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German scientists claim they have the answer to producing cheaper non-spherical lenses with lasers



A rosy forecast

SPIE's Photonics Europe in Brussels was buzzing with activity last month, the industry once again showing that it is at the forefront of the slow recovery the world economy is seeing. The positive outlook is reflected in the number of new sales offices, marketing vice presidents and distributors that companies are announcing, you can read about it all in this month's news section. Also in this month's news section, new product launches, a €7 billion European photonics research proposal, and new laser processes for welding plastics and cutting Alumina ceramics.

Process development is a thread running through the features in this issue with technical advances outlined in our laser marking, portable spectroscopy and machine vision optics features. In machine vision the hot topic is lens manufacturing development for the best possible picture quality; in laser marking it is about creating sophisticated anti-counterfeiting barcode-like markings that can't be forged; and in portable spectroscopy it is about miniaturisation and how people's use of smartphones is shaping their expectations of mobile instruments.

No doubt these topics and more will be making an appearance at both Optatec in Frankfurt this month and Lasys in Stuttgart in June. *Electro Optics* will also be attending these shows. In this month's issue you can see our Optatec show preview. But if we won't see you there you can still find out the latest news from that show, and from Photonics Europe, in the email newsletters you can subscribe to, EONewline and EOProductline. As always, I can be contacted through my email rob.coppinger@europascience.com or you can phone me on +44 1223 211185.

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IN BRIEF

Edmund Optics has launched its Norman Edmund Inspiration Award, to honour the contributions made by the company's founder Norman Edmund in advancing the science of optics.

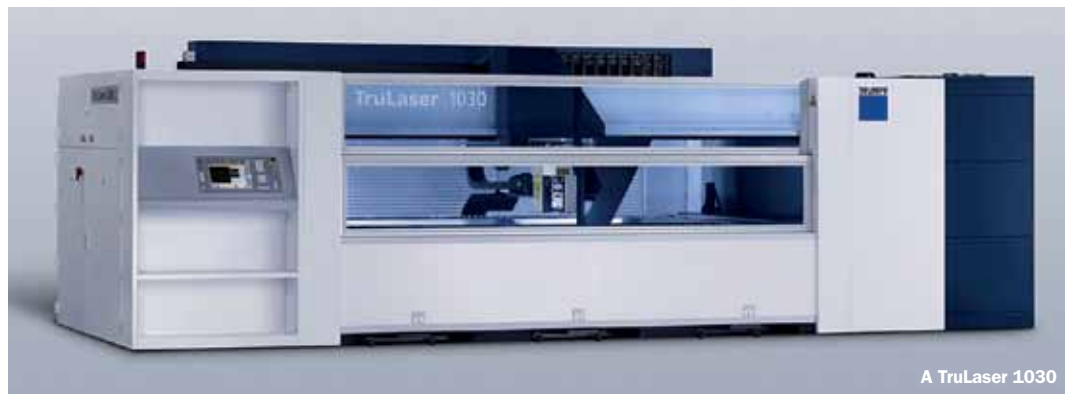
ULO Optics has announced the opening of a new office in the USA that will offer thermal imaging optics for defence and commercial applications.

An independent survey has found that **Edmund Optics** is one of the best places to work in the Philadelphia region, for the third year in a row.

Radiant Zemax has announced it has established a Chinese subsidiary, **Radiant Zemax Trading**, which is headquartered in Shanghai.

European customers can now order **ILX Lightwave** products directly from Newport's sales offices.

Trumpf's Trulaser 1030 and 5040 will be available in the UK this November



Trumpf's new Trulaser 1030 and 5040 products will be available in the UK from this November although they have been launched in Germany and elsewhere.

The Trulaser 1030 Fibre comes with a Trumpf 2001 TruDisk Laser and the Trulaser 5040 Fibre has the option of a 3001 or 5001 TruDisk Laser. The 1030 will consume up to 23kW, has a working area of 3000 x 1500mm and is viewed as an entry level machine that is low cost and compact. The 2001 TruDisk is a solid-state laser that uses a crystal and beam delivery is through fibre optic cable. 'The energy consumption of the [2001] machine is considerably less than a CO₂ laser, the electrical connected load is very, very low at 26kVA,'

said Trumpf UK's sales manager Nick Namjanovic, speaking at the company's press day on 28 March. The Trulaser 1030 is being aimed at users that would previously have used CO₂ laser systems.

The Trulaser 5040 has a working area of 4000 x 2000mm and the option of either the 3001 TruDisk laser, with a 3kW laser, or the new 5001 TruDisk, which has a 5kW laser. Aimed at thin sheet metal processing, the 5001, which will consume up to 58kW, will cut 25mm mild steel, 10mm copper and brass, and 20mm stainless steel and aluminium. Compared to the 3001, the 5001 delivers cutting speed increases, which are 40 to 100 per cent faster. In November Trumpf UK will have a 5030 machine on show with 5kW disk laser installed.

LightPath Technologies signs \$1.1m IR optics research contract

LightPath Technologies has entered into a \$1.1 million research and development contract with Raytheon Vision Systems to develop low cost manufacturing processes for infrared optics.

The IR optics research is part of the US government's Defense

Advanced Research Projects Agency's Low Cost Thermal Imaging Manufacturing (LCTI-M) programme. The goal of LCTI-M is to develop a wafer scale manufacturing process that will result in a camera on a chip, so every soldier can have a thermal imager. LightPath has more than

25 years of infrared aspherical optics moulding experience and the LCTI-M contract will allow the firm to further develop its moulding technology.

Jim Gaynor, president and chief executive officer of LightPath, said: 'This contract allows us to continue our work to develop

even lower cost materials and processes for infrared optics, which we believe will enable critical defence capabilities.'

With this technology Lightpath is targeting applications such as infrared countermeasures, thermography, gas sensing and commercial night vision systems.

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PHOTONICS PEOPLE

Engineering company and laser marking provider The 600 Group has announced that its chief executive officer **David Norman** has retired from the company with immediate effect.

Laser manufacturer JK Lasers has appointed **Michael Haase** as its new German sales manager. Haase trained as a mechanical engineer and has ten years experience in the laser industry.

Flir Commercial Systems has appointed **Loic Premartin** as Europe, Middle East and Africa sales vice president.

DISTRIBUTOR NEWS

Lot UK has announced that it is now a distributor for **Andor Technology**. This includes distribution of Andor's range of CCD/ICCD/EMCCD and sCMOS cameras, spectrographs and related accessories.

ProPhotonix has three new distribution partners, **NexLase** in Munich, **Nevis** in Taiwan and **Saber1** located in Chelmsford, Massachusetts.

European Commission supports €7 billion photonics partnership



European Commission vice president Neelie Kroes has announced her support for a €7 billion photonics public private partnership, to which industry says it can commit more than €5 billion.

This combining of industry and government resources would be undertaken within the Horizon 2020 framework. Horizon 2020 is to be the EC's seven-year research and development programme, which previously has been known as the seventh framework, because it was the seventh multi-year R&D programme. Horizon 2020 will operate from 2014 to 2020.

Neelie Kroes said: 'Europe needs to face up to the challenges of a rapidly globalising economy. The photonics sector can unleash massive economic potential and help deliver the digital

agenda for Europe. EU policies that support research, demonstration, and application are crucial for spurring Europe's competitiveness.'

The digital agenda is the EC's plan to encourage the use and growth of information and communication technologies in the EU. Photonics industry group Photonics21 expects such a public private partnership to create an additional 70,000 to 100,000 jobs for the EU economy. Photonics21 wants the partnership to help industry overcome the problems of developing a technology from concept to product. Known as the 'valley of death', photonics innovation can fail during the development stages between a successful laboratory demonstration and pilot scale industrial deployments, which starts to create jobs.

£6.5 million project to exploit Terahertz lasers and microwave photonics

A £6.5 million project is to exploit Terahertz (THz) quantum cascade lasers, microwave photonics and THz quantum state control to open up the THz spectrum for widespread scientific and commercial applications.

Funded by the UK government's Engineering and Physical Sciences Research Council, the project's goal is to solve the problems

of complexity, bulk, high power consumption and lack of coherence that have stopped the exploitation of the THz spectrum. The THz frequency region is the last largely unexploited part of the electromagnetic spectrum.

The benefits from overcoming these obstacles are expected to be, a thousand-fold enhancement in the bandwidth available to untethered devices,

advanced biomedicine imaging technology, and optically controlled gates in silicon for quantum information processing.

The project's principal investigator is professor Alwyn Seeds, head of University College London's (UCL) Department of Electronic and Electrical Engineering. He said: 'This programme will enable us to address the THz spectrum

with the same precision and sensitivity as is today possible at radio frequencies.'

The project will involve the Cavendish Laboratory, the University of Cambridge, UCL's Department of Electronic and Electrical Engineering, the London Centre for Nanotechnology, and the University of Leeds' School of Electronic and Electrical Engineering.

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Laser delivers 20 per cent boost for cell manufacturer

High-temperature measuring cell specialist Imes has invested in a laser welding station leading to a 20 per cent production capacity increase.

The investment followed a record year of sales in 2011 for Imes' measuring cells, designed for large gas and diesel engines. This meant the company faced the challenge of doubling its production capacity by the turn of the year. Imes, located in southern Germany, manufactures high-temperature resistant pressure sensors that are in the main supplied to manufacturers of engines for large ships and static engines, generally with power ratings from 250kW to 18MW. With the increase in production capacity required, laser welding in-house was deemed necessary.

'We are already welding an additional joint with the laser,' said Imes' managing director Stefan Neumann. 'And our new product, which we will launch in 2012, features several laser welds.'

Imes is using the Rofin Select laser workstation. It is both a manual welding laser and a high-precision CNC system with a multi-functional joystick. It has a CNC-driven rotary axis that allows for a fully-automated process. The Rofin team were able to deliver the laser welding station within four weeks from the point at which work began on application development.

Star tracker directs European spacecraft to dock with space station

On 23 March e2v imaging sensors were launched into space onboard the European Space Agency's (ESA) Edoardo Amaldi spacecraft, the third Automated Transfer Vehicle (ATV) to be sent to the International Space Station (ISS).

The e2v CCD47-20 imaging sensors are used for the ATV's star tracker, an optical device that determines spacecraft orientation by its position relative to stars, and a videometer, which is for ISS rendezvous and docking. The first and second ATVs, named Jules Verne and Johannes Kepler, were also equipped with these e2v imaging sensors.

e2v's marketing manager Jon Kemp said: 'Edoardo Amaldi is the third ATV to have been successfully launched into space. e2v's imaging sensors are a key component in enabling the ATVs to dock successfully with the ISS and provide essential support to the astronauts onboard.'

The Edoardo Amaldi, named after the Italian physicist and spaceflight pioneer, was carried into orbit onboard an Arianespace Ariane 5 rocket from French Guiana. The Amaldi carries almost 7,000kg



of cargo to the ISS, 360km above the Earth. The ISS relies on frequent deliveries of equipment, spare parts, food, air and water for its permanent crew.

The unmanned ATV is essential in delivering supplies to it and will stay attached to the station until the 27 August. The ATV fires its rocket to boost the station's orbital altitude during its stay. After it undocks in August the ATV will be commanded to burn up in the atmosphere over an uninhabited area of the southern Pacific Ocean.

Roaming robots could zap weeds dead, say scientists

Pesticides may not be needed for clearing weeds after the demonstration of a laser system that could be used by field roaming robots to kill individual plants.

An infrared CO₂ laser with a wavelength of 10.6µm is fired at weeds that are identified by a stereo camera system, which also optimises the laser beam position. Researchers have determined how much energy is needed to destroy plants' sensitive growth centres, known as meristems, making the method

very efficient. The researchers expect that large fields could be swept by autonomous field robots that would identify weeds and laser them. Researchers know seedlings can be killed with 35 Joules.

Using image analysis techniques such as threshold level filtering and edge detection, the position of a plant's leaves can help locate the meristem position. By using a galvanometer scanner with a flexible mirror system, the laser beam can be focused with high precision on the

near-surface meristems. Under laboratory conditions, an accuracy of <±1mm could be achieved, and under greenhouse conditions, a laser on a rail carriage achieved accuracies of ±3.4mm. The use of a galvanometer scanner with a flexible mirror system also enables the laser to be moved quickly from plant to plant.

Funded by the German Research Foundation, the work was carried out by Laser Zentrum Hannover and Leibniz Universität Hannover's Biosystems and Horticultural Engineering faculty.

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Clearly in focus

The 11th Optatec international trade fair for optical technologies, components and systems, that takes place from 22-25 May at the Frankfurt Exhibition Centre, offers an opportunity to view the latest innovations from the many companies and new products on offer. Here's a preview of what to expect



Avantes will introduce its AvaSpec-RS spectrometer. Miniature spectrometers are versatile, portable and well appreciated by researchers and engineers worldwide. Avantes has developed a configurable miniature spectrometer, allowing easy on-the-go slit and connector changes. According to Avantes, only a screwdriver is needed to reconfigure the spectrometer and continue the measurements with a new set-up. This microspectrometer can be adapted to changing needs, whether the user requires higher throughput or higher resolution. This is enabled by a proprietary Avantes ultralow stray light optical bench technology. Due to

this technology, the stray light performance is up to five times better, combined with thermal and mechanical stability. The Avabench-RS optical bench technology is now available in all Avantes UV/VIS/NIR AvaSpec spectrometers. AvaSpec spectrometers include a choice of 13 different standard gratings, 10 different detector options and many more options and accessories. The application areas for Avantes spectrometers and optical products include industrial, chemical, petrochemical, geology, biomedical, semiconductor, light measurement, agriculture and food processing technology.

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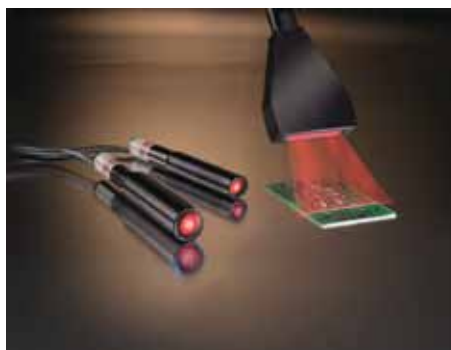
made of high quality glass, guaranteeing an excellent intensity distribution. The rugged mechanical design ensures a beam pointing stability of $<10 \mu\text{Rad}/^\circ\text{C}$. Internal voltage and heat protection and a potential-free housing, ensure an increased lifetime. These thermoelectrically cooled lasers enhance wavelength stability up to $0.25\text{nm}/^\circ\text{C}$.

www.coherent.com

Laser Components will show examples from its recently added ion-beam sputtering (IBS) coating capabilities. Coatings that are produced through IBS feature compact and drift-free layers that are insensitive to variations in temperature. In addition, this cold process makes it possible to apply coatings to temperature-sensitive materials such as laser crystals. Highest damage thresholds and highest possible reflection



Coherent will present its new Structured Light Laser Portfolio at Optatec 2012. Coherent will continue its expansion within the machine vision market by direct distribution of its own Structured Light product line. With a market presence of more than 20 years, Coherent's Structured Light laser technology stands out through its diversity of services. The built-in powell lense and the diffractive optical elements provide dot matrices structures that are all



values ($R > 99.99\%$) make IBS the perfect choice when cutting-edge optics are needed. At Optatec, Laser Components will be exhibiting its Gaussian mirrors (also known as graded reflectivity mirrors (GRMs)). The special coating is characterised by a degree of reflection that falls off in a Gaussian-shaped curve starting from the centre of the optic. Gaussian mirrors are used as output couplers in unstable resonators where they help to

IDQ will offer photon-counters based on avalanche photodiodes in Geiger mode for the visible and infrared regions. It also includes Telecom short-pulse laser sources (id300). The id100 is a photon counter based on silicon APD for VIS wavelength. id210 Near-Infrared Photon Counter with World Record 100MHz trigger rate is an advanced System for Single Photon Detection at telecom wavelengths, i.e. 1310nm and 1550nm. Its performance in high-speed gating at internal or external frequencies up to 100MHz by far surpasses the performance of existing detectors. Photons can be detected with probability up to 25 per cent at 1550nm, while maintaining the dark count rate at low levels. A timing



resolution as low as 250ps can be achieved. The id220 brings a major breakthrough for single photon detection in free-running mode at telecom wavelengths. It is the first single-photon detection module built around an InGaAs/InP passively quenched avalanche.

www.idquantique.com

reduce the beam divergence at high pulse energies. This makes them interesting for a wide range of applications, including military.

www.lasercomponents.com

Ocean Optics is known for its highly configurable miniature spectrometers and again at Optatec 2012 it will be showcasing several new products. Ocean will be showing the second generation of its flagship product QE65000, called QE65-Pro (www.qe65pro.com). This high end miniature spectrometer is known for its high dynamic range and signal to noise ratio. Ocean has added



more new gratings, improved thermal stability for harsh environments, and added user exchangeable slits. Ocean will also be demonstrating a new version of the MayaPro family, the MayaPro-VISNIR. This back-thinned detector based spectrometer has its detector and grating optimised for NIR responsivity, which makes it ideal for low-signal spectroscopy like 785nm raman applications. Besides Ocean's new spectrometers, customers at Optatec can have a look at some examples, showing the company's capabilities to providing customers with custom solutions. Ocean's engineers can work closely together with customers to create spectroscopy system designs for OEM-, industrial or field applications.

www.oceanoptics.com

Qioptiq's new laser modules, the Nano 100 Series, are compatible with the Linos Microbench. The dimensions of this new miniaturised system are adapted to the smaller Linos Nanobench system. The housing, while measuring only 25 x 25 x 40mm, contains not only the laser diode with collimation optics but also the controller. The maximum output power is up to 100mW. No additional power supply unit is necessary, because the module is powered over a USB connection. The USB port also provides a computer interface for monitoring and manipulating the operating parameters of the laser modules, which come with the Nano control software for Windows. All the commands for programming the interface are described in detail in the user manual.

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Marking time

Small decorative logos for mobile phones and sophisticated codes for industrial traceability require laser technology to become more precise and reliable, as Rob Copping discovers

Marking is a word whose simplicity belies the increasing myriad of laser types and applications that making a mark on an object really encompasses. From excimer lasers to CO₂ and solid state, from mobile phone cases to anodised aluminium, marking can create black on silver patterns or white on black.

'We are more precision marking, which you can barely see with your eye, and you don't want to see it mostly. For this you want short wavelengths,' says Ralph Delmdahl, product marketing manager for Coherent. His company provides excimer lasers that are used for transparent hard materials such as diamond, glass and some polymers. They operate at 193nm with 10mJ pulses to avoid creating cracks in the glass and mark, among other things, ophthalmic lenses made of mineral glass and polymers. The marking will encode information for the optician such as the lens' astigmatic power, its overall characteristics, to identify what prescription the lens is for. The mark might be on the side or edge of the lens and the intention is that the user can't see it. Because polymer lenses have several coatings to make them hard and provide an anti-reflection quality, the markings can record what coatings the lens had.

Another application for excimer marking lasers, where



Coherent

Marking on glass can involve excimer lasers

details about the lased object can be recorded on its surface, is the diamond industry. Again the 193nm wavelength is used because diamond only absorbs below 200nm. Above this wavelength more energy is needed and that would heat up the diamond and potentially induce cracking.

As well as details about the diamond sometimes people like to have their names or the reason for the diamond's purchase to be inscribed on the side of the jewel. As well as this personalisation of the diamond, branding by a company can also be carried out. Or a company may want marks for security and anti-counterfeiting purposes. 'You can induce carbonisation to create a blacker mark,' explains Delmdahl.

Counterfeit parts are a problem the aerospace industry has been tackling for a number of years. A comprehensive traceability of products becomes more and more important for manufacturers in various branches of industry, because nowadays the piracy of products poses a serious

You can induce carbonisation to create a blacker mark

problem for worldwide operating enterprises. Components are marked by conventional laser systems or by needle stamping. However, the markings of both techniques can be easily copied by the use of suitable equipment. The economic damage caused by product piracy amounts to about



Ondrej Schumann/Shutterstock.com

Counterfeit aerospace components can find their way into maintenance supply chains

➤ 30 billion Euros every year and taking Germany as an example, 10,000 people lose their jobs every year due to it. A technology that will help to fight this is now reaching the market, in the form of forgery-proof laser-holography identification marking, according to its developer 3D Micromac. The result of a two-year project called Perfekt, Yves Rausch, 3D Micromac's head of laser applications, said: 'It is called holographic because it has lots of colours like a rainbow. The code

itself is the pattern. The reader looks like a bar code reader. Inside is a special laser that hits the patterns and you get a special reflective pattern, which gives you the code.'

The reflective pattern is a characteristic interference pattern, which is marked on the aerospace part with cuts no deeper than 200nm using an ultra-short-pulse laser. A combination of the laser and different diffractive optical elements (DOEs), which shape the laser beam, create the

pattern. 'The cuts go down to 200nm and no deeper. Aerospace wants marking in the area of nanometres because any deeper and you can damage the part. We've just started marketing the new technology,' explains Rausch. By rotation and movement of the DOEs, the interference pattern changes and individual, unique patterns can be created. This marking is covered with a transparent coating and the marking's codes can be deciphered using a mobile reading device. Rausch adds that this laser-holographical marking is resistant to reverse engineering because it is not possible to determine the kind of DOEs used or their position to each other by reading the pattern. The wavelength and power levels the ultra-short-pulse laser uses are also a closely guarded secret.

The two-year project involved companies that developed the mobile reading device's camera and the algorithm for reading the code. Local academics were

also involved and some local government funding supported the work. Following this work that was focused on marking metal, silicon has been marked and Rausch expects that it will be possible to apply the technology to glass and ceramics in future. However, for ceramics and glass you need more energy and if the power is raised, precision can

laser holographical marking is resistant to reverse engineering

decrease and precision is needed to create the holographic patterns.

Traceability codes are not the only permanent marking that is becoming commonplace; consumer products increasingly require complex decorative marks, such as corporate logos. 'Consumer goods are becoming a significant product group in the use of marking. For goods such as mobile phones and cameras, customers often want complex

Coherent



The ExcistarXS laser is used for glass and plastic lens and diamond marking

and visually aesthetic marks,' commented SPI Lasers product line manager for pulsed lasers, Jack Gabzdyl. The laser systems used to create these decorative markings have to be extremely reliable. These products are manufactured in millions of units per month, so today's contract manufacturers can have factories with hundreds or thousands of laser marking stations to meet demand. Factories in China can be the size of a European town and, as Gabzdyl explains, it is unlikely that the number of stations is going to be reduced. 'It is difficult to speed up production without adding more marking stations; just increasing the power doesn't necessarily scale it up. Some materials can be delicate or difficult to mark and, with manufacturers needing a consistency in mark quality, they need reliable and consistent laser sources.'

In some instances, marking of consumer products becomes more surface texturing and patterning, where relatively large areas need to be processed. In a case like this, the beam quality can have a significant impact on the quality of mark achieved; a high beam quality produces an intense central peak, whereas in higher moded beams the energy is more evenly distributed.

Whether for patterning or for smaller marks, good control of pulse characteristics is needed, and some applications benefit from shorter pulses, ensuring that the materials being processed are not damaged. But sometimes darker effects are needed, according to Gabzdyl. There are times when customers want black marks on stainless steel, which is achieved through careful surface oxidation with no melting. This is controlled oxidation and the process can benefit from an entirely different shape of pulse and/or beam quality. An oxide can be added to improve oxidation, melting the oxide

material in, to create a dark mark. But this also requires more power. Another common marking process is anodised aluminium. Anodised means that the base aluminium is covered in an oxide layer that is often coloured. Marking this normally involves removing a small amount of this layer of colour to produce a mark on the aluminium beneath.

Not as power hungry but requiring great precision is the process to create white marks. This requires a small grouping of dots that reflect light in such a way that the human eye perceives it as a white mark. 'This needs very good quality beams to produce the dots so the mark appears white from any angle,' adds Gabzdyl.

Mass production, reliable, cost effective, marking with lasers has all the characteristics of any important process necessary for production. Marking might only be skin deep compared to engraving and cutting but it provides a product feature important to manufacturer and user, brand recognition and a quality feel. ●



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Ferdinand Braun Institute wins Transfer Prize for very efficient diode lasers

The Ferdinand Braun Institute has been awarded the Transfer Prize WissensWerte for development of high-power diode lasers for materials processing.

The Institute collaborated with Jenoptik's diode laboratory to create novel designs that achieve an efficiency of 63 per cent at an output power of 12W, compared to today's diode lasers that deliver around 10W. The next step for the research is to achieve up to 20W while maintaining the level of efficiency and beam quality. The Transfer Prize is worth 50,000 euros.

JK Lasers improves Alumina ceramic processing

JK Lasers has developed a method of processing Alumina ceramic (Al_2O_3), a material that is prone to thermal stress.

Using JK Lasers' single mode 200W fibre laser (JK200FL), a high standard of finish could be achieved with Al_2O_3 . Using the JK200FL, good quality cuts in Al_2O_3 up to 1mm deep are possible. With the Nd:Yag JK100P laser, a combination of high peak power (10kW), short pulses (15-200µs) and high repetition rate (2,000Hz) also make this laser well suited to cutting Al_2O_3 .

European project develops 1567nm laser source for plastics welding

A 500W Erbium multimode fibre laser source adapted for polymer welding has been developed under the European project Polybright.

The laser emits at 1567nm to weld polymers, which are known to be hard to weld because plastics only possess high laser radiation absorptivity at the longer wavelengths in the infrared spectral range. Commercially available laser sources emitting at these wavelengths have not been available until recently.

For Polybright, two laser sources, 1940nm and 1567nm that are both at 120W, are being used to evaluate the absorption behaviour of different polymers for additive-free welding applications. The aim of the project is to develop high power high brilliance lasers with new wavelengths between 1500 and 1900nm that are adapted to the absorption properties of polymers. Laser producer IPG Laser, based in Burbach, Germany, is

participating in Polybright. IPG's new laser source, developed under Polybright, is called ELS-500. This combines several single mode Erbium fibre lasers and feeds their outputs into a single 200µm diameter multimode fibre.

To use 1567nm for welding applications the next step is to increase the power spot sizes to overcome industry demands for positioning accuracy. The lasers will also need 'tophat' beam profiles to achieve the necessary spot sizes during welding.

Polybright's total budget is €10.2 million with €3.6 million from industry and €6.6 million of government funding. Polybright started in October 2010 with 18 partners from nine countries. Its aim is to develop high power, high brilliance lasers with wavelengths between 1500 and 1900nm, which are absorbed by polymers. According to Polybright's website the project will end in September 2013.

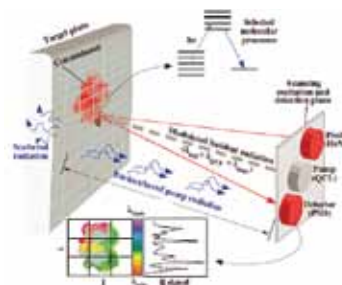
Double laser spectroscopy can deliver more data say researchers

Chemical and biological agents could be rapidly identified from a distance by zapping them with a quantum cascade laser and then analysing the target's response with a second laser, according to researchers at the US government's Department of Energy Oak Ridge National Laboratory (ORNL).

Called photothermal spectroscopy, this technique that the researchers have developed uses probe beam reflectometry, which minimises the need for wavelength-dependent expensive

infrared components such as cameras, telescopes and detectors. This proof of principle success could lead to advances in standoff detectors with potential applications in quality control, forensics, airport security, medicine and the military.

'With two lasers, one serves as the pump and the other is the probe,' said Ali Passian, a member of ORNL's measurement science and systems engineering division. 'The novel aspect to our approach is that the second laser extracts information [and] provides a robust



Operating principle of photothermal spectroscopy using a quantum cascade laser

and stable readout approach independent of the pump laser settings.'

This new type of hyperspectral imaging is expected to provide high-resolution chemical information as well as topographical data.

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Mark your calendar for Blue Photonics 3



The Island of Texel, about one and a half hour's drive north of Amsterdam, sits in the Wadden Sea and is the largest of the Dutch North Sea Islands. NIOZ is located at about 5 minutes walking distance from the ferry terminal at Texel

From 18 to 20 March 2013 the third EOS Topical Meeting on "Blue" Photonics Optics in the Sea (Blue Photonics 3) is to take place at the Royal Netherlands Institute for Sea Research (NIOZ) in Texel, Netherlands. In June 2012, the first call for papers will be published.

Like the previous conferences, the third edition has its main focus on the understanding of the unique environment of the marine realm and in the sustainable use of marine resources which are of high societal relevance. Blue Photonics 3 provides a platform for scientists and engineers to discuss relating issues, to develop ideas for their own work, and build-up a network of colleagues for future interaction. The conference will highlight topics like environmental monitoring, crowdsourcing – apps,

ocean colour, radiative transfer and modelling, marine bio-optics and remote sensing, fluorometry – AOP – IOP, 2D and 3D underwater imaging as well as innovative sub-sea optical techniques and instrumentation.

Chairs:

Marcel R. Wernand - Royal Netherlands Institute for Sea Research (NIOZ) (NL)

Oliver Zielinski - Marine Sensor Systems (ICBM), University of Oldenburg (DE)

Hans van der Woerd - Institute for Environmental Studies (IVM), VU Amsterdam (NL)

The former meetings took place in Aberdeen, Scotland, UK (2009) and Bremerhaven, Germany (2011).

JEOS:RP seeking for active reviewers

Being open for every researcher in optics and photonics, JEOS:RP welcomes experts from academia and industry to sign up as reviewers, a unique opportunity for peers interested in contributing to the community and in networking. In particular, the latter is worth the effort: section editors looking for reviewers in

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of their knowledge. Since the reviewer's name is only visible to the editors and section editors the authors will not know who performed the review and privacy is guaranteed.

All persons concerned are asked to register at www.jeos.org or to contact the editing team at jeos-rp@myeos.org.

JEOS:RP: FIRST PAPERS IN VOLUME 7 (2012) PUBLISHED

Nine papers were recently published in JEOS:RP, the online *Journal of the European Optical Society: Rapid Publications*. To read the full papers please go online at www.jeos.org.

Unresonant interaction of laser beams with microdroplets

M. L. Pascu, G. V. Popescu, C. M. Ticos, I. R. Andrei [12001]

UV-curable glassy material for the manufacture of bulk and nano-structured elements

R. Gvishi, G. Strum, A. Englander [12002]

Light scattering measurements for quantifying biological cell concentration: an optimization of opto-geometric parameters

A. G. Mignani, L. Ciaccheri, L. Giannelli, A. A. Mencaglia [12003]

Eigenvalue calibration methods for polarimetry

C. Macias-Romero, P. Török [12004]

Effect of the Metallization on the Resonances of THz Fishnet Metamaterials

C. Sabah, H. G. Roskos [12005]

Applications of Digital Holography: From Microscopy to 3D-Television

T. Kreis [12006]

Microlens array production in a microtechnological dry etch and reflow process for display applications

T. Knieling, M. Shafi, W. Lang, W. Benecke [12007]

Broadband photonic crystal antireflection

M. Malekmohammad, M. Soltanolkotabi, A. Erfanian, R. Asadi, S. Bagheri, M. Zahedinejad, M. Khaje, M. H. Naderi [12008]

Spatially encoded localized wavepackets for ultrafast optical data transfer

R. Grunwald, M. Bock [12009]



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DESIGN AND TEST OF FAST LASER DRIVER CIRCUITS

By iC-Haus

In laser sensor and measurement applications the challenges of the design of fast driver circuits is a very demanding task. This white paper describes the design of fast driver circuits, PCB layouts and optical measurement considerations, as well as a solution to achieve an ideal design for pulses as short as 2.5ns



AC CONDUCTIVITY OF CDSSE-DOPED BOROSILICATE GLASSES

By R Janelidze, O Bakradze, O Gogolin, E Tsitsishvili and C Klingshirn

We report measurements of dynamic (ac) electrical conductivity in borosilicate glasses doped with the semiconductors CdS_xSe_{1-x} and AgI in a wide range of frequencies and temperatures. The concentrations of homogeneously dissolved dopants are governed by the heat treatment conditions of the glass samples leading to a creation of CdSSe and AgI nanocrystals. The ac conductivity rises with increasing average size of the CdSSe nanocrystals, in contrast to the case of the metal halide doped borosilicate glasses.



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Resolving power

Greg Blackman finds out that in order to acquire a high-quality image from a machine vision camera, a lot depends on the quality of the optics

Machine vision excels in measuring dimensions that are indiscernible to the human eye. Measuring to the manufacturing tolerances for valves for a car engine is a classic example. While camera sensor resolutions have been steadily increasing over the years, it's not simply the number of Megapixels the camera delivers that determines the quality of the image. Lighting also plays a big role, as does the lens, and it's really how good the lens is as to whether you'll get the most out of the specifications of the camera.

'The lens has a big impact on what resolution the system will be able to image and how small a defect it will be able to pick up,' states Nicholas James, product line manager at optics specialist Edmund Optics.

As camera sensor technology has advanced pixels have become smaller. Five or so years ago, 1.3 Megapixel sensors were considered high resolution and in a 1/2-inch format the pixel sizes were relatively large. Cameras are now available at 5 and 10 Megapixels in 1/3-inch formats, so the pixel sizes have become minute (a 10 Megapixel, 1/2-inch CMOS sensor can have pixels as small as 2µm). Mark Williamson, director of corporate market development at vision distributor Stemmer Imaging, explains that one of the challenges in machine vision is to differentiate which lenses are suitable for which sensors. 'It's not only the circle size of the lens,

Telecentric lenses are ideal for making measurements of high-precision parts. Image courtesy of Schott-Moritex.



but how good the lens is at resolving the image onto small pixels,' he says. 'A 5 Megapixel camera might cost £250, say, but the pixels might be so small that optically it's very difficult to achieve the maximum resolution of the sensor unless you pay for an expensive lens, which can be around £800.'

The resolution of a lens is determined by its modulation transfer function (MTF), defined as the number of line-pairs per millimetre the lens can resolve (a line-pair being a sequence of one black and one white line). As alternating black and white lines become closer together,

the transition from fully black to fully white eventually becomes blurred so that the lens will only be able to reach a level of grey before having to switch to the next transition. Any detail in the image that's below this value will be lost. Hence, a low resolution lens will still capture everything in the field of view, but the detail will be less, because the optics can't translate the change from black to white quickly enough.

'With cameras being released with smaller pixels, lenses have to have higher MTF to maximise the sensor,' Williamson notes. 'Cheaper CCD cameras will typically have smaller pixel

► sizes to shrink the sensor. However, if you want to get the same image quality at the maximum resolution, you'll need a more expensive lens.'

Optical distortions

Any optical system will have a certain degree of distortion within it, most of which can be designed out of the system and high quality machine vision lenses will correct for many distortions. Some of the more common types include barrel distortion, where the optical path changes as you move further from the centre line of the lens, creating a fisheye-type effect. This is more prominent, according to Raf Slotwinski, business development manager at Alrad Instruments, for wide angle lenses with short focal lengths, although he adds that low distortion lenses are available at a price. Alrad, based in the UK, represents a number of machine vision lens manufacturers.

Vignetting is another, whereby less light reaches the sensors at the edges of the image. It can be digitally corrected by flat-field correction, but this reduces the dynamic range of the system. Vignetting can be the result of being at the edge of the field of view of the lens or it can be caused by the mechanics of the lens creating a shading effect.

A third distortion is sensor shading. Image sensors have micro-lenses covering each pixel to funnel all the light into the sensitive part of the pixel. Moving out towards the edges of the sensor, the light entering the micro-lenses will be at different angles and therefore will have different focal points, which effectively equates to less light reaching the pixels.

Higher quality lenses will generally have more

lens elements, with some exceeding 10 optical elements, to correct for various distortions. 'Minimising distortion is important for machine vision when making precise measurements of an object,' notes Williamson.

Imaging at different wavelengths can also create artefacts in the image that need to be ironed out by the optics. 'As the wavelength alters, the optics diffract the light differently,' states Williamson. This can potentially be a problem for colour imaging, as the red passing through the optic will diffract differently to the blue resulting in colour banding at the corners

The lens has a big impact on what resolution the system will be able to image

of image. This is most obvious with a three-chip camera, because there will be a prism diffracting the light as well. Three-chip cameras should use a 3CCD lens to avoid this, says Williamson, which has a specific optical setup to achieve the same level of diffraction throughout the lens.

Imaging in the infrared will again have a different focal point and to be able to switch between infrared and visible requires an infrared-corrected lens, although Williamson notes there is generally not a big demand for doing this in machine vision. A standard lens will still operate in the infrared, but will have a slightly different focal point compared to working in the visible.

Working in the shortwave infrared (SWIR) band, the lensing becomes significantly more difficult due to the lack of glasses available,

according to James of Edmund Optics. 'Glasses for the visible are common, which makes designing and optimising the lens easier. It can be significantly more complicated in the SWIR,' he says. SWIR imaging has the advantage of identifying defects that visible systems wouldn't be able to pick out, such as bruising on fruit. In addition, certain materials, such as some plastics, which are opaque in the visible, appear transparent under SWIR lighting, meaning contents of plastic bottles can be inspected, for example.

'There are fewer glasses available with strong indices in the SWIR to balance the lens design,' James continues. 'The light passing through an optic will be diffracted differently depending on the wavelength. To try and balance that with the glasses available is a difficult proposition, which ends up requiring more elements and more exotic glasses for SWIR wavelengths.'

Telecentric lenses

The lens most closely associated with machine vision is the telecentric lens, or the so-called 'measurement lens'. Standard lenses will image from one point, so that at the edges of the field of view the camera will be looking from a slight angle. With telecentric lenses, all the light entering the lens is parallel, which means the lens delivers the same view irrespective of the distance – the view of the object is from a single point flat on. This is important when measuring an object.

'Telecentric lenses are very useful when measuring objects with different heights or making measurements of holes,' explains Williamson. 'However, the lenses can be expensive as they need a lot of glass,' – to receive all the light in parallel, the front of a telecentric lens has to be the same width as the field of view.

Closer objects will appear larger than those further away with a standard lens. A telecentric lens will flatten the image so that it doesn't matter where the object lies in relation to the lens as to determining its size. Pins protruding from a circuit board, for instance, will all be viewed head-on with no distortions in size, which is important when making accurate measurements. In addition, because the light entering the lens is parallel, telecentric designs eliminate perspective distortion and increase the depth of focus, according to Slotwinski at Alrad.

Schott, through its subsidiary Moritex, provides telecentric lenses incorporating coaxial lighting. 'In high-end machine vision

LASER TRIANGULATION

Laser triangulation is a common technique in machine vision, used to acquire a 3D height profile of a part under inspection. The typical setup involves a camera imaging distortions in a laser line as the part moves across the line's path.

Various optical systems are available to shape the laser light for 3D triangulation, creating light patterns, like lines, crosshairs, or grids of points. 'The optics are typically refractive or a combination of refractive and diffractive elements, depending on the type of pattern,' says Wallace Latimer, product manager at Coherent, which produces optics for this area. 'You can create high intensity illumination fields that are highly structured for vision applications.'

The optical systems are made up of a prism and an aspheric cylinder lens, which distributes the light in a controlled and uniform fashion, important for machine vision. The optic converts

a Gaussian into a top-hat profile, which has fairly steep edges with most of the power contained within the line. 'Imaging systems will incorporate any illumination falloff or intensity variation into the images,' explains Latimer. 'This results in potentially false edges, false measurements, low resolution, or a dynamic range that's outside the limits of the camera. A stable illumination profile is therefore important to make accurate measurements.'

Commercial semiconductor laser diodes have a wide variation in their beam profile and divergence, says Latimer. The light therefore has to be managed relatively strictly with machine vision to get accurate measurements.

The optics for these laser diodes might be a relatively niche area for Coherent, but Latimer states that there is a lot of value in them, in getting higher accuracy and repeatability in machine vision systems.

applications, customers want to use high-power lighting to maximise the speed of inspection and the rate of throughput,' explains Hiroaki Tomono, responsible for Schott's machine vision business in Europe. Tomono adds that if the lens system is not designed to be used with high-power illumination, then potentially internal reflections within the optics can reduce the image quality.

Moritex began by designing and developing illumination systems for machine vision and other markets. It subsequently built on this knowledge by combining imaging optics with its illumination systems.

'Designing the optics in combination with the illumination is a big advantage for developing high-performance machine vision lenses,' states Tomono. Schott-Moritex has an advanced lens simulation system for designing optics, which incorporates both illumination and optical design data.

The optical and illumination axes are the same with the telecentric lenses. The light travels through the optics and reflects from the surface under inspection back through the lens to the sensor, all on the same optical axis. In

this way, according to Tomono, an image can be captured without reflections from a surface blinding the camera. In addition, distortions within a telecentric lens are low because the optical beam from the lens is always parallel. Schott's Advanced Optical Glass technology supports development for Moritex's optics to maximise the image quality.

Designing for the application

Megapixel lenses might incorporate aspheres to make it easier to compensate for some of the optical aberrations in the system. 'An asphere will usually allow the number of elements in a system to be reduced, thereby making the lens smaller, or allow higher resolution with the same number of elements,' explains James of Edmund Optics. 'However, aspheric lenses are usually more expensive than standard lenses by five or 10 times the price.'

Multi-conjugate designs are also available for high resolutions within a given focal length. A traditional fixed-focal length lens will work from 100mm to infinity, for example. A multi-conjugate version of that design would work from 100-400mm, for instance, another from

400-1,000mm, and a third from 1,000mm to infinity. 'If you're trying to design a lens that works from very close to very far away, you have to balance the resolution so that it works over that entire focal range, which means the resolution is not as high as it could be in any particular region,' explains James. 'If you have a lens that will operate just from 100-400mm, it will have a much higher resolution peak in that region, although the lens won't resolve objects well outside of that working distance range.'

As in most cases, the application will dictate the optical specifications. 'People often don't value the cost of optics,' comments Williamson at Stemmer Imaging. 'They pay for a camera and think any lens will do. Lenses can actually solve a problem; if you get the right lens it can make your life so much easier.'

Williamson adds that using filters correctly can also make a big difference. 'If you don't need colour, illuminate with a single wavelength and filter out all other extraneous light,' he says. This removes the effect of different wavelengths having different focal lengths. 'Illuminating with one wavelength and filtering out all the other light will result in a far sharper image.' ●





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Spectroscopy everywhere anytime

Rob Coppinger

finds that the age of the smartphone and MP3 player is changing customer expectations, raising industry's game when it comes to portable spectroscopy

Mobile devices are ubiquitous in society today and advances in spectroscopy are reflecting this trend with miniaturisation. Customers now expect the smartphone experience with their spectrometer, with features such as wireless internet, Bluetooth and ever improving performance with semiconductor-like technology.

'We need to look to offer more mobile instruments, and the packaging to make it more sexy, similar to what Apple has done with the iPod; it's nothing more than an mp3 player but it lasts a little longer with the battery and it looks sexy,' says Avantes chief executive officer Benno Oderkerk. Avantes spectrometers are small, at less than 500g and so can be portable. They can operate independently of a desktop computer and are used in agriculture in what is called green tech. For example, in greenhouses users carry out



Ocean Optics' Jaz is a mobile modular optical sensing suite that can have up to eight spectrometer modules

measurements on light conditions or reflections from the leaves, examining the amount and quality of the chlorophyll present. The portable spectrometer will generate the data but there is some onboard data processing capability translating it into functions to measure. Avantes products have other uses, the company makes generic instruments because its spectrometers are used for so many applications. And like today's smartphones Oderkerk explains that future improvements for their spectrometers include: 'longer [battery] life time, shorter high current charging, and more easily replaceable battery packs.'

Ibsen provides handheld spectrometers for the medical market for detecting the likes of cholera, or for using the visible or infrared wavelengths for examining food. Like Oderkerk, Thomas

Rasmussen, Ibsen Photonics, says: 'We see a strong trend for people to want to miniaturise.' Rasmussen also sees competitive advantage in miniaturisation. 'We see those two things [miniaturisation and lower costs] go hand in hand, if you make things smaller it becomes lower cost because various devices become smaller and so cheaper,' he says. Below the \$1,000 price tag there is a market for spectrometer modules that have, according to Rasmussen, 'reasonable performance', for instance 1-4nm resolution, low stray light, and good sensitivity. While 20-100nm resolution can be achieved with much simpler and lower cost devices, typically \$10-\$100, based on light emitting diodes and colour filters.

'The sub-\$1,000, 1-4nm resolution spectrometer market is the segment we are targeting with our new compact Freedom spectrometer and we see a strong demand for the combination of compact size and good performance. Our module is just 25 x 48 x 16mm and provides resolution down to 1nm. Naturally, other spectrometer suppliers target the same segment,' explains Rasmussen, 'Ocean Optics' STS module for example.' One technical aspect driving this miniaturisation and increased performance dynamic is the ability to use semiconductor-like manufacturing technologies with wafers upon which gratings are made.

However, there is a drawback to using semiconductor-like replication techniques: they can ruin the stray light performance, which means the noise in the system can get worse. 'But we think we have got around that,' adds Rasmussen.

According to Rasmussen, Ibsen can get several hundred gratings

We need to look to offer more mobile instruments... similar to what Apple has done

on the same wafer, which is how they get the volume of scale benefits akin to semiconductors' production. 'Adding more gratings to the wafer will improve device performance further,' adds Rasmussen.

For medical and food analysis the goal is to have both low cost

and higher performance modules using Raman spectroscopy for detecting various drugs. But it is hard to get the high Raman resolution required from small modules. One option is to use the cheaper portable spectrometers to quickly check batches of foodstuffs and other products and to then take suspect material to the laboratory for a more detailed inspection. Rasmussen explains that carrying out quality control checks on pharmaceuticals is one application area, 'if you can do it on site you can know within a few minutes if the lot is OK or not and if you find something you have to send it to a laboratory.'

That difference between the laboratory and the environment on the shop floor or in the field is of concern to Laser Quantum sales and marketing vice president Barney Mitchell. 'In going from the lab to something portable, there is the challenge of increased shocks and less stable temperatures. The environment is far less controlled.' And by shock Mitchell includes spectrometers being dropped. A drop from waist height will deliver a shock equivalent to 1,000 g, which is devastating for most lasers. Mitchell adds that customers are looking for a single frequency laser so they can get the highest possible resolution. 'Laser Quantum has an actively locked single frequency laser that has solved those problems, but with size and weight being key considerations, a multimode laser allows for a far more compact solution, and these are inherently more stable than single frequency lasers in terms of both wavelength and power,' says Mitchell but he warns, 'for portable spectrometers, Raman single frequency lasers often don't behave very well; unless actively mode locked they can drift across large wavelength ranges and mode hop and it becomes very difficult to get repeatable results. A multimode laser with a bandwidth of 30GHz over one wavenumber will give excellent repeatability,

albeit at slightly lower resolution.'

With an unlocked single frequency laser, it is possible to get a drift across 1-2 wavenumbers for just a plus or minus one degree temperature change. With a multimode laser you can get 5pm repeatability across 20 degree temperature range.

Multimode lasers also have

better shock resistance as intra-cavity alignment is less critical.

Mitchell explains that for Raman spectrometer applications 785nm has been the traditional wavelength but now the industry is seeing increasing interest in 532nm, a useful wavelength for biological samples and organic compounds. 'There is an interest at 660nm,

because there is a hydrogen line that disappears off the end of the silicon response range if you go any further into the infrared,' comments Mitchell. 'Then if you go any further into the green you see increased fluorescence and you lose the Raman signal that way.' A popular wavelength, according to Mitchell, for surface enhanced

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► Raman spectroscopy, is 671nm or 660nm. 'We are seeing uses for that [wavelength] in the food industry, for detecting chemicals that shouldn't be there, and in homeland security 532nm is preferred for the forensics of chemical detection and counterfeit substance detection.'

Delivering laboratory-like services in the field is also a goal for Hamamatsu. Ray Livingstone, sales engineer, says, 'Hamamatsu's mini-spectrometers are small, USB devices that can be taken on site to make measurements in real time rather than having to take the sample back to the laboratory.' Applications include measuring water and air pollution, solar radiation, as well as in forensic science. Livingstone explains: 'Generally, a fibre light source is used to illuminate a cuvette holding the sample. In the case of testing for nitrates in water systems, UV light would excite the nitrates to fluoresce, which could then be measured by the UV spectrometer positioned at 90° to the sample. A trace of intensity verses wavelength can then be viewed on a computer, with the intensity of light at a specific wavelength corresponding to the concentration of nitrates present in the sample.'

Some laboratory-based spectrometers are heavy and bulky and have moving parts. The fibre-optic portable spectrometers have no moving parts and therefore are a lot more robust. Hamamatsu's Micro Electro Mechanical Systems (MEMS) spectrometer is fabricated as a single substrate. The diffraction slit is etched into the CMOS sensor using a femtosecond laser and the grating itself is fabricated on the lens by nanoprinting. 'Everything is on a single substrate manufactured by MEMS techniques, and because of this, it is very small, has a good alignment, and low light losses. Larger lab-based spectrometers typically contain separate image sensors, gratings, and optics, which all take up space. In addition, there are numerous optics in the setup, so there can be a lot of stray light, which disturbs the measurement.'

The drawback of manufacturing the detector as a single substrate is that the spectral resolution is somewhat limited, but in some applications this isn't deemed as crucial. The spectral resolution with these devices is around 12-14nm but with larger laboratory-based spectrometers the resolution can be 1nm or better. The range of Hamamatsu's mini-spectrometers is between 340-750nm, which is sufficient for the visible and the far-UV region. Most applications such as pollution measurements, environmental sensing, solar thin film analysis, and forensics are all sensitive in the UV, visible, and near-

infrared. Another application is blood analysis and looking at the presence of proteins in blood samples. 'The MEMS technology allows spectrometers to be fabricated much smaller now. The sensors and optics are made smaller with nanofabrication techniques. The Hamamatsu MEMS spectrometer weighs only 9g and measures 27.6 x 13 x 16.8mm,' says Livingstone.

Ocean Optics is another company that is adapting to the new expectations customers have for mobile devices. 'Definitely the customers are expecting a nice colour screen and easy touchpad devices as they are used to that. Our Jaz platform is one way of going about that [for consumer-like devices], it has a screen and buttons built in,' says Ocean Optics sales and marketing director Marco Snickers. 'It is used by research scientists for all types of field applications.' The Jaz platform, introduced two years ago, is a spectrometer that is built up from various modules and a module can have a




Spectroscopy is really becoming a commodity...and the volumes are getting larger

very specific functionality. It could include one or more optical spectrometers, a light source, ethernet and a battery module. Its brain is a Linux computer with a keypad and display.

Ocean has a history of spectrometer miniaturisation, 20 years ago it created a spectrometer to be used in the field of ocean research. 'Since then we've developed quite a lot of spectrometers; you must be able to carry the spectrometer to the sample,' says Snickers. 'Our customers have been looking for a low cost and small spectrometer and for that we developed the STS micro-spectrometer, which is very small about 2 x 2 x 2cm. It has very high resolution and can serve similar applications as our regular spectrometers.' Another low cost approach Ocean is taking is to extend its ColorBug range to add more channels for spectroscopy type applications, and one of the products will be called SpectraBug. Snickers says: 'I think one day the devices will be multispectral. Spectroscopy is really becoming a commodity in this respect and the volumes are getting larger and larger.'

Whatever the volumes, spectrometers are getting smaller and like all other mobile devices the trend, whether it is a phone or a sensor, is to get smaller, cheaper, energy efficient and with more functions. ●

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Lasers with one direction

Rob Coppinger rounds up the latest diode laser products

Cobolt has announced the release of the Cobolt MLD Series lasers, high performance laser diode modules covering a spectral range between 405 and 660nm. The lasers offer optimum beam quality and modulation performance from a small and compact package. Manufacturing using Cobolt's unique HTCure technology ensures world-class quality reliability and lifetime, as well as unmatched robustness. The Cobolt MLD lasers provide a spectral complement to the company's lines of high

performance CW DPSS lasers for demanding fluorescence analysis applications such as confocal microscopy and flow cytometry. In addition, the Cobolt MLD lasers have the feature of direct intensity modulation capability, allowing fast and deep modulation from versatile input signals. The selection of wavelengths combined with direct intensity modulation capability make the Cobolt MLD lasers a perfect choice also in applications such as optogenetics, microlithography or metrology.

Cobolt has designed an easy-to-integrate compact diode laser module with all control electronics fully integrated in a laser head of industry standard size. An optional external control box allows CDRH compliant operation with a key-switch and emission indicators. The Cobolt MLD Series lasers are intended for stand-alone use in laboratory environment, or for integration as an OEM component in analytical or metrology instrumentation equipment.

www.cobolt.com

This device is rated at 600W, 976nm for usage in commercial applications such as direct diode as well as for fibre and solid-state laser pumping.

www.dilas.com

Hamamatsu Photonics has introduced a new high power 5W CW single chip laser diode, the L11374. This new diode is a lateral multimode type, with a broad emitting area of 100µm and a centre wavelength of 915nm. This new laser diode adds to Hamamatsu's current range of 1 Watt to 8 Watt high power single chip laser diodes, available at wavelengths from 808nm to 1064nm. The L11374 features very long lifetime characteristics, and is available in

Coherent's

world-renowned Lasiris range of structured light lasers include the SNF laser that offer structured light patterns including single and multiple laser lines with uniformity down to ± 15 per cent. Fan angle and working distance can be tailored to match your application. What distinguishes the SNF laser from conventional lasers (with cylindrical optics) is the evenness of the illumination pattern. Lasiris lasers incorporate an optical line generator that eliminates Gaussian distribution of the light, resulting in the most uniform laser lines on the market. The design provides superior quality light patterns while avoiding the intricacies



of installation alignment and detector calibration. Other light patterns such as square, circles, dotted lines; grid or cross hair are also available. Lasiris SNF lasers are ideal for a wide range of image analysis applications including 3D contour mapping and profiling, high precision surface analysis, web inspection etc.

www.coherent.com

Dilas has announced its state-of-the-art tailored bar architecture T-Bar for high-brightness fibre coupling, capable of delivering up to 800W output from a 200µm (NA 0.22) fibre at 976nm. The T-Bar is designed to realise high-brightness output while maximising fibre coupling efficiency for an overall high efficiency product. The T-Bar



was developed so that automated active optics alignment can be utilised for efficient fibre coupling into a 200µm fibre. The device is a monolithic multi-emitter diode source that permits the handling multiple emitters during each manufacturing step to lower both complexity and enhance reproducibility of the beam quality and fibre coupling. The 800W module is based on spatial and polarisation multiplexing of individual beamlets and is equipped with a high-power QBH fibre connector.



a Head-out OHS package. This new high power laser diode has potential applications in both the medical and industrial fields, for marking, engraving and surface treatments. Hamamatsu also offer a range of laser bar devices, supplied either as bare diodes, or provided as a module, with CW powers up to 60

LTB Lasertechnik Berlin provides the Double Echelle Monochromator Demon. The Demon combines very high spectral resolution, high optical throughput and a short read-out time of the detector due to on-chip binning. Its patented optical design with pre-monochromator and echelle grating gives the user the capability of resolutions up to 150.000 (4pm @600nm). In contrast to interferometric testing systems the Demon enables the user to monitor the spectral bandwidth, intensity profile and absolute wavelength simultaneously. The large inspection range of the Demon allows monitoring the main mode together with the side modes. Thus the Demon is the ideal instrument to characterise the complete emission behaviour of the diode laser.

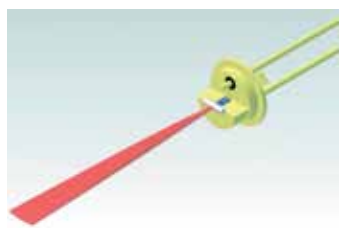
www.ltb-berlin.de



Watts per bar and a choice of water cooling, peltier cooling or Hamamatsu's patented funryu cooling technology. Stacked bar arrays (with up to several Kilowatts output power), fibre-optic coupling and a choice of other wavelength laser diodes are all available to specific customer request.

www.hamamatsu.eu

Laser Components' HI-Series feature a divergence of 25 x 12 degrees compared to the industry standard of 12 x 30 degrees for a higher intensity output ready for pin-for-pin replacement. The HI-FAC-Series is the result of combining these high performance HI-Series with a Fast Axis Collimator lens mounted directly in front of



the laser diode chip inside the hermetic TO-can. A divergence of 5mrad is achieved depending on the lens used resulting in 12 degree x 5mrad divergence which can save engineering costs

and allow for a more compact range finder design. The design can withstand high acceleration rates of over 1000g/ms and can withstand high temperatures of up to +85°C. This technology is also available with 905nm pulsed laser diodes and if the wavelength has to be controlled exactly a thermoelectric cooler (TEC) can be integrated into the housing.

www.lasercomponents.co.uk

Qioptiq has expanded its range of iFLEX-Gemini lasers to include additional pairings like 405nm and 660nm, plus 488nm and 640nm. The iFLEX-Gemini dual diode laser system is compact, low noise, has low power consumption and dual-wavelength collinear output enabling researchers and manufacturers to innovate their approach to laser illumination to achieve smaller instruments, performance improvements and cost savings. Novel architecture allows both wavelengths in the iFLEX-Gemini to be controlled independently, CW or directly modulated. The singlemode, linearly polarised fiber output from the iFLEX-Gemini can be provided with connectors such as FC, APC, FCP8, or alternatively with a collimated or focussed

output using achromatic lenses to maintain true beam collinearity. iFLEX-Gemini includes kineFLEX technology that has long been used in biomedical and metrology applications requiring high power throughput

and ultra-stable beam pointing. Now iFLEX-Gemini is enabling more applications including new leading edge point of use analysers for forensics and remote sensing.

www.qioptiq.com



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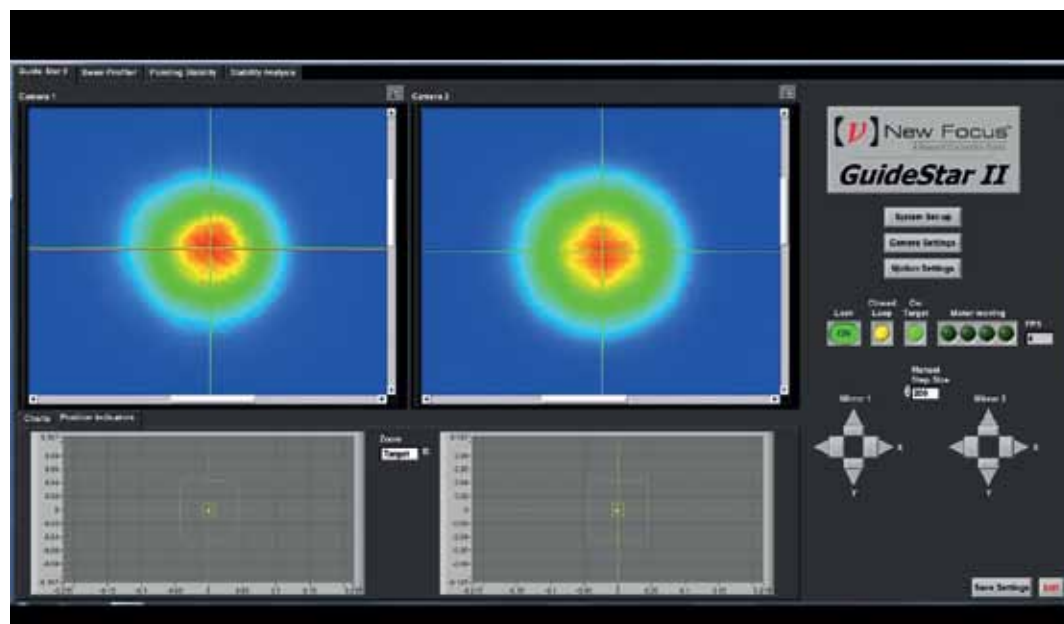
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Accessories

Sputtering to deliver compact near infrared coatings

Laser Components now offers precise, compact layers with a very low wavelength drift using sputtering. This process along with the company's on-line monitoring system produces repeatable coatings with complex layer designs, resulting in the lowest scatter loss and a high reflection of >99.99 per cent, while achieving very high laser damage thresholds. The sputtering process is a cold method that makes it suitable for temperature and moisture sensitive substrates. Laser Components' experience combined with its coating processes allows the company to produce UV coatings with good performance and high damage thresholds. For specialist requirements, Laser Components are able to offer special substrates to work with particular lasers such as a fused silica designed for excimer grade lasers, thus helping to maximise the efficiency of the coating.

www.lasercomponents.co.uk



Mirror mount steering gets a correction

Newport has announced the new Picomotor mirror-mount-based laser beam steering correction system, the New Focus' GuideStar II. Providing high reliability and high precision control of laser pointing and position drift, the New Focus system includes two independent Picomotor-actuated, motorised mirror mounts to provide both manual and active 4-axis control with passive stability. There are two miniature CMOS cameras that provide position sensing and continuous tracking of both laser beam positions and laser beam profiles. The system's patented control algorithm ensures correct

alignment of the laser beam in both the x and y, and near- and far-fields. The GuideStar II controller can be connected to both cameras and to a Windows computer using the convenient USB ports. This makes it easy to view beam profiles, position and shape data in real-time, or alternatively, the data can be tracked, stored and analysed later. The included DVD software and set-up menu helps guide new users through installation. Intuitive and simple settings menus permit user control over a wide range of camera and beam stabilisation parameters.

www.newport.com

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Accessories

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Optical Surfaces' debris shields for target-facing optics protection are being offered in any shape and thickness. The use of debris shields to protect expensive reflective or refractive focusing high power optics is an established technique for extending their lifetime. Working with a range of glasses including BK-7 and fused silica, which provide transmission from the ultraviolet to the near-infrared, Optical Surfaces is able to supply customer specified debris shields in many shapes and thicknesses. Debris shields up to



600mm in diameter with a typical wavefront error of $\lambda/10$ and surface finish of 40/20-10/5 can be produced.

www.optisurf.com

Cameras and Imaging

Order of magnitude improvement for near infrared

Hamamatsu Photonics has introduced a new streak camera with sensitivity in the near infrared region, up to 1650nm.

Like other streak cameras, the new C11293 model simultaneously records intensity vs. time vs. position (or wavelength) with very high temporal resolution. Up to now, the only photocathode material

available for streak measurements at > 1000 nm has been the so-called S-1 material. S-1 material features excellent temporal resolution of better than 1ps, but suffers from low quantum efficiencies. Hamamatsu Photonics is now making available a streak photocathode made of InP/InGaAs. This photocathode has a sensitivity several orders of magnitude higher than S-1, and also extends its range up to 1650 nm.

www.hamamatsu.com

See it all with iStar

Scottish camera design and manufacturing company NCTech has launched its automatic instant 360° panoramic camera.

Designed to be integrated with a Lidar scanning process, this rapid imaging camera processes its images internally with no need for a computer to complete post-production processing or stitching.

The iStar produces instant 50 megapixel high resolution full spherical images to help accurately measure, document and visualise a location, building or terrain. The image resolution of the iStar exceeds that of traditional cameras and when superimposed onto point cloud data allows the viewer to visualise the scene.

www.nctech.co.uk

Shortwave imager for defence promises ruggedness

FLIR Systems has announced the availability of the Tau SWIR 15, a shortwave imager incorporating FLIR's new 15 micron pixel 640 x 515 InGaAs focal plane array.

The Tau SWIR 15 is designed for defence system developers demanding SWAP+C requirements. The system delivers best in class

sensitivity of $<50e$ noise at 20°C case temperature and can be operated at integration times as short as 100 microseconds. The Tau SWIR runs on less than 4W of power, weighs less than 130g and takes up approximately 1,302cm of volume. The camera operates at 30 frames per second and supports sub windowing when higher frame rate are required.

www.flir.com

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Laser and diodes

Emitters get narrow beam, high output

ITW Photonics Group member Opto Diode has announced the first in a new series of super high-power gallium aluminium arsenide (GaAlAs) infrared (IR) emitters. The OD-110L has ultra high optical output with a very narrow optical beam, for night vision (NV) and other military imaging applications. The OD-110L is housed in a standard 3-lead, hermetically-sealed TO-39 package to accommodate the small-size (0.026 x 0.026-inch) chip. There are four wire bonds on die corners and all surfaces are gold-plated for added durability. Typically, the total power output at 25C is 110mW and the minimum output is 55mW with peak emission wavelength at 850nm. The absolute maximum rating at 25C for power dissipation is 1000mW, with a continuous-forward-current rating at 500mW. The OD-110L lead-soldering temperature (1/16-inch from the case for 10 seconds) is 260C. Storage and operating temperatures range from -40C to 100C.

www.optodiode.com



Plug and play with Obis

Coherent has expanded its Obis family of plug-and-play smart laser modules and accessories by introducing the 6-Laser Remote that integrates the power supply and control of up to six separate lasers. This new accessory is the same compact size (105 x 68 x 36 mm) as the existing Obis single laser remote. The 6-Laser Remote not only integrates operation of multiple lasers, it also reduces the cost of ownership and the footprint of

the overall system, since it allows all the lasers to use a single 12V power supply. It incorporates a CDRH-requisite on/off master key switch, as well as individual colour-coded flip switches to power on/off up to six different Obis lasers. Moreover, this new remote is offered as a package with a 12V power supply module, together with colour-coded labels and six colour-coded cables to clearly identify different wavelength lasers.

www.coherent.com

Small is low cost for laser module dot series

Laser Components' Low Cost Laser Module Dot (LC-LMD) series offer competitive, inexpensive and one of the smallest designs available worldwide. The LC-LMD series are low cost modules for the consumer market, where the high demand is coupled with a need for reduced prices. The smallest LC-LMD laser module measures just 3.3mm x 7mm long, while others include focusing optics, coaxial alignment and other useful parameters. In addition to the 650nm modules already introduced, 635nm, 780nm and 850nm wavelength modules are also available.

www.lasercomponents.co.uk



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Laser and diodes

Multi-emitter is monolithic diode

Dilas has announced its state-of-the-art tailored bar architecture T-Bar for high-brightness fibre coupling, capable of delivering up to 800W output from a 200µm (NA 0.22) fibre at 976nm. The T-Bar is designed to realise high-brightness output while maximising fibre coupling efficiency for an overall high efficiency product. The T-Bar was developed so that automated active optics alignment can be used for efficient fibre coupling into a 200µm fibre. The device

is a monolithic multi-emitter diode source that permits the handling multiple emitters during each manufacturing step to lower both complexity and enhance reproducibility of the beam quality and fibre coupling. The 800W module is based on spatial and polarisation multiplexing of individual beamlets and is equipped with a high-power QBH fibre connector. This device is rated at 600W, 976nm for fibre and solid-state laser pumping.

www.dilas.com



Single frequency is mode locked for stability

Laser Quantum has launched its actively mode-locked single frequency 532nm 750mW Torus laser at Pittcon 2012. Laser Quantum claims the Torus is the world's only actively mode-locked single frequency. The Torus features

5 picometre wavelength stability across 20C background temperature shifts. Laser Quantum states that this temperature stability prevents mode-hop and delivers high-resolution capabilities for industrial environments. The Torus has also been shock tested to 1,200 g.

www.laserquantum.com

Compact green laser world first

Spectra-Physics claims a world first with its Explorer XP, the first compact 5W all-in-one green laser that combines laser head and power supply into a single package that fits in the palm of your hand.

Based on the proven Explorer architecture, the Explorer XP laser is rugged and highly reliable for demanding 24/7 applications. It delivers exceptional performance including short pulse width for minimum heat affected zone, unmatched pulse-to-pulse stability and superior beam quality. It operates across a wide repetition rate range from single shot up to 300 kHz. With its short laser resonator cavity, Explorer XP lasers produce high peak powers that in some materials can outperform higher average power green lasers. The superior mode quality ($M^2 < 1.1$ typical) over the full repetition-rate range leads to



improved spatial resolution and larger depth-of-focus. The Spectra-Physics patented intra-cavity design enables efficient conversion to the green, resulting in the highest pulse-to-pulse stability for consistent processing and higher yields.

www.newport.com

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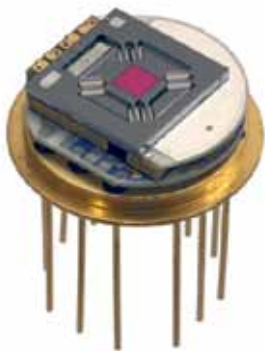
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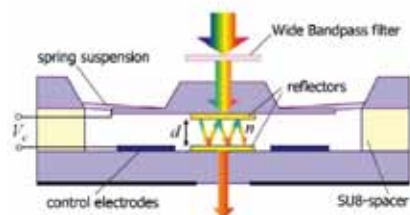
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Lenses and optics



Mid infrared optics get greater mechanical durability

High volume precision optical manufacturer Reo has introduced a new range of mid-infrared optics that provide a higher laser damage threshold, a better spectral performance, improved environmental stability and greater mechanical durability. These zinc sulphide (ZnS or Cleatran) components are intended for use with Ho:YAG pumped optical parametric oscillators (OPOs) and other laser systems operating in the $2\mu\text{m}$ to $5\mu\text{m}$ spectral range. The ZnS substrates are precision ground and polished and then coated using ion beam sputtering (IBS) technology. The IBS process yields fully densified thin films that are virtually impervious to water absorption and extremely stable. These characteristics make

them particularly well suited to demanding applications such as IR countermeasures, laser designating/rangefinding, atmospheric sensing, and small molecule spectroscopy. This series of ZnS optics includes both flat and radiused components with substrates ranging from 5mm to 150mm in diameter. They all feature high surface accuracy and excellent surface quality (20-10), and are offered with a wide range of antireflection, high reflection and multi-spectral coating options. The laser damage threshold of the antireflection bands of these coatings has been measured to be $>8\text{J}/\text{cm}^2$ (at $2.05\mu\text{m}$ in a 75nsec pulse), while high reflection bands have demonstrated a damage resistance of $>50\text{J}/\text{cm}^2$ for the same pulse specifications.

www.reoinc.com

Filter for dependability

Lake Shore Cryotronics has introduced its BPF series of terahertz (THz) and infrared (IR) band pass filters. These filters are specifically designed for applications where precision and dependability are paramount, especially when used in extreme environments. BPF series filters are perfect for THz and Fourier transform infrared (FTIR) spectroscopy, materials and THz device characterisation and testing, THz

and millimeter wave imaging/security, as well as ground and airborne-based astronomy and astrophysics. The filters block unwanted energy, reducing noise and enhancing signal detection in advanced electro-optical systems, and can also serve as excellent calibration references, providing known frequency/amplitude profiles. They are specifically designed for use in cryostats.

www.lakeshore.com

Lenses and optics

Mirror mounts have not two, but three actuators

Lasers and photonics solutions provider Newport has introduced its high-precision stainless steel Suprema SN200 Series Mirror Mount for 2-inch (50.8mm) diameter optics. The clear edge mirror mount is designed to be more compact than other 2-inch mounts, allowing the user unencumbered access to the edge of the mirror. Conveniently,



the new SN200 is available in either right-handed or left-handed versions for situations where the mirrors need to touch or be in close proximity. The mount is available with two or three locking actuators making it ideal for demanding research applications. Newport's precision mount utilises micro-polished carbide pads and 100-TPI adjustment screws which enable smooth, high-resolution alignment and exceptional stability.

www.newport.com

Safety

Ultra-short pulse goggles get coated mineral glass

Protect-Laserschutz is now offering laser safety eyewear with combination filters to protect from the radiation of harmonic ultra-short pulse laser.

The filters combine absorption mineral glass with additional dielectrical coatings. There are two versions. The standard filter type, O165, which protects against radiation of harmonic Nd:YAG, disk- and fibre lasers with high protection levels in the area of 180-532nm and 930-1100nm. And the second is the filter type, O160, which provides, in addition to type O165, protection against radiation of pump lasers. The expanded protection covers 180-532nm and 750-1200nm.

www.protect-laserschutz.de/

Amplifiers and power supplies

High voltage jolts industrial, medical laser systems

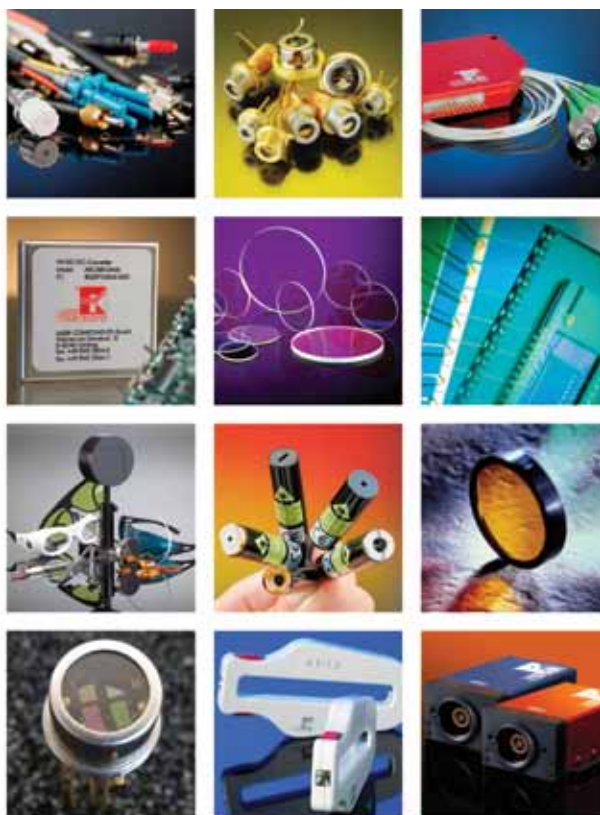
Unipower has announced its LRC series high voltage power supplies designed for use in mid-power CO₂ and similar medical and industrial laser systems. Combining rugged and high reliability circuitry with high efficiency, a compact footprint and the choice of open frame or enclosed configuration, the LRC

series provides 300W and 700W output power. As standard, the 300W unit meets EN60601 for leakage current and this approval is available for the 700W model as an option. Strike voltages are 30kV and 50kV, respectively. Input voltage can be 115 or 230VAC at 50/60Hz. The LRC series has super pulsing capabilities, providing maximum pulse currents of up to 60mA and repetition rates to



2kHz at 100 per cent duty cycle. Full power is available at 75 per cent of maximum voltage.

www.unipowerco.com



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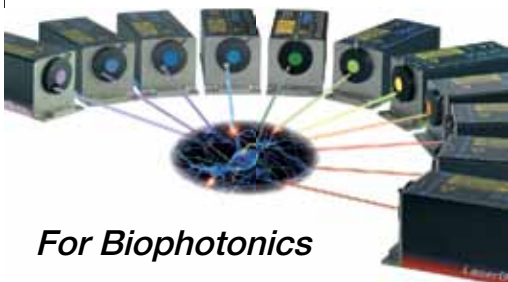
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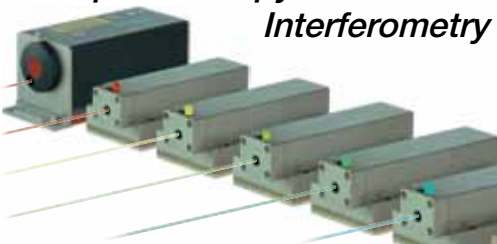


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Analysis, test and measurement

Laser diode testing gets high powered

Yelo, the laser diode test, burn-in and life test systems provider, has launched its new system for high power laser diodes. Yelo's solution can test microchannel cooled packages, chip-on-substrate, CS-mount or C-mount lasers with currents up to 250A per device in continuous wave or quasi continuous wave, pulsed, modes. The laser diode test, burn-in and life test system offers protection features at a low cost per device, according to Yelo.

www.yelo.co.uk



Beam analyser goes low cost

Precision laser measurement equipment provider and Newport brand Spiricon has announced BeamMic, a new laser beam analyser for a low-cost, entry-level system.

BeamMic includes easy-to-use software that measures a beam's size, shape, uniformity, and mode content. Beam intensity profiles are displayed simultaneously in 2D and 3D. Statistical analyses can be performed

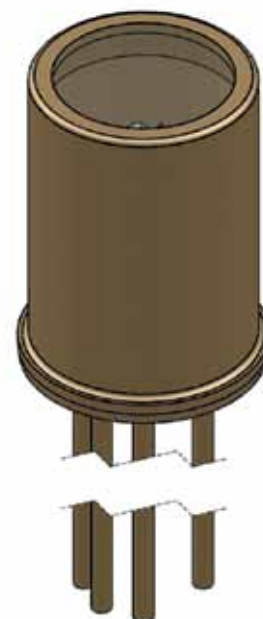
on measurement functions and minimum, maximum limits can be set for pass/fail testing. Results are logged and can be exported to industry standard formats. A configurable report generator allows cutting and pasting of results, images and settings. BeamMic software is integrated with one of four Spiricon USB CCD cameras designed specifically for beam measurements.

www.ophiropt.com

Compact photodiodes available for small systems

Laser Components has unveiled its H0 series of photodiodes receivers that are supplied in a compact, modified TO5 housing with a diameter of about 5mm. The H0 series can be integrated into small systems that can be used for measuring distances or detecting the smallest light signals. With its H0 series, Laser Components has developed an APD receiver with an inherent noise of nearly zero. Depending on the integrated feedback resistor, a bandwidth from DC and up to 80MHz can be achieved. If the SAR500, a Avalanche PhotoDiode receivers (APD) with a diameter of 500µm, is integrated, the module has a noise equivalent power of 4.86fW/√(Hz) at an amplification of 3 x 10⁷V/W. With the 80µm or 200µm Indium Gallium Arsenide APD of the IAG series, the following values can be achieved: 1.1 x 10⁶V/W @ 0.47pW/√(Hz).

www.lasercomponents.co.uk



Analysis, test and measurement

Temperature accuracy hots up

ILX Lightwave has announced the addition of LDT-5940C Thermoelectric Temperature Controller to its portfolio of thermoelectric temperature controllers, designed for testing of laser diodes and other optoelectronic devices.

The LDT-5940C features 60W of temperature control, an intuitive front panel, and standard GPIB and USB 2.0 remote interface. The LDT-5940C was designed for customers requiring higher power and high stability. This new temperature controller with digital PID control loop achieves temperature stability of less than $\pm 0.003^{\circ}\text{C}$ with output current noise and ripple less than 2mA rms. For fast setup, the LDT-5940C incorporates preset PID values and a fast auto-tune PID mode that automatically determines optimal PID values. The LDT-5940C is compatible with

a wide range of sensors including thermistors, RTDs, LM335, and AD590 IC sensors. A new linearised thermistor sensor mode allows the LDT-5940C to achieve $\pm 0.2^{\circ}\text{C}$ temperature accuracy over a wide temperature range from -30°C to 85°C with standard 10K Ω thermistor. Interlocks allow the

user to connect the LDT-5940C to a laser diode driver and will disable the laser output if the LDT-5940C is disabled or is over the user-configurable temperature limit. An additional feature of the LDT-5940C is an analog voltage input for temperature sweeping or tuning without using a remote

interface or front panel control. The LDT-5940C includes USB 2.0 and IEEE 488.1 GPIB interfaces for remote instrument operation in R&D or manufacturing environments. LabVIEW drivers for the LDT-5940C are available for download from the ILX Lightwave website. www.ilxlightwave.com

Software

Oslo 6.6 is Windows 7 compatible

Lambda Research has announced the latest release of its Oslo lens design software version 6.6.

Oslo 6.6 is now fully compatible with Windows 7 and program improvements include Step file export, Tops merit functions, NotePad++ editor, a user selectable private folder, Q-Type Asphere improvement (Premium edition only) and an updated help system. This release also includes updated glass and vendor lens catalogues. The new Tops merit functions are based on merit functions developed in the 1960s and 1970s by professor Charles Wynne, Prudence Wormell, Dr Michael Kidger, David Freeman and others. The Tops version will only work with the Standard and Premium editions of Oslo, but Tops_educ will work with Oslo Edu and Oslo Light. Both will generate an error function which can be used off the shelf for rapid improvement of many types of rotationally symmetric lenses, or tailored to finalise the design by adjustment of weights and targets.

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Photomultipliers have always offered significant performance advantages over other types of low-level light detection devices and this is as true today as ever before. But what has changed is that photomultipliers are now much easier to use due to the wide range of ready-to-use associated electronics and HV supplies, and modular analogue and photon counting systems, in many cases operating from low voltage.

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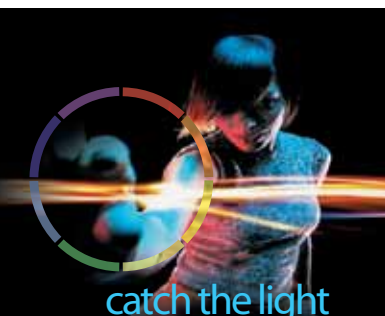
- Sockets and voltage dividers for almost any photomultiplier type and application
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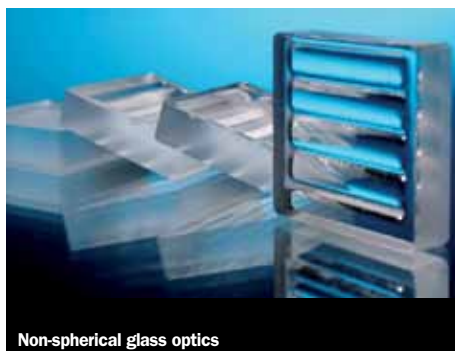


Laser and Laser Systems
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Ablating light optics

Scientists see ablating 1.5kW CO₂ lasers or 1030nm ultra short pulse lasers as the key to better optics. **Rob Coppinger** digs deeper into the issue



Non-spherical glass optics

The Fraunhofer Institute for Laser Technology (ILT) has developed a process for manufacturing optical glass components that should be good for cost-effectively producing aspheres and free-form optics.

There is a growing demand for non-spherical glass optics but the lenses for cameras or multifocal glasses are still very costly to manufacture. This is because non-spherical optics have been produced through time-consuming grinding and polishing processes. In optical systems, headlights, projectors, camera lenses and lenses for glasses, ensure that light is focused through their surface form and finish quality. With these commonly used spherical optics the risk of aberration is reduced by combining several lenses into a single system. However, this approach also increases

the weight and size of the optical system. By using non-spherical lenses, whose surface form deviates from the curvature of a spherical lens, engineers can effectively minimise such aberrations and reduce system weight.

It is a research team at the Fraunhofer ILT that has developed the new three step process for individual manufacturing of aspheres and free-form optics, producing non-spherical and free-form surfaces with different degrees of curvature.

Made out of a quadratic piece of fused silica and following computer generated data, the researchers claim 'nearly any surface form desired can be produced'. Starting with a fused silica preform, a 1.5kW CO₂ laser beam operating at the wavelength of 10.6µm is used on its surface, rapidly ablating it to shape the preform into the geometry wanted. It is because

of the wavelength transparency of silica that the CO₂ laser has a wavelength of 10.6µm. While this ablation is taking place an extraction system is used to remove the vaporised glass from the processing area. The next step is to heat the silica to its evaporation temperature, over 230°C. The heated surface becomes fluid and its roughness is reduced as surface tension ensures the material attains a polished-like state once it has cooled. After this laser polishing step, any remaining form defects are corrected with further laser-based precision ablation. 'For the laser polishing step you definitely need to use the CO₂ laser and for the other two process steps, these can be done with CO₂ and we favour this technology right now but it can also be done by ultra short pulse lasers,' says the project's leader Sebastian Heidrich. Despite silica's transparency at wavelengths of the far infrared, its ablation is possible with an ultra short pulse laser at the wavelength of 1030nm. Throughout this three stage process, geometry and shape accuracy is measured. The temperature of the glass also has to be controlled very precisely. This is achieved with a pyrometer that adjusts the laser power accordingly. With the resulting improved surface Heidrich's researchers expect multiple spherical optics to be replaced by one aspherical lens. The advantage of this is that it will reduce the system weight substantially. ●



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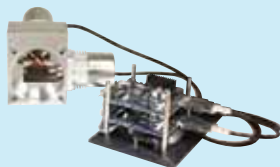
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For the past 20 years, our innovative approach has enabled hundreds of new products and technologies. With dedicated support and resources, Ocean Optics OEM is your trusted and experienced OEM partner.



Global Company - Local Support

With engineering, manufacturing, service and support in the United States, Europe and Asia, as well as representation in over 80 countries, we are ready to support all of your OEM business needs.



Flexible Approach - On Time Delivery

We offer customised solutions, rapid prototyping and a wide range of inhouse capabilities. With our quality and production processes we ensure reliable, scalable delivery - now and in the years to come.



Markets

- » Anti-counterfeit
- » Life Sciences
- » Medical
- » Pharmaceutical
- » Process Control
- » Environmental
- » Agriculture & Food
- » Lab Instrumentation
- » Semiconductor
- » Metrology
- » LED & Lighting

**ISO9001:2008
CERTIFIED**



HALMA
Ocean Optics is a Halma company

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