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SPIE Optics+Photonics 2013 Edition

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The **Product Focus** delivers a range of products from both exhibitors and non-exhibitors alike. We have included booth numbers *(where available)* making it easy for you to check out the products for yourself.

In addition to some of the latest product launches we've also included a selection of the most recent and topical stories from the photonics industries longest running on-line resource.

In this issue we include an article on the $4M funding for a 'freeform optics' development center, the use of laser peening by Rolls Royce in the manufacture of jet blades and further advances in 3-D printing as NASA tests a laser-printed rocket engine injector.

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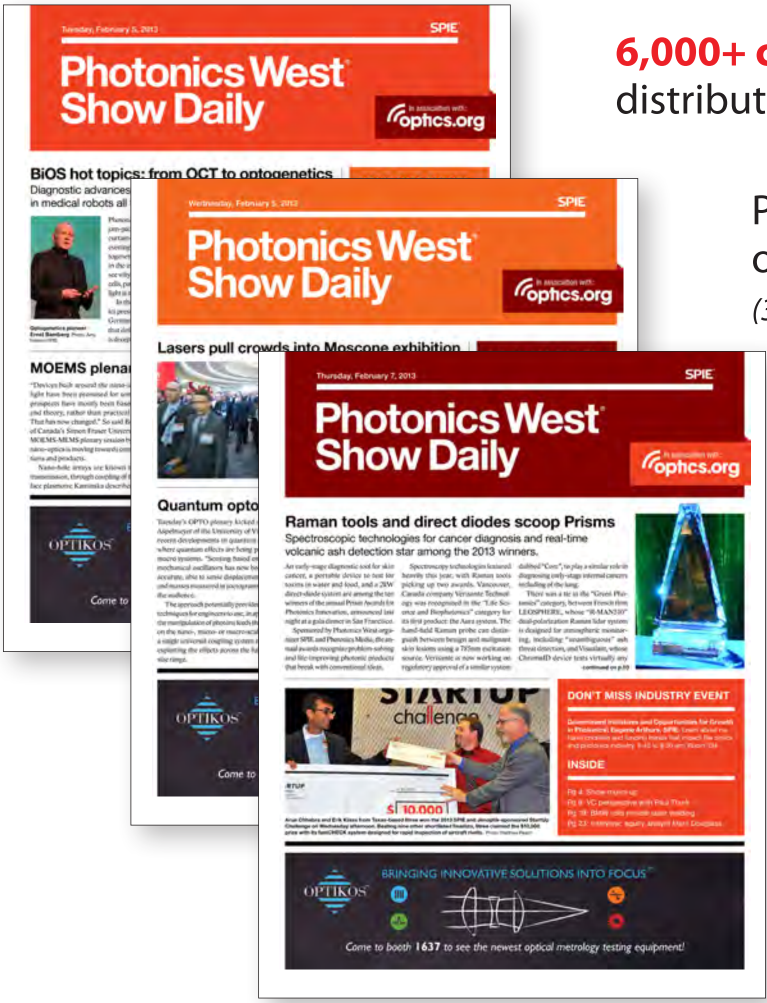

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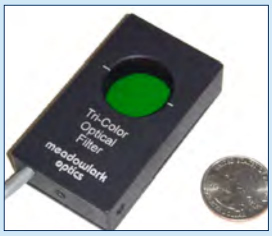

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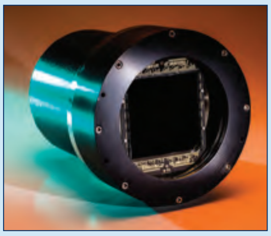

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$4M for 'freeform optics' development center

New network of experts looks to advance the emerging field of freeform optics through industry/university partnership.

The development of so-called "freeform optics", devices with potential applications in head-up displays, LED lighting, remote sensing and astronomy, has received a major funding boost in the US.

A new multidisciplinary center headed up by experts in the emerging technology at the University of Rochester in New York has just landed $4 million through a combination of federal, academic and industry support.

Rochester will join forces with the University of North Carolina at Charlotte (UNCC) and industry partners - including Ball Aerospace and Schott North America - in a bid to take the technology out of the laboratory and make it commercially viable.

Jannick Rolland, the Brian J. Thompson Professor of Optical Engineering at Rochester, has been appointed as the director of the Center for Freeform Optics (CeFO). She said in a statement:

"Freeform optics research is applied research and is best done in collaboration with industry – the new center will make this possible."

The professor also stressed the role that the center will play in educating optics graduate students, adding: "Innovation in this area will require industry to have well-trained employees who can understand the fundamental research and also how to apply it."

Rochester academics have pioneered the theory behind the freeform approach to optics, developing an understanding of how such surfaces guide light in three dimensions.

Together with fabrication and metrology expertise, this will constitute the main focus of the center, whose stated vision is to create "compact, affordable and performant [sic] optical systems that permeate precision technologies of the future".

Aside from optics, the center will draw upon expertise in mathematics, materials science and instrument design to support what is considered "pre-competitive" research – that is, applied research that is not yet ready for a commercial launch.

Pioneering role

Robert Clark, senior vice president for research and dean of the Hajim School of Engineering and Applied Sciences at Rochester, said: "Jannick is ideally suited to lead the new center for freeform optics, which brings university and industrial researchers together to ultimately advance manufacturing."

Photo: J. Adam Fenster/University of Rochester.

CeFO director Jannick Rolland will head up a collaboration featuring seven colleagues from Rochester, six experts from UNCC, and nine industrial partners.

He added: "The Institute of Optics at the University of Rochester has served a pioneering role in optics for nearly a century, and Jannick builds upon the university's strengths and that of the local region in advancing our mission to serve as an international leader in this ever growing field."

CeFO brings together the two universities with no fewer than nine partners from industry and US national laboratories. A five-year grant from the National Science Foundation's Industry/University Cooperative Research Centers Program starting August 1 will provide seed funding, while the nine partners are each contributing $48,000 towards the collaboration.

The collaborators say: "The goals of the center include advancing freeform optics research as a basis for innovation, demonstrating the innovation for state-of-the-art optical systems and educating the next generation workforce, which is critical to industry."

The collaborating partners are:

- US Air Force Research Laboratory
- Ball Aerospace and Technologies Corp.
- NASA Goddard
- OptiPro Systems
- PolymerPlus
- Rochester Precision Optics (RPO)
- Sandia National Laboratories
- SCHOTT North America
- ZYGO Corporation

Said to have first emerged as an idea at a 50-strong "incubator meeting" in freeform optics that took place back in November 2011, CeFO will include eight faculty members from Rochester.

Aside from Rolland, the CeFO team includes associate director John Lambropoulos, Miguel Alonso and Jim Fienup – all from Rochester's Institute of Optics – as well as Stephen Burns and Jon Ellis from the university's mechanical engineering department, Stephen Jacobs from the Laboratory for Laser Energetics, and visiting scientist Kevin Thompson from the company Synopsys.

UNCC will provide a team of six, led by optics specialist Angela Davies and mechanical engineer Christopher Evans. Joined by Matt Davies, Brigid Mullany, Tom Suleski and Glenn Boreman, they will focus on fabrication and metrology of new types of optical devices that could feature textured and segmented surfaces, for example imitating the compound eyes of insects.

In an interview with optics.org last year, Zygo's John Stack said that the company was looking at freeform optics for potential application in head-up displays, while just a couple of months ago the UK firm PowerPhotonic said that it was launching "the world's first low-cost freeform micro-optics rapid fabrication service".

Student involvement

Graduate students are set to become an integral part of the center, and Rolland will also start working on opportunities to involve undergraduate students in the new venture. Part of that will involve the R.E. Hopkins Center for Optical Design and Engineering, which she also heads up, and which is dedicated to teaching undergraduate students to design and build optical systems.

Congresswoman Louise M. Slaughter, who represents the Rochester region, said: "I am delighted that Rochester will be home to the Center for Freeform Optics. Our area has the rich history and unique academic and industry resources that truly define us as a world leader in optics, and the establishment of this center is just the next step in our efforts to advance the optics industry in Rochester."

Article appeared optics.org/news/4/7/44

NASA tests laser-printed rocket engine injector

Mission-critical components made with selective laser melting could be 70 per cent cheaper, says the space agency.

NASA says that it has recently completed initial tests on a rocket engine injector component manufactured by selective laser melting, and will now start working on a full-size demonstration of the technology.

Additive manufacturing, or "3D printing" as it is more commonly known, comprises a wide range of techniques – some of which use lasers, and some of which do not – and is more usually associated with the production of simple, less-critical components such as brackets.

In contrast, the injector component being developed by NASA's industrial partner Aerojet Rocketdyne represents one of the most complex and critical in spacecraft design.

"Rocket engine components are complex machined pieces that require significant labor and time to produce. The injector is one of the most expensive components of an engine," said Tyler Hickman, who led the testing at NASA's Glenn Research Center in Cleveland.

The team believes that additive manufacturing has the potential to deliver rocket engines much more quickly and cost-effectively than current production technologies.

They say that when manufactured with traditional processes, the injector would take more than a year to produce. With laser additive manufacturing, that time period is cut to just four months, bringing a 70 per cent reduction in cost.

Credit: United Launch Alliance.

Future rocket launches like this one from Cape Canaveral earlier this year could use mission-critical components fabricated by selective laser melting.

Hot firing

NASA's Glenn center conducted "hot firing" tests on the new component for Aerojet Rocketdyne through a non-reimbursable Space Act Agreement.

A series of firings of liquid oxygen and gaseous hydrogen demonstrated that the injector component, which Aerojet Rocketdyne fabricated using high-power lasers to melt and fuse fine metallic powders into three-dimensional structures, could move on to the next stage of development.

"Hot fire testing the injector as part of a rocket engine is a significant accomplishment in maturing additive manufacturing for use in rocket engines," explained Carol Tolbert, manager of Glenn's manufacturing innovation project. "These successful tests let us know that we are ready to move on to demonstrate the feasibility of developing full-size, additively manufactured parts."

A laser-printed spacecraft?

According to NASA, the injector component could be just the start of a revolution in the way that spacecraft are produced. Michael Gazarik, the agency's associate administrator for space technology, said:

"NASA recognizes that on Earth and potentially in space, additive manufacturing can be game-changing for new mission opportunities, significantly reducing production time and cost by 'printing' tools, engine parts or even entire spacecraft."

Jeff Haynes, Aerojet Rocketdyne's additive manufacturing program manager, believes that the injector represents a significant advance. "The injector is the heart of a rocket engine and represents a large portion of the resulting cost of these systems," he said.

The Glenn and Aerojet Rocketdyne team partnered on the project with the Air Force Research Laboratory (AFRL) at Edwards Air Force Base in California. At AFRL, a unique high-pressure facility provided pre-test data early in the program to give insight into the spray patterns of additively manufactured injector elements.

GenCorp subsidiary Aerojet Rocketdyne says that the next steps in the adoption of the technology will involve the generation of scale-up and establishing production requirements.

Article appeared optics.org/news/4/7/20

Rolls-Royce expands laser peening to include latest jet blades

Nd: glass laser technology to improve resistance to metal fatigue was originally developed at Lawrence Livermore.

Rolls-Royce has extended its use of laser peening technology in the manufacture of its jet engines, with the addition of a new production cell at its site in Singapore.

Curtiss-Wright Corporation, the US firm that established and now operates the cell, says that the facility is already up and running, and processing the "wide chord" fan blades that are used in Rolls-Royce's "Trent" aero engines.

The company already operates laser peening facilities in Livermore, as well as Earby in the UK, Frederickson, WA and Palmdale, CA, and also has mobile laser peening systems that can be transported to sites anywhere in the world.

In the peening process, high-energy laser pulses are fired at the surface of a metal part, generating pressures of one million pounds per square inch. Multiple firings of

This photograph is reproduced with the permission of Rolls-Royce plc © Rolls-Royce plc.

Rolls-Royce's "Trent 1000" engine, used to power the world's most advanced civilian aircraft.

The technology is based on a neodymium glass laser, and was originally developed in conjunction with Lawrence Livermore National Laboratory (LLNL) in California. A much more powerful version of the Nd: glass laser is used in the National Ignition Facility (NIF), which is also based at LLNL.

According to Curtiss-Wright, the peening mechanism is able to impart deep compressive stresses on the surface of metal parts, which can then be used to minimize the maintenance and inspection interval of the critical components.

the laser in a pre-defined surface pattern impart deep levels of compressive stress that are said to provide greater resistance to potential fatigue and corrosion failures.

The approach, first mooted in the 1960s but only becoming commercially feasible more recently, has found increasing use in aerospace applications over the past decade.

"We are very pleased to be providing Rolls-Royce with our state-of-the-art laser peening technology for their most advanced commercial engine designs," said Martin R. Benante, the CEO of Curtiss-Wright, in a statement.

"This award is a significant milestone in continuing to expand our proprietary laser peening technology globally. A number of industry leaders, such as Boeing and Siemens, have also recognized the benefits of this unique and highly technical offering."

Trent engine family

The Rolls-Royce Trent engine design is widely used in commercial aircraft, including the latest designs such as Boeing's 787 Dreamliner, as well as the Airbus A350 and A380.

The engine maker's 154,000 m2 Singapore facility was opened in February 2012, and is said to be able to produce as many as 250 engines per year.

The manufacturing facility is the company's first outside the UK to make the hollow titanium wide chord fan blades (WCFBs) that are used in the Trent engines, and at full capacity the Singapore site will produce over 6,000 blades per year.

Trent engines came under worldwide scrutiny back in November 2010, when one of four powering a Qantas A380 flight bound for Sydney exploded shortly after take-off from Singapore, damaging parts of the aircraft's wing, fuselage and control systems in the process.

Last month, the Australian Transport Safety Bureau reported that the incident was caused by a leak from an oil pipe on the failed Trent 900 engine. Rolls-Royce said that the oil pipe was one of a small number that had been incorrectly manufactured as a result of a measurement error during a precision drilling procedure.

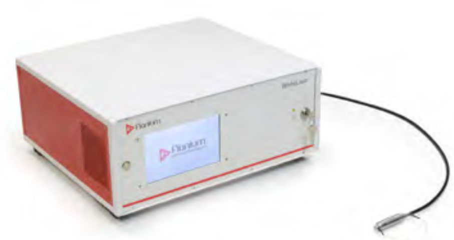
The oil leak led to a fire in the engine and the break-up of a turbine disc, fragments of which exited the engine – an incident known in the aviation industry as an uncontained disc failure. The aircraft returned to Singapore and landed safely, and although such failures are extremely rare (the previous such failure on a large Rolls-Royce civil engine happened in 1994), the company has implemented a number of changes to its design and manufacturing processes as a result.

Article appeared optics.org/news/4/7/29

Sponsored Editorial

High Reliability Supercontinuum Sources Move into Industrial Applications

The phenomenon of Supercontinuum generation, the ultra-wide spectral broadening of a laser via non-linear effects, was discovered in the 1970s using solid state lasers and bulk non-linear materials. While scientifically intriguing, the complexity of this new "white-light laser" presented an obstacle to the adoption of the technology as a useful light-source in its own right. The advent of two significant optical fiber-based technologies changed this; advances in fiber laser technology matured in the post-telecom bubble resulted in development of cost effective and reliable ultrafast fiber lasers



Fianium WhiteLase SC480-10

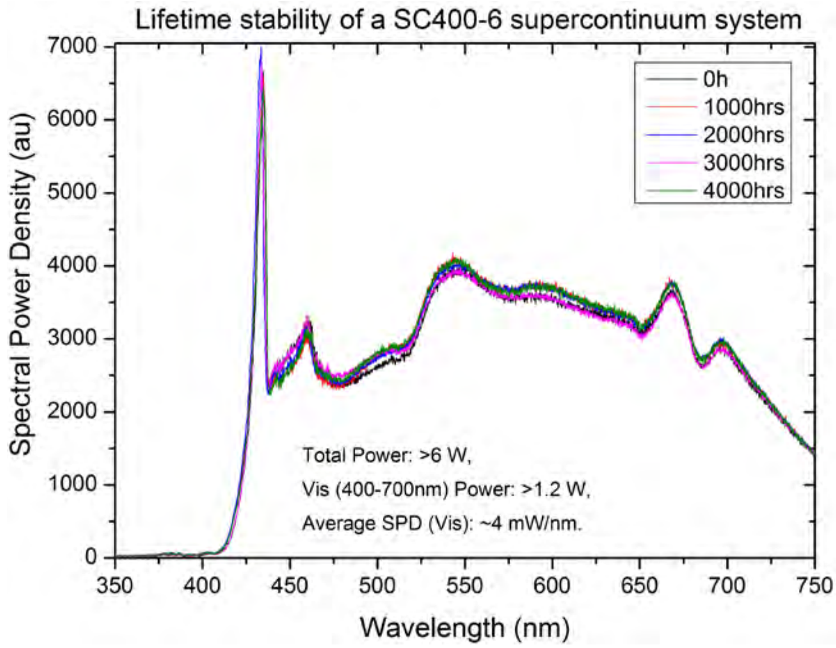
and discovery of microstructured optical fiber, commonly known as Photonic Crystal Fiber or PCF. The fiber laser source provides high peak power picosecond pulses at MHz repetition rates and the non-linear spectral broadening is then achieved in a length of specially designed micro-structured (PCF) fiber. The resulting supercontinuum fiber laser can be compact, robust and provide multi-Watt output across a spectrum spanning over 2000nm. These features, combined with low cost in volume manufacturing, make this an ideal source for laboratory and industrial use.

It is approaching the 10th anniversary of the first commercially available high power supercontinuum fiber lasers, launched by Fianium in 2004. Early adopters of this technology were mainly academic customers and industrial R&D departments pushing the limits of their respective fields including biomedical imaging, nanophotonics and materials science. The unique combination of the spectral properties of a lamp and the brightness and beam quality of a laser has enabled many experimental techniques to be carried out using a single light source. The lasers have proven to be extremely useful in broadband spectroscopy, fluorescence excitation (including fluorescence lifetime measurements), Optical Coherence Tomography (OCT), flow cytometry and many others.

Driven by the requirements of researcher's at the cutting-edge of science, the performance available from the supercontinuum sources has also rapidly increased. One of the first areas to see significant improvement was the maximum spectral bandwidth that can be generated with customers requesting ever shorter wavelengths. Better understanding of fundamental effects involved into formation of supercontinuum radiation goes hand in hand with technological advances in development of supercontinuum fiber lasers resulting in ability to tailor parameters of supercontinuum to a particular application. Utilising the ability to carefully design the microstructure of the PCF, the supercontinuum spectral shape can be tailored to achieve a blue-enhanced spectral output. The first generation of picosecond fiber-based supercontinuum systems had a spectrum spanning from approximately 550nm to 2000nm but by 2007 cut-in wavelengths down to 400nm were being offered. Today, UV-enhanced supercontinuum systems, such as the Fianium WhiteLase SC-UV series, offer a continuous spectral range of approximately 380nm to 2500nm allowing researchers to explore beyond the visible spectrum.

The second area of significant technical development over recent years is the average power output of supercontinuum fiber lasers. The earliest commercial supercontinuum lasers provided an output power of up to 1W which corresponded to approximately 100mW of power in the visible region of the spectrum. For the majority of applications it is the available visible power that is of critical importance. Power improvement was initially achieved by refining the parameters for the pump laser and PCF design to provide more efficient generation of visible wavelengths. Because each pulse generates the same supercontinuum spectrum, with the same pulse energy, the average power can also be increased linearly with repetition rate, without significantly affecting the reliability of the system, and therefore further improvements could then be achieved by increasing the repetition rate of the pulsed laser. Currently the highest average power available from a commercial supercontinuum laser (Fianium WhiteLase SC480-10) is 10W, providing an impressive 1.5W in the 400-750nm spectral range. With further development, the available power is expected to at least quadruple to 40W, with over 6W of visible light in the future.

As the technology has developed, the lifetime and reliability provided from these maintenance-free turn-key supercontinuum sources has also improved significantly. Current state of the art supercontinuum sources are now a viable alternative in illumination and inspection applications currently employing high power lamps, multiple single wavelength lasers or LEDs. The main problem with high power lamps is their limited operational lifetime. Typical high power Xenon lamps have an operational lifetime of between several hundred hours and one thousand hours. Worse still, during this operation the spectral shape changes continuously and, in high specification applications where the chromaticity often has tight requirements, the useful lifetime of the lamp can be substantially less. Supercontinuum lasers, in contrast, maintain a remarkably stable spectrum over several thousands of hours of operation providing improved performance and reduced cost. The figure below shows the intrinsic spectral stability and operating lifetime of the Fianium WhiteLase



SC400-6 system which is the highest power blue-enhanced supercontinuum laser currently on the market.

Driven by the requirements in these new industrial applications, particularly the high volume biomedical instrumentation market, extensive development in performance and reliability has been achieved. This has resulted in the development of industrial grade broadband sources which meet customer expectation not only in optical performance but also in economical effectiveness. Supercontinuum fiber lasers therefore offer a unique industrial solution for lamp-like applications, requiring straight forward high luminous output, as well as a laser replacement in applications where the high brightness of the source and multiple wavelength output are critical.