of VCSELs over DFB lasers for TDLS applications). These VCSELs have a tuning range that can extend to several nanometres, which is much wider than that of a DFB laser. This is because VCSELs have a much smaller active region, so that their internal temperature is much more susceptible to increases in drive current than a DFB laser. The tunability yields a wider range of measurements. For example, pressure-broadened absorption lines can be examined, several lines relating to one species can be observed simultaneously and multiple species can be detected in a gas mixture. The VCSEL wavelength can also be tuned through the absorption line several million times per second, enabling real-time monitoring of rapid combustion processes.

Although GaAs-based VCSELs for optical communication applications are made in their millions – their use in TDLS systems is restricted to the detection of oxygen, which has an absorption line at 760 nm. Emission can be extended to 1300 nm while maintaining an adequate level of performance, but this is still short of the absorption lines for important species such as methane (1651 nm), carbon dioxide (2004 nm), water vapour (1854 nm) and ammonia (1512 nm).

Unfortunately, the performance of the long-wavelength VCSELs has lagged behind that of their short-wavelength counterparts, due to technological difficulties linked with the different material system required. The ternary and quaternary InP-based compounds that are needed to reach the longer wavelengths suffer from a relatively small index contrast, which means that a very large number of mirror

Characteristics of VCSELs and distributed feedback lasers

Laser type	Threshold current (mA)	Output power (mW)	Current tuning rate (nm/mA)	Current tuning range (nm)	Temperature tuning rate (nm/°C)	Maximum frequency modulation (MHz)
VCSEL	0.5–2.0	0.4–3.0	0.3–0.8	3.0–5.0	~0.1	>1.0
DFB	20	10	<0.05	<1.0	~0.1	<0.1

hs offer gas sensing source

n VCSELs that could be used to detect the carbon monoxide a good choice for a variety of gas-sensing applications.

Coping with heat

Optical gain in InP-based lasers is very sensitive to temperature variation, so internal heating has to be suppressed to produce sufficient performance. Vertilas's buried tunnel junction (BTJ) design addresses this issue by reducing the thickness of the p-doped layers. Low-resistance, n-doped layers are used because of their negligible absorption. Thermal characteristics are also improved by attaching a hybrid gold-dielectric mirror to one side of the VCSEL. This decreases heat resistance by almost an order of magnitude compared with the ternary and quaternary InP-based semiconductor Bragg mirrors, and has no detrimental effect on reflectivity.

The dielectric mirror on the bottom of the BTJ VCSEL can be made with electrically insulating materials, which opens up the design space to pairs of materials with greater refractive index contrast. The upper mirror carries no heat flow, which means that this part of the VCSEL can still be made from normal semiconductor alloys.

The dielectric mirrors typically have a total reflectivity of 99.5–99.9% and are constructed from either 2.5 or 3.5 periods of CaF_2/a-silicon (refractive index difference, Δn of 2.1) or CaF2/ZnS (Δn of 0.9) that are coated with gold. The VCSELs also feature an electroplated metal layer on the bottom of the structure that provides mechanical stability and serves as an excellent heatsink. Finally, the InP substrate is completely removed from the device.

pairs are needed to produce the required reflectivity for the laser cavity. Thermal conductivity is also more than an order of magnitude below that of the AlGaAs/GaAs compounds, making thermal management a major problem. Despite efforts to improve thermal dissipation by attaching a heat sink to one of the mirrors, most of the long-wavelength VCSELs fabricated so far have poor performance characteristics.

Success is possible, however, if one turns to novel designs, such as our InP-based VCSELs that feature a buried tunnel junction (BTJ) and dielectric mirrors. We demonstrated this approach in 1999 and since then have improved the performance of our devices and increased their spectral coverage. Our BTJ VCSELs now operate at over 100 °C, have good thermal management properties (see "Coping with heat") and deliver singlemode output powers of more than 1 mW at 85 °C. They also have a wavelength tuning range of several nanometres, modulation speeds in excess of 10 Gbit/s and are compatible with high-volume manufacturing – the full-wafer processes we use today on 2 inch material can be scaled to larger sizes.

Our BTJ VCSELs are mounted on a TO-header with an integrated thermo-electric cooler and thermistor to monitor and control the laser stage temperature. Temperature stability is demanded by gas sensing applications because the temperature-dependent wavelength is crucial to accurate detection. In a final production step, the header is completed with a cap and a wavelength-specific antireflection coating. The lasers' gas-sensing capability has been demonstrated by absorption measurements of ammonia, which have shown many fine details (figure 1). We acquired these spectra by operating the laser at –3.4 °C and then 15.2 °C to provide a coarse control of the emission wavelength and using current tuning for fine adjustments.

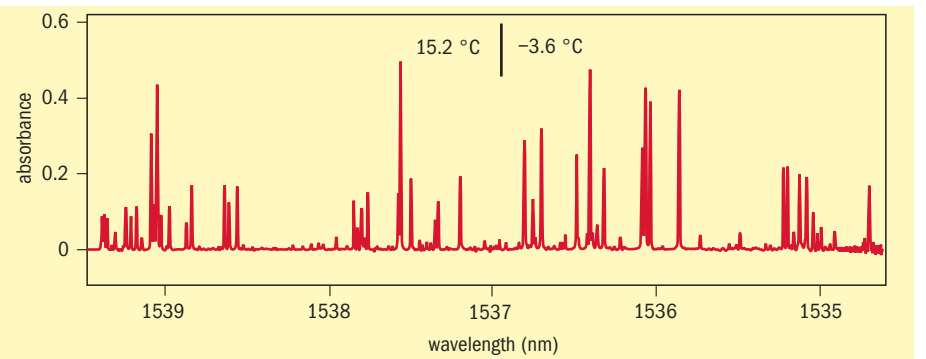

Fig. 1: by setting the operating temperature of the laser to 15.2 °C and –3.6 °C, Vertilas's VCSEL can be used to investigate the absorption spectrum of ammonia. The measurements were made on ammonia gas contained in a 44 cm quartz tube and held at a pressure of 9.6 mbar. The absorption measurements are in excellent agreement with the simulated data taken from the database standard.

By adjusting the thickness and composition of the active region and epitaxial and dielectric mirror layers, we produced singlemode BTJ VCSELs operating from 1.3 to 2.05 µm. We also demonstrated the first electrically pumped room-temperature continuous-wave 2.3 µm BTJ VCSEL. This produces 1.47 mW at 0 °C and 0.74 mW at 20 °C, and a tuning range of 4.2 nm at room temperature. It only operates in a multimode fashion that is unsuitable for spectroscopy, but we are developing a singlemode version that could be used to detect carbon monoxide, which has a 2332 nm absorption line. This work will extend the range of our BTJ VCSELs, which can provide a cost-effective, tunable source and offer a good choice for a variety of gas-sensing applications. □

Markus Ortsiefer is a co-founder of Vertilas GmbH and is responsible for the company's production and research and development divisions. *He would like to thank M Lackner from ProcessEng for technical discussions.*

This article originally appeared in the November 2006 issue of *Compound Semiconductor.*

Weigh up your options before buying eyewear

Deciding which laser-safety eyewear is the best option for your experiment can be difficult. **Tom MacMullin** looks at what's on offer and details the criteria to consider before choosing.

Some of the frequently asked questions that we hear regarding laser-safety technologies suggest that even the most sophisticated laser users do not usually understand the basics of protective eyewear. For example, some common queries that often complicate the eyewear buying process include: Can I get a plastic version of this glass eyewear? Is polycarbonate eyewear as safe as filter-glass eyewear? Where does the laser radiation go if it hits my eyewear? Can I choose the colour of my filters?

Kentek Corporation

Knowledge transfer: other applications include workstation viewing ports and optical table enclosures.

Eyewear technologies

Let's briefly review what a laser filter is designed to do. A laser emits radiation at a specific wavelength that may or may not be within the visible spectrum. Some lasers, particularly tunable lasers, emit radiation at several wavelengths simultaneously. A laser filter must protect the eyes from a particular set of wavelengths but, at the same time, allow at least some normal ambient light to pass through to the eyes. This means that one filter alone cannot block all the wavelengths while still allowing the user to see their work. Although the laser filters described in this article are primarily related to eyewear, similar science applies to filter-glass windows and other laser work-area viewing products and optics.

There are two basic types of laser-protection filter technology: absorption and reflection. With absorption, the energy of the laser is captured by the protective medium and transformed into heat, which must then be dissipated by the surrounding materials. Absorbers can be formulated for selective wavelength attenuation and for broadband or multiple wavelength attenuation. Reflection means that laser radiation directed at the filter bounces off in a different direction, often in a broad scattering pattern. Reflective filters can also be designed for one or several wavelengths.

- **Absorption: filter glass.** Filter glass is traditionally used in protective eyewear to absorb laser radiation. Products are sometimes referred to by the colours of the final product, for example blue glass, green glass, and orange glass. Each filter contains an element, or mixture of elements, that is known to absorb laser energy at particular wavelengths. Two approaches involve introducing ions of heavy metals or rare earth elements and colloidal colorants into the glass.
- **Absorption: polymers.** Polymers impregnated with dyes and other materials will reproduce the absorptive behaviour of mineral glass-laser filters. The polymers used in laser safety are typically polycarbonates, but other materials, including nylons and acrylics, may be used. As is common in many industrial plastics processing technologies, the dyes are mixed directly into the polymer during the moulding process, extruded into concentrated pellets of the desired end-product material and later diluted for product moulding, or impregnated into the surface of the polymers. Plastic laser-safety compounds can be moulded into a much wider variety of sizes and styles compared with filter-glass products.
- **Reflection.** Reflective laser-safety coatings come in the form of thin-film coatings, metallic-film coatings, dielectric films, or dielectric interference coatings. Multiple layers of specially selected materials are applied to a substrate under vacuum conditions. This creates a custom-designed interference pattern that reflects only the desired wavelengths and allows the remaining light to pass through. The laser energy is reflected not only at the surface, but at the layers built up near the surface of the substrate. The coatings used in laser safety are primarily applied to glass, but similar coatings on polymers are an eventuality.
- **Combination technologies.** Some laser-safety products comprise several technologies, the most common include coatings on filter glass; laminations of multiple filter-glass substrates; and laminations of filter glass and polymer substrates. Lamination of multiple protective layers is often the best way to build a product that protects against multiple wavelengths and unusual combinations of wavelengths. ▷

Safety eyewear FAQs

Q: Can I get a plastic version of glass eyewear?
A: Yes, but you may give up some visible light transmission (VLT) in exchange for a lighter-weight product.

Q: Is polycarbonate eyewear as safe as filter-glass eyewear?
A: Yes, similar optical density protection levels are achievable in polycarbonate, but you may lose some protection against any potential direct hits.

Q: Where does the laser radiation go if it hits my eyewear?
A: Absorption technologies convert laser energy into heat, which dissipates. Reflection technologies send the laser radiation elsewhere, often in a diffused pattern.

Q: Can I choose the colour of my filters?
A: Yes, some of the time. Be aware of the trade-offs, including reduced VLT and colour recognition. Do not rely on colour alone when identifying eyewear that is suitable for your laser application.

• **Patient eye protection.** Completing the inventory of laser-safety technologies is the growing family of opaque patient eyeshield products. These are technically absorptive products and are usually entirely opaque through the extended laser spectrum from 380–11 000 nm. These products are often metallic or contain a metal layer and are increasingly available as disposable products for use in dermatological laser and intense pulsed-light applications.

Making your selection

Be aware that there are trade-offs involved when selecting any laser-safety eyewear technology. The table on p26 summarizes our filter-technology recommendation algorithm and lists criteria to consider when selecting eyewear. One common trade-off is that filter glass will be heavier than polymer products, but usually provides better visible light transmission (VLT).

Coated substrates are selected when multiple-wavelength protection is required, but these products tend to be among the most expensive and require the most care. The physical properties of polycarbonate make eyewear based on this technology suitable for all-day wearing and for moulding single-lens products with a wide field of view.

Kentek Corporation

Laser-protective eyewear is available in a wide range of styles to suit different work environments.

Before finalizing your selection of laser eyewear, consider your work environment and not just the laser system. High VLT products are best for low-light environments. Impact resistance is necessary in production environments and should be considered in all workplaces, whereas UV protection and glare reduction may be needed for welding. Larger products and wrapping eyewear products provide additional splash protection for medical appli-

Laser protective eyewear: a comparison

Performance needs	Filter glass	Polymer	Coated glass	Laminated
Multiple wavelength coverage	Very good for standard wavelength combinations	A few good choices available	Best overall. Product selection currently limited	Often the only solution for unusual combinations
Prescription (R_x)	Good choice. R_x may be used in laser lens	Usually requires an adapter	Good choice. R_x may be in laser lens in newer products	Not typically used. Thickness and layers impact the optics
Selective far-IR wavelength coverage (e.g. 1540 nm)	Best current choice	May not be possible depending on wavelength	Technologically feasible, requires customer design	Good choice if combining far IR with other wavelengths
Femtosecond (mode-locked) coverage	Best current choice	Some new products emerging	Not available at present	Some new products emerging
Wide field of view	Larger lenses often too heavy	Moulded single-lens products are best choice	Larger lenses often too heavy	Larger lenses often too heavy
Eight-hour shift wear	Excellent VLT. Request impact resistance from supplier	Lowest weight, impact-resistant products	Excellent VLT. Request impact resistance	Not typically used
High-power protection	Best choice for direct laser impact	Excellent OD levels available, but not for direct hit	Excellent OD levels available. Review each product for direct hit	Excellent OD levels available. Review each product for direct hit

cations and many of these customers prefer lightweight polycarbonate eyewear. The technology you select will impact these performance characteristics.

Because laser-safety eyewear is a personal protective device, a review of the failure modes and failure characteristics of products made from the various technologies may assist you further in your choice.

Failure modes

Glass filters generally provide superior thermal stability when compared with plastic filters, and polycarbonate ones in particular. In high temperatures, however, glass will tend to splinter or shatter due to heat distortion. Glass filters should be treated or coated to hold the pieces together in the event of a catastrophic failure due to a direct hit from a laser. It is worth noting that even a cracked glass filter provides some protection if the pieces remain intact.

Polymer lenses may carbonize if they are subjected to a direct hit by a laser with a high power density and can then be penetrated. The dyes used in polymers may also exhibit photochemical bleaching, a phenomenon in which the intensity of the laser radiation impinging on the dyes exceeds the ability of the material to absorb and dissipate the energy. The effect is to open a temporary window through the lens for the duration of the high intensity exposure.

A consideration for coated products is the angle of incidence. The coating layers must protect against stray radiation that impinges the lens at an angle away from the perpendicular. Current standards require 30° of protection and some products are available with up to 40° of protection.

To summarize, laser-protective filter technology selection depends not only on the application, but also on the characteristics and relative trade-offs of each technology. A careful review of your work environment and eyewear-performance expectations against the various outlined criteria will enable you to shop smartly and effectively for laser protection. □

Tom MacMullin is president and general manager of Kentek Corporation. For more information, visit www.kentek.com or e-mail tmacmullin@kentek.com.

FEBRUARY 2007

EOS NEWSLETTER

THE OFFICIAL PUBLICATION OF THE EUROPEAN OPTICAL SOCIETY

EOS marks 2006 milestones and successes

2006 was a highly successful year for the EOS.

Over the last few years, the EOS has become the largest representative of the European optics and photonics community. With eight national societies acting as full branches (France, Germany, Hungary, Italy, Russia, Sweden, Switzerland and the UK) and 10 affiliated societies, the EOS has more than 5000 individual members, 20 educational members, 50 corporate members, and brings together the academic and industrial worlds.

There were two great achievements last year: the launch of *JEOS:RP*, an online journal, in June and the largest EOS annual meeting (featuring six topical meetings), which took place in Paris in October. This meeting was also the venue for the first focus groups on imaging; information optics and micro-optics; metrology; optical fabrication technology and quality management in optics production; terahertz and microwave radiation; training and education; visual optics and colorimetry. These groups will promote networking within the society following strategic guidelines; help scientific co-operation; and organize future topical meetings.

The European Community's interest in photonics has increased. Thanks to a great effort from key industrial and academic players across Europe, the Photonics21 technology platform has established a strategic research agenda for the 7th Framework Programme. This new agenda raises important issues for the future, but also presents us with great responsibilities and challenges.

It is commonly believed that the 21st century will be the century of photonics. Indeed, optics and photonics technologies are used and have the potential to enhance the quality of life in many areas from environmental science and security to medicine and health; from information and telecommunications to consumer technologies. What's more, highly innovative research fields are emerging that will allow photonics to enter the nanoscience and nanotechnology area.

The EOS, thanks to the enthusiastic activity and talents of its members, and to the professional work of its central office, has the potential to become the driving force of initiatives devoted to the development of roadmaps for Europe and can provide a common platform for the academic world, research institutes and industry.

In the near future, we should concentrate our efforts in specific areas to strengthen Europe's influence in the photonics arena.

Roberta Ramponi is the current president of the EOS.

- **Education and training:** improving education in optics is the first step that will allow optics and photonics to make a stronger impact in research and production environments. Networking and mobility are key factors in fully exploiting existing teaching and training structures throughout Europe. In this respect the EOS can make an important contribution by collecting up-to-date information and making it available to all.
- **Bridging academia and industry:** one of the main problems when innovative technologies are being developed is closing the gap between academic institutions, where brilliant new ideas are often proposed but research tends to stop as soon as feasibility is demonstrated, and industry where short-term periods are sought between research and production implementation. The EOS can provide a forum where the different players can interact and fill this gap through mutual help. This will also benefit Europe's competitiveness.
- **Knowledge dissemination:** The EOS can make an important contribution to knowledge dissemination through organizing topical meetings and larger events. Increased co-operation with other learned societies and national institutions is of major importance as it will give greater visibility to European activities. Increasing scientific publication activity, mainly through *JEOS:RP*, and trying to attract both European and worldwide contributions, is also of significant importance.

I would like to conclude by wishing all EOS members and photonic-related activities in Europe the best of success in 2007.

Roberta Ramponi (e-mail roberta.ramponi@fisi.polimi.it).

OPERA2015 goes to Helsinki

Photonics database makes debut at Helsinki event.

Photonics21 and OPERA2015 had a booth at the ICT showcase event, which was held in Helsinki, Finland, 21–23 November 2006. More than 4000 delegates attended and there were presentations and demonstrations on all areas of ICT technology. OPERA2015 was invited to speak and gave a talk entitled "The photonics information exchange and the IST project OPERA2015", at the Photonic Components and Subsystems conference session. The aim of the session was to present and discuss the strategy and content of the ICT work programme in photonics.

The beta version of the OPERA2015 web-based database on photonics research labs in Europe was demonstrated at the booth and the partner search tool attracted a good deal of interest from the photonics community. More than 400 new contacts were made by photonics researchers all over Europe. Significant steps were taken towards completing the database of European photonics research labs as several key network contacts, especially from Eastern Europe, were identified.

OPERA2015 gives support to Photonics21

Photonics21 outlines successes at its annual meeting.

Michael Lebby, Alexander von Witzleben (top) and Rosalie Zobel (middle) presenting to a full house (bottom) at Photonics21's annual meeting in December 2006.

Photonics has been given a firm place in the European Union's (EU) 7th Framework Programme (FP7). The European Commission has created a new unit dedicated to photonics and plans to increase funding for photonics by more than 40% (€90 m) in 2007–2008. These were the positive results that the Photonics21 European Technology Platform (TP) presented at its annual meeting in Brussels in December 2006.

Thierry van der Pyl has headed the new photonics unit since January. "I would like to see that private–public partnerships work in research. This challenge is not only a matter between the EU and the research stakeholders, but also concerns the member states. A comprehensive strategy in Europe is the key," stated van der Pyl while attending his first Photonics21 meeting.

Rosalie Zobel, director of DG Information Society and Media of the European Commission, called on Photonics21 to continue to update its strategic research agenda and to go into more detail. She underlined the importance of photonics as a business area and invited Photonics21 to support the EU and the community to maintain competitiveness with the US and Asia. Zobel added that Photonics21 needs to identify and build a means of developing the photonics area and synergies between national programmes and private investment.

Since its constitution in December 2005, Photonics21 has established a firm foundation for the further development of photonics in Europe. Through the efforts of the TP, the topic has been taken up by eight other units within the Directorate-General for Research and incorporated into areas of great future potential such as the life sciences and manufacturing technology.

The Photonics21 recommendations have two core aspects: higher European and national expenditure on R&D in photonics; and a pan-European strategic approach. One of the first actions by members of the TP, which was supported by leading European companies in the optical technologies industry, was to call for a doubling of EU research expenditure on photonics and a pan-European strategy instead of a fragmented national approach. In view of the concerted investment strategy being pursued by rival markets in the US and Asia, the members of Photonics21 warned that a fragmented approach by the European research community would weaken Europe's ability to compete. The members also announced that they would increase their own research spending by €330 m per year.

The Photonics21 TP also outlined its role with regard to FP7. It will compile information on photonics research topics; structure the collected information; develop research priorities for Europe and provide a common platform for companies and research institutes. The Photonics21 TP will neither review FP7 proposals nor evaluate, assess or recommend FP7 proposals.

"We are very pleased with the results of our work so far. The boost being given to the area by the EU represents a large step forward, in view of the ongoing process of structural change, and will allow photonics-related topics to become firmly anchored in the FP7," declared Alexander von Witzleben, chairman of the executive board of German company Jenoptik AG and president of the Photonics21 TP. "The first essential foundations have been laid, namely a photonics community at the European level and the appropriate funding resources. The next step is to make use of this newly established basis to achieve our planned objectives in a reasonable timescale."

von Witzleben explained that photonics in some member states still has considerable potential to grow. He explained that this year it will be crucial for the community to set up a mirror group composed of representatives from each country with responsibility for photonics. This mirror group will help to improve national support for photonics and align national and European research priorities. The first countries that will be approached are France, the UK, Germany, Sweden, Ireland, Slovenia, the Netherlands, Austria, Poland, Italy, Spain and Finland.

Norway hosts Northern Optics

The 2006 Northern Optics conference was held in Bergen in June 2006.

The Norwegian optics community is grouped within the acoustics and optics section of the Norwegian Physical Society. The section has approximately 100 members, and for practical purposes, it consists of two independent groups. The 80 members who belong to the optics group are associate members of the EOS. Because the optics and physics communities in Norway are small, we have preferred to stay within the Norwegian Physical Society rather than forming a separate optical society.

The main activity of the optics group is to organize the biennial electro-optics meeting. This meeting usually attracts around 100 attendees, including several invited speakers from abroad. The optics group is one of the co-organizers of the Northern Optics conference series, in collaboration with Denmark, Estonia, Finland, Latvia, Lithuania and Sweden.

2006 was Norway's turn to host Northern Optics, which was held in Bergen in western Norway, 14–16 June 2006. The meeting attracted 235 attendees and 17 exhibitors from 18 different nations. The academic programme consisted of five plenary talks, 10 invited talks, 36 contributed talks in two parallel sessions and approximately 100 posters.

The session topics were optics in life sciences; optical metrology and advanced imaging; lasers, nonlinear optics and quantum optics; optical sensors, guided wave optics and surface plasmons; optics in communication and micro-optical devices; and nanophotonics and material optics.

Delegates at Northern Optics 2006 take a boat trip.

One of the plenary speakers was Malgorzata Kujawinska who gave a presentation on Photonics21 and the opportunities for optics in the European 7th Framework programme. The research organization Sintef is now working to set up a Norwegian mirror group of Photonics21.

As is customary at the Northern Optics conference, there was a social programme, which included a boat trip and a conference dinner.

The next Northern Optics meeting, which will be the fourth in the series, will be held in 2009. The exact dates and location will be announced later this year.

The EOS names fellows, and small branches elect board members.

The EOS fellows 2006

The EOS named its fellows for 2006 at its annual meeting in Paris in October. All fellows are judged to have made a remarkable contribution to the European optics and photonics community, and are regarded as a driving force of the EOS. The 2006 fellows are:

- **Mario Bertolotti**

Mario Bertolotti is a professor of physics at Universitá di Roma "La Sapienza" in Italy. He serves on the advisory committee of the EOS and is the first editor of *JEOS:RP*. He has made outstanding contributions to the understanding of coherence, lasers and nonlinear optics.

- **Susana Marcos**

Susana Marcos works at Instituto de Optica "Daza de Valdéz", CSIC in Madrid, Spain. She is currently president of the vision sciences committee of the Spanish Optical Society. She has made outstanding contributions to the understanding of the optical properties of the eye.

- **Giancarlo Righini**

Giancarlo Righini is professor and research director at Nello Carrara Institute of Applied Physics, CNR Laboratory of Optoelectronic Technologies, Florence, Italy. He is a founding member of the EOS and a co-founder of the Italian Society of Optics and Photonics. He has made outstanding contributions to optoelectronics, fibre and integrated optics.

- **Maria Yzuel**

Maria Yzuel is a professor of physics at Universidad Autónoma de Barcelona, Spain. She is a founding member of the EOS and was secretary from 1996 to 1998. She has contributed significantly to the development of optics in Spain and has made outstanding contributions to optical information processing.

Fellows nominations for 2007

Any EOS member can elect a person as a fellow of the society. The 2007 nominations of excellent scientists, researchers and engineers in optics and photonics to the EOS fellow status closes on 14 February. For more information on the procedure, please see www.myeos.org/members_fellows.php.

Small branch and affiliated societies

The small branches and affiliated societies of the EOS have elected their representatives to the EOS board. Prof. Peter Seitz (Switzerland) will represent the affairs of the small branches (Hungary, Italy, Russia, Sweden and Switzerland) while Prof. Concepción Domingo Maroto (Spain) will look after the affairs of the affiliated societies.

Calendar

DATE	EVENT	LOCATION
13–16 March	2nd International Exhibition for Laser and Optical Industries	Moscow, Russia
3–8 June	Optical Interference Coatings (OIC 2007)	Tucson, US
12–15 June	Adaptive Optics for Industry and Medicine	Galway, Ireland
17–19 June	EOS Conference on Trends in Optoelectronics	Munich, Germany
18–20 June	EOS Conference on Frontiers in Electronic Imaging	Munich, Germany
11–14 September	8th International Conference on Correlation Optics	Chernivtsi, Ukraine
12–14 September	3rd EOS Topical Meeting on Advanced Optical Imaging Techniques	Lille, France
30 September – 3 October	Topical Meeting on Optical Microsystems	Capri, Italy

For more information on any of these events, please visit **www.myeos.org**.

Are you a member of the EOS?

Look at the benefits

Individual members are eligible for:

- reduced fees for *JEOS:RP* at www.jeos.org;
- a regular *EOS Newsletter* e-mail;
- reduced conference fees;
- reduced prices for EOS journals;
- free subscription to *Optics & Laser Europe*;
- and, for those living outside Germany, a 50% discount on a subscription to the German-language journal *Photonik*, published by AT-Fachverlag.

Additional benefits for corporate members:

- a company profile in the EOS directory;
- a presence on the EOS website;
- free advertisements for jobs in the EOS market;
- reduced conference fees for all employees.

EOS 2007 membership fees

Individual members (who do not belong to a branch or affiliated society of the EOS): **€40**
Students (who do not belong to a branch or affiliated society of the EOS): **€10**
Corporate members (regardless of the number of employees of the company or members of the institute): **€200**

Individual members of the branches SFO (France), DgaO (Germany), HOS (Hungary), SIOF (Italy), LAS (Russia), SOS (Sweden), SSOM (Switzerland) and the Optical Group IOP (UK) are automatically full individual members of the EOS. Individual members of the affiliated societies Promoptica and CBO-BCO (Belgium), CSSF (Czech and Slovak Republic), DOPS (Denmark), FOS (Finland), the Optics Division of the Norwegian Physical Society (Norway), the Optics Division of the Polish Physical Society (Poland), ROS (Romania) and SEDO (Spain) are automatically associate members of the EOS.

Membership information

To find out more about joining the EOS, contact Klaus Nowitzki, executive director, Hollerithallee 8, D-30419 Hanover, Germany (tel +49 (0)511 2788 115; e-mail info@myeos.org; web **www.myeos.org**).

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EOS IOP

PRODUCTS

If you would like your company's products to be featured in this section, please send press releases and images to James Tyrrell (james.tyrrell@iop.org).

Imaging workstation

Jenoptik

Jenoptik's image-documentation system is equipped with a macro-zoom objective lens that can capture objects from $6 \times 4\,mm^2$ up to $40 \times 30\,cm^2$. Dubbed "macro workstation", the unit features an extremely low vibration-guiding column with a manual friction drive. Ergonomic manual levers provide a means of aligning the objective lens.

According to Jenoptik, the macro workstation can be combined with any of the firm's ProgRes cameras. ProgRes Capture software displays a live image for monitoring and offers automatic image setting and image-saving functions. For convenience, images can be triggered using a foot switch. This option allows the user's hands to remain free for the positioning of photographic objects.

www.progres-camera.com

Laser workstation

JPSA

"Tough, tiny and table top" is how JPSA describes its latest laser-based materials-processing system. The IX-70 ChromAblate has been developed for the repair of flat-panel displays, microcircuits and wafers. Configured with either an infrared, visible or ultraviolet laser source, the system is able to process a wide range of materials from metals to polymers.

Various geometric shapes can be projected onto the work surface using an adjustable aperture or optional mask-indexing wheel. In addition, the system is equipped with a co-axial, high-resolution charge-coupled device camera, adjustable zoom lens and LCD for real-time viewing of the work in process.

www.jpsalaser.com

Imaging light source

Polytec

Polytec says that its Stroboscope BSV-II Wotan can be used to capture dynamic events without any motion blur. It can also help to deliver sharp pictures with good contrast in changing ambient light conditions. At the heart of the device is an ultra-stable pulsed xenon flash lamp that gives a colour temperature of about 5000 K. For convenience, output from the light source is focused into an optical fibre (using an elliptical reflector).

The unit has a maximum pulse frequency of 200 Hz and pulse-to-pulse stability of approximately 2.5%. Triggering formats include TTL (5 V), SPS (24 V) and PAL/CCIR video signals.

www.polytec.de

Multiple-framing camera

Specialised Imaging

The Specialised Imaging Multiple-framing camera is now available from Specialised Imaging of the UK. The firm says that target applications for ultra-high-speed multiple-framing cameras include material studies, combustion research, stress failure, aerodynamic performance and plasma-display studies.

"Our system is able to eliminate effects such as parallax and shading, and the high spatial resolution (>50 lp/mm) is the same frame to frame in both axes," said Wai Chan, the company's managing director. "We have also overcome simultaneous high-speed image-capture problems by incorporating an optical port into the primary beamsplitter to which various secondary recording instrumentation can be interfaced."

www.specialised-imaging.com

Nanosteppers for 3D microscopy

PI

PI has introduced a series of high-speed microscopy objective scanner systems for 3D microscopy applications. The PIFOC piezo Z-drive systems are designed for easy integration into high-resolution microscopes and are available as components, or as complete systems including the piezo-objective scanner, a controller and two distance cases.

The PIFOC units are said to be ideal for high-speed Z-stack image acquisition and come with travel ranges of 100 or 400 µm. The firm quotes a typical focusing time and resolution of 10 ms and 1 nm respectively.

www.pi.ws

PRODUCTS

Lithography system

ASML

ASML, a provider of lithography systems for the semiconductor industry, has introduced what it calls an advanced 193 nm exposure system. "The XT:1450 is in response to our customers' demands for an exposure system with very tight overlay capability," said Martin van den Brink, ASML's executive vice-president of marketing and technology. "Some of our leading-edge customers already have products with 32 nm half-pitch features on their roadmaps. Double patterning could provide the solution for an early introduction and the XT:1450 can help them prepare for that technology."

www.asml.com

Half-ball lenses

Edmund Optics

Edmund Optics is offering hemispherical lenses made from sapphire. The lenses suit a variety of applications including fibre-communication equipment, endoscopes, microscopes, optical pick-up devices and laser-measurement systems.

The firm adds that the lenses are an attractive option for use in severe environments because they are made from sapphire – a material known for its ability to withstand exposure to harsh chemicals and extreme temperatures. The lenses have a very short back focal length and a flat surface that allows easy mounting.

www.edmundoptics.com

Ethernet adapter

Analytical Spectral Devices

Analytical Spectral Devices (ASD) has released a smart Ethernet adapter for use with its ASD Pro model FieldSpec, LabSpec and QualitySpec parallel-port spectrometers. The adapter contains a specialized high-performance internal microprocessor to enable RJ45/ Ethernet connectivity. The adapter allows users of ASD parallel-port instruments to upgrade controllers and software versions, which in turn enables advanced features such as the ASD TCPServer Developer's kit for autonomous control of spectrometer systems and seamless compatibility with LabVIEW systems.

www.asdi.com

Top-emitting LEDs

Avago Technologies

Avago Technologies says that it can now supply the industry's thinnest surface-mount LED in the smallest industry-standard (0603) footprint available. The HSMR-CL25 (blue) and the HSMW-CL25 (white) LEDs designed for applications including backlighting key pads and status indicators in mobile-phone handsets.

The blue emitter is based on indium gallium nitride and features a dominant wavelength at 473 nm and 11.2–45 mcd luminous intensity. The HSMW-CL25 uses a phosphor, and Avago quotes a luminous intensity of 28.5–112.5 mcd. Package dimensions are 1.6 × 0.8 × 0.25 mm.

www.avagotech.com

Battery upgrade

Cedip Infrared Systems

A long-life battery and integrated-screen options are now available from Cedip Infrared Systems for its Silver range of high-performance infrared cameras. The firm says that the combination of both parts allows Silver users to make thermal measurements remotely from a computer and electrical power supply. Applications set to benefit are listed as stress measurement of outdoor structures, non-destructive testing and portable IR experiments where direct access to a computer or electrical power source is difficult.

www.cedip-infrared.com

OPO

High Q Laser

High Q Laser and APE have developed a picosecond laser-pumped OPO capable of emitting over a wide wavelength range. The system comprises a 532 nm picoTRAIN Green modelocked laser from High Q that synchronously pumps an APE LEVANTE EMERALD OPO resulting in a signal output from 690 to 990 nm, and an idler from 1150 to 2300 nm in a TEM_{00} beam. Optional nonlinear wavelength extensions result in second harmonics between 345 and 495 nm (signal) and 575 to 700 nm (idler); third harmonics between 230 and 330 nm; and difference frequency generation from 2.5 to 14 μm using a LEVANTE IR. The LEVANTE EMERALD OPO is said to reach an output power of >2 W (signal + idler @ 4 W pump at 532 nm) in a 76 MHz pulse train with pulses of 5–6 ps duration.

www.highqlaser.at

Neutral-density filters

Reynard Corporation

US-based Reynard Corporation says that it is now able to completely customize its range of circular variable neutral density (CVND) filters. The filters can be supplied with a linear or customized density gradient based on user-defined functions. Available on a variety of substrates including BK-7, fused silica, ZnSe and Ge, gradient coatings can be supplied from 45 to 360° of rotation.

The firm adds that CVND filters can be supplied from 1 to 8 inches in diameter, and gradient

coatings and substrates are available to operate from the ultraviolet to the far infrared.
www.reynardcorp.com

Broadband dielectric mirrors
Optarius

A range of broadband dielectric mirrors that provide more than 99% reflectance at a 45° angle of incidence is now available from Optarius. Useful for white-light and multi-spectral applications, separate wavebands are available covering the visible, near-infrared and telecom wavebands.

Both the substrate and the coating are said to have an equally important effect on the performance of the mirrors. Optarius supplies the components on highly polished BK7 flats with a flatness of $\lambda/8$ and a surface quality of 20/10 or better. Broadband mirrors with diameters of 20, 25.4, 38.1 and 50.8 mm are available, as are custom sizes.
www.optarius.co.uk

Fizeau interferometer test optics
Melles Griot

Additional Fizeau interferometer test optics are now available from Melles Griot to complement its Absolute Fizeau $\lambda/40$ transmission sphere product line.

The firm says that Absolute Fizeau $\lambda/50$ concave and convex reference spheres will allow the user to record and store reference wavefronts for subtraction from interferometric test data, substantially improving their interferometer system's absolute accuracy.
www.mellesgriot.com

Deposition system
Oxford Instruments

Oxford Instruments has developed a new tetraethoxysilane tetraethyl orthosilicate (TEOS) delivery module for plasma-enhanced chemical vapour deposition (PECVD) of silicon dioxide. TEOS offers an alternative PECVD precursor to the commonly used silane for applications such as photonics and dielectric layers, says the firm.

The module is designed to be safe and convenient to use. According to the company, the TEOS source is easy to access and change. The delivery system can be linked up to a clean-room extraction system and an optional glovebox fitting is available.
www.oxford-instruments.com

Pulsed-fibre laser
Lumics

German firm Lumics has introduced a series of pulsed fibre lasers that emit at a wavelength from 1060 to 1080 nm. The LU1065F005 is a MOPA-configured pulsed ytterbium fibre laser that offers an average optical output power of 5 W and a pulse energy of 0.5 mJ.

Available in a robust industry-type housing, the unit measures 270 × 120 × 50 mm and is supplied with an external power supply and driver software. The system can be programmed via a conventional USB interface to deliver pulse repetition rates from 10 to 100 kHz and pulse widths from 50 to 250 ns.
www.lumics.com

Glass polarizer
Codixx

Codixx of Germany has expanded its range of glass polarizers to include the colorPol VIS 600 BC4. Operating within the wavelength range of 500–720 nm, the polarizer features a high contrast ratio of 10^4:1. Produced by doping soda-lime glass with silver nanoparticles, the component is said to be highly durable against ultraviolet radiation as well as most chemicals.

The firm says that its glass filters can be delivered in custom shapes from 0.5 × 0.5 mm up to a maximum size of 100 × 60 mm. Standard mounts are available in 12.5 and 25 mm diameters as well as 0.5 and 1-inch versions.
www.codixx.de

PMT
Photonis

Photonis, US and Europe, has come up with a compact 13 mm round photomultiplier tube (PMT) that covers the spectral range from 270 to 650 nm. Featuring a combination of high gain and low noise, the XP1322 is designed for applications such as scintillation counting and high-energy physics, as well as bioluminescence and uses in the life sciences.

A specifically designed voltage divider (+HV VD307/A) is available for the PMT and together they are said by the firm to offer optimum performance in a streamlined package.
www.photonis.com

Bandpass filters

Oerlikon

Oerlikon Optics has developed what it calls a new-generation bandpass filter for automotive, automation and instrumentation applications. Produced using sputter techniques, the filter comprises very dense coating layers that the firm claims give enhanced environmental resistance. For example, the filters offer temperature stability of up to 300 °C. In addition, sputter technology enables the optical tolerances to be improved by a factor of two, which greatly improves the signal-to-noise ratio of optical sensors, says the company. Further information is provided on its website.
www.oerlikon.com

Light-to-frequency converter

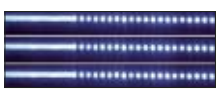
Pacer

Available from Pacer, UK, the TAOS LTFEVM light-to-frequency evaluation module consists of a motherboard and six daughterboards that feature light-to-frequency converter devices arranged in a variety of different sensing configurations. The unit's daughterboards are hot-swappable to allow a quick comparison of sensor characteristics. Five of the six daughterboards include PWN-controlled LEDs, which enable simulation of either a reflective or transmissive light-sensing application.

Windows-based application software features frequency and period measurement, LED brightness control and a strip-chart recorder. The module connects to a PC via a USB interface and requires no external power supply. Applications listed by the firm include the measurement of light absorption, and reflection in products such as white goods, photographic equipment, colorimeters, chemical analysers and display contrast controls.
www.pacer.co.uk

Diffusers

Luminit



Luminit has released a range of elliptical diffusers with transmission efficiencies of more than 85% for homogenizing and diffusing LED strip lights. The list includes 50 × 4°, 40 × 0.2°, 30 × 1°, 15 × 1° and 26 × 0.2°, where the first value refers to the amount of light spread in the horizontal direction, and the second figure gives the corresponding value in the vertical direction.

According to the firm, the diffusers are holographically recorded randomized surface-relief structures that give excellent homogenization without sacrificing transmission efficiency. The company's experience includes biomedical, semiconductor metrology, architectural lighting and display applications.
www.luminitco.com

PRODUCTS

Image-processing software

Multipix Imaging

UK firm Multipix Imaging is offering the eVision machine-vision tools from Euresys of Belgium. The image-processing software is said to provide a wide range of powerful, flexible and advanced machine-vision libraries. Dedicated interface functions allow operators to link the image to eVision objects for processing, simply by using the relevant image parameters. According to the software's designers, this makes the process of moving an application across different acquisition technology more straightforward. The software suits a wide variety of machine-vision uses such as object recognition, inspection measurement and alignment, to name just a few.

www.multipix.com

Machine-vision resource

Moritex

Moritex is offering an online machine-vision lens finder via its website. The facility enables engineers to enter data such as the optimum magnification range, working distance, resolution, and vertical and horizontal fields of view. Designed to determine the most appropriate machine-vision lens for an application, the online package can be found at www.moritexusa.com/lens/index.php.

www.moritex.com

Camera adapters for microscopes

Klughammer

Klughammer of Germany says that its KL-MVP adapter connects almost any digital camera with threaded lenses to most microscopes. The firm carries dozens of attachment kits to fit hundreds of popular digital cameras and updates its stock regularly. The KL-MVP kit includes adapters to fit microscopes with C-mount, C/S-mount, 23 and 30 mm eyepieces. Camcorders with threads from 30 to 62 mm can also be connected.

www.klughammer.de

Rotary table

Loadpoint Bearings

Loadpoint Bearings, UK, is offering an aerostatic rotary table that it says gives low-motion errors below 25 nm. The unit is made from hardened

stainless steel to improve wear and corrosion resistance and includes a through shaft for component holding. Rotary tables are available with a diameter of 150–500 mm and feature a direct-drive integral motor with an encoder resolution of 0.2 arcsec. Operating speeds of up to 3000 rpm are available. Axial stiffness, radial stiffness and axial load are given as 1370, 450 and 5000 N respectively.
www.loadpoint-bearings.co.uk

Diffuse-reflecting ceramics
CoorsTek

CoorsTek has introduced a number of ceramic materials designed for laser reflector/pump-chamber applications. Specifically, the firm claims that its CeraLase AHP-99 grade material provides greater than 98% reflectance at typical solid-state laser wavelengths, as verified by Labsphere. Compared with traditional diffuse-reflector materials, ceramic materials are said to offer superior dielectric strength, thermal stability and hardness.
www.coorstek.com

High-speed camera
Photron

Photron, US, has introduced what it claims is the world's fastest high-speed megapixel video camera. Dubbed Fastcam SA-1, the unit can be operated at 5000 full frames per second (fps) with megapixel resolution. The camera's CMOS sensor provides true 12 bit pixel depth and is capable of reduced resolution operation as fast as 150 000 fps, says Photron.

The Fastcam SA-1 is supplied with an LCD-equipped keypad and two rear-panel BNC connectors that provide users with both composite video (NTSC or PAL) and SDI outputs. Customers can choose from 8 or 16 Gbit memory options, which correspond to around 6 or 12 s of recording at 1000 full fps.

Applications include missile and ballistics testing, and vehicle impact analysis. An optional particle-imaging velocimetry facility is also available to study the flow of gas in a wind-tunnel environment or to analyse flow in fluids.
www.photron.com

Asphere metrology tool
Zygo

Zygo is offering an interferometer designed specifically for the measurement of aspheric-shaped surfaces. According to the firm, its VeriFire Asphere instrument suits production metrology of injection-moulded, diamond-turned and machine-polished aspheres. The tool provides automated alignment, acquisition and analysis to give rapid throughput and low cost of ownership.
www.zygo.com

Fibre-splicing software
Adaptif Photonics

Adaptif Photonics of Germany has released new software to accompany its A1200 PER Analyzer. The system is said to enable highly accurate splicing between any combination of polarization-maintaining (PM) fibres. Applications include the splicing of speciality PM fibres, such as non-circular fibres, double-clad fibres, and the splicing of non-matched PM fibres like Panda to Bow-tie or Tiger to Bow-tie. According to the firm, the package allows high-quality splicing with extremely high polarization extinction ratios.
www.adaptifphotonics.com

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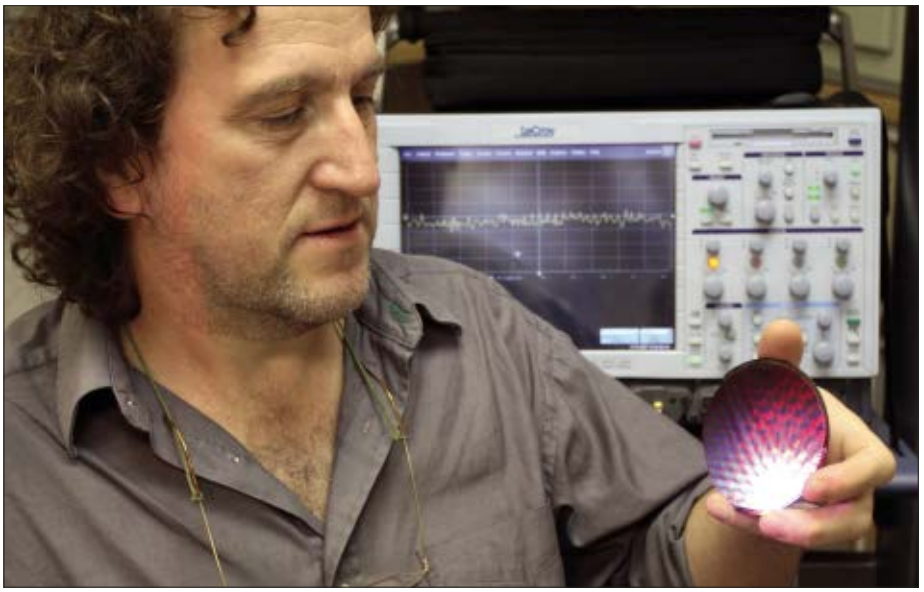
More emphasis on networking could help technology transfer

High-performance microchannel plate photomultipliers developed for use in space could have a wealth of terrestrial applications from drug screening through to environmental science. **Jon Lapington** tells us more.

How did you become interested in MCP technology?

I started working on microchannel plate (MCP) detectors at the Mullard Space Science Laboratory, UK, which is University College London's Department of Space and Climate Physics, and became involved in a number of European Space Agency (ESA) and NASA missions. In 2000, I moved to the Centre for Space Physics at Boston University, US, as a payload manager. I returned to the UK in 2003, and in 2004 began working at Leicester University's Space Research Centre.

I'm still involved in space missions, but we are becoming increasingly aware of new roles for our MCP detectors on the ground, particularly in the field of life-sciences. In general, we find that people don't know what our MCP detectors are capable of.



Photek

Hands on: Jon Lapington helped to develop MCP-based detectors for ESA and NASA space missions.

What can MCP technology offer?

MCP detectors are sensitive to electrons, ions and photons, and offer single-event detection with low noise. In simple terms, an MCP is a wafer of glass comprising an array of pores that can be as small as 2 μm in diameter. The top and bottom surfaces of the wafer are each covered with an electrode and a high voltage is applied between them. When operated in a vacuum, the pores act as an amplifier – you put one electron in and get 10^4 electrons out per MCP. We can achieve spatial resolutions of less than 10 μm and timing resolutions of around 10 to 20 ps for a single electron, ion or photon.

MCP detectors suit applications in a wide range of fields that require photon timing and correlation, and probably the most important of these are in biology and medicine. For example, techniques such as fluorescence lifetime imaging and Forster resonance energy transfer, which are enabled by MCP-like detectors, have major roles in proteomics.

Following on from genomics, proteomics is the next holy grail of biomedical research. MCP technology allows you to tag a protein and see what is happening dynamically in a cell while it is still alive. In the past, researchers have had to break things apart. Proteomics is still in its infancy, but we are developing detectors that will hopefully bring the technique on. The technology is also very useful for drug screening as you can analyse a lot of very similar compounds and look out for the right reaction.

What's the best way to transfer technology across disciplines?

To define a winning device you need a combination of researcher, developer, end user and manufacturer, and it is essential to get all of these people working together. I'm currently involved in a project to develop an MCP detector that is going to be equivalent to a thousand photomultiplier tubes all put together in a package with an active diameter of just 18 mm. The goal is to create an engine for next-generation biomedical tools. As well as the team here in Leicester, our partners include CERN, Gray Cancer Institute, Manchester University's pharmaceutical science department and UK firm Photek.

How important is networking to technology transfer?

Networking is absolutely crucial to finding end users and industrial partners. A few years ago we were looking to create a centre of excellence in 3D photon and particle-counting technologies and I applied for basic technology funding. The application was unsuccessful, but it turns out that all of the subsequent projects that were funded have sprung from those initial contacts.

When I arrived at Leicester, I actually went through a cold-calling exercise to find people who would be interested in the technology and establish contacts in new fields that I hadn't dealt with before. It proved to be an incredibly valuable exercise.

I don't think that there is enough communication across scientific boundaries. Things are beginning to happen, but there are still many more opportunities out there if you can make the contacts. The UK government's Knowledge Transfer Networks are useful, but I think more funding should be made available for networking. Funding the individual who really wants to go out there and promote the uptake of their research would really help to drive the networking process and make it much more focused. Certainly for me, this would have made things much easier and I believe could have made our work even more successful. □

To find out more information contact jon@lapington.com.

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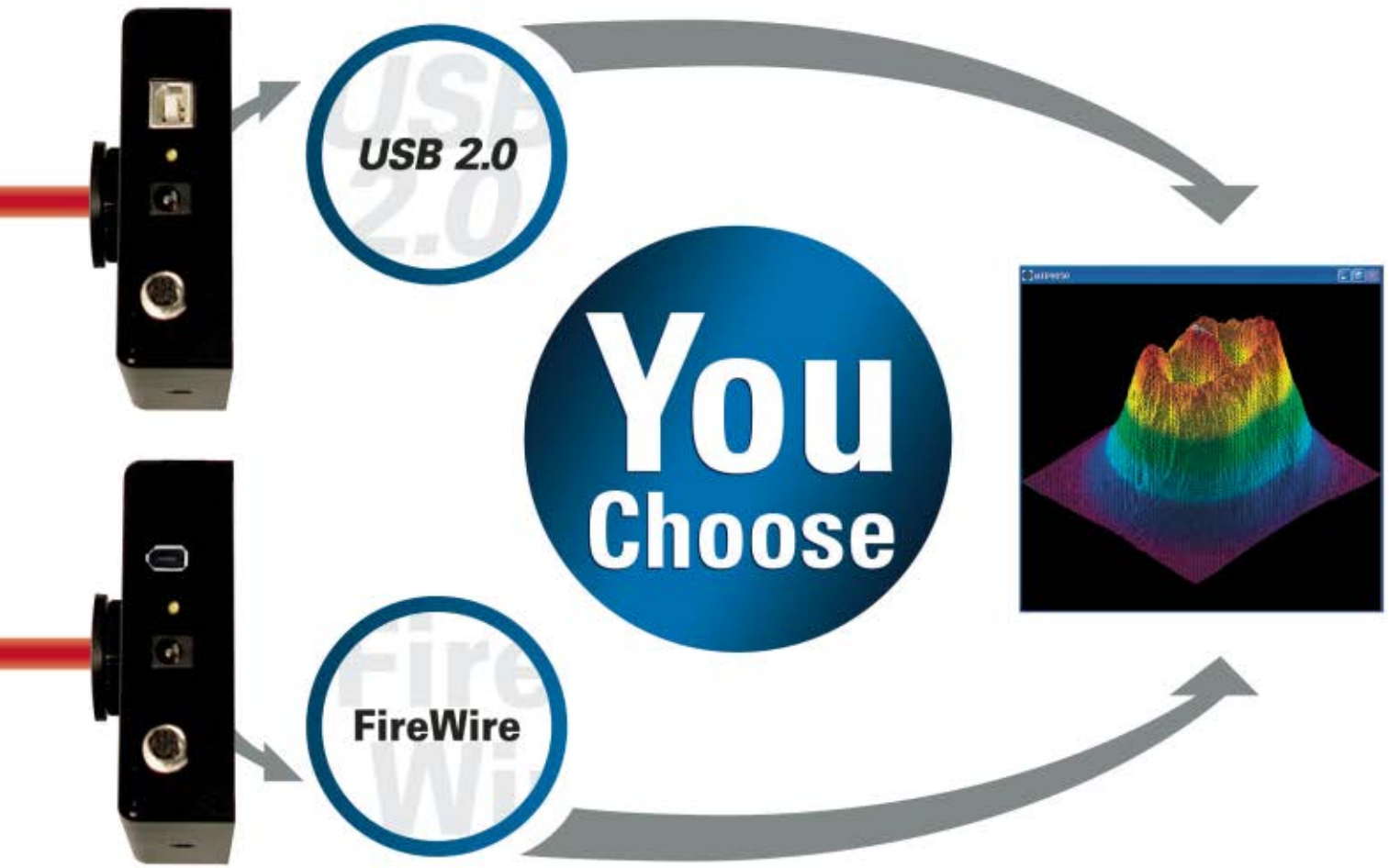

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