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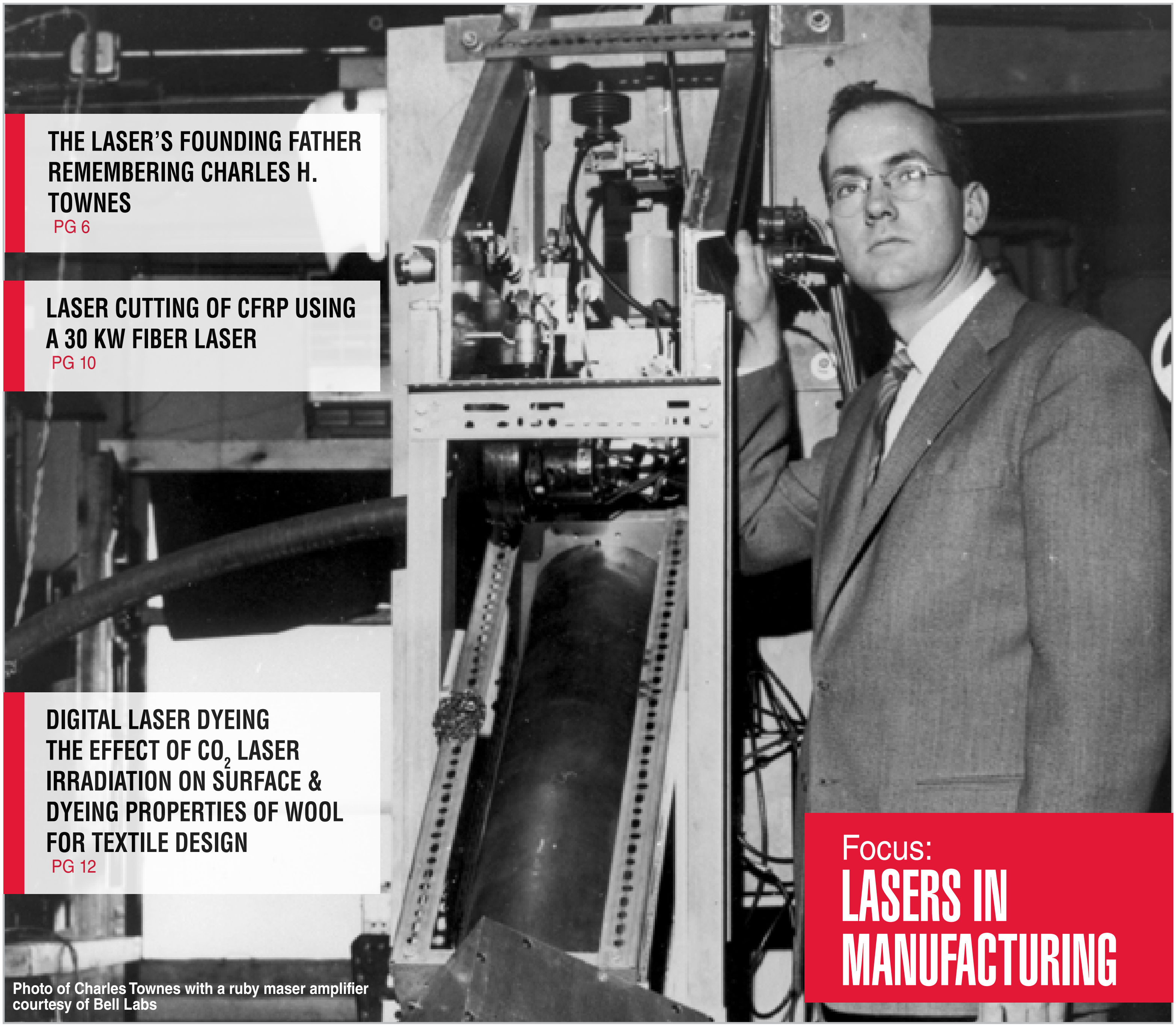
JUL/AUG 2015

THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

# LIA TODAY



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Focus:
LASERS IN MANUFACTURING

Photo of Charles Townes with a ruby maser amplifier courtesy of Bell Labs

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## ABOUT LIA

Laser Institute of America (LIA) is the professional society for laser applications and safety. Our mission is to foster lasers, laser applications and laser safety worldwide.

We believe in the importance of sharing new ideas about lasers. In fact, laser pioneers such as Dr. Arthur Schawlow and Dr. Theodore H. Maiman were among LIA's original founders who set the stage for our enduring mission to promote laser applications and their safe use through education, training and symposia. LIA was formed in 1968 by people who represented the heart of the profession – a group of academic scientists, developers and engineers who were truly passionate about taking an emerging new laser technology and turning it into a viable industry.

Whether you are new to the world of lasers or an experienced laser professional, LIA is for you. We offer a wide array of products, services, education and events to enhance your laser knowledge and expertise. As an individual or corporate member, you will qualify for significant discounts on LIA materials, training courses and the industry's most popular LIA conferences and workshops. We invite you to become part of the LIA experience – cultivating innovation, ingenuity and inspiration.

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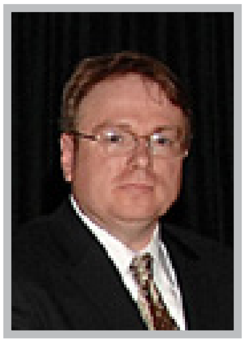
# President's Message



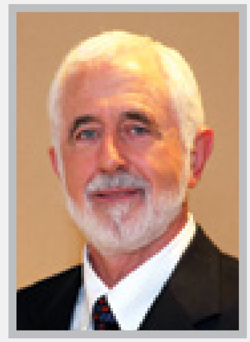
At the end of July, we celebrated the 100th birthday of Charles H. Townes, honored with a Nobel Prize just over 50 years ago for contributions to fundamental work in quantum electronics, leading to the development of the maser and laser. Dr. Townes was often quoted as saying about these inventions "It was strange, in a way, because there were no ideas involved in the laser that weren't already known by somebody 25 years before lasers were discovered. The ideas were all there; just, nobody put it together." As we celebrate Townes' 100th birthday, we reflect on this observation and ask ourselves: "what other ideas are out there for us to put together in an equally profound way (and not have the process require 25 years!)?"

This observation is reflected in the description of Townes by Freeman Dyson, who described Townes as a "fox" in the context of *The Hedgehog And The Fox* essay in which the hedgehog views the world from the perspective of a single defining idea or "one big thing," while the fox draws on a variety of experiences and perspectives. No doubt, the many ideas that resulted in the laser, were brought together through experience in a variety of physics and engineering projects during undergraduate, graduate and research careers. As a community, it is critical that we foster the free exchange of these ideas and highlight significant advances. The foxes among us will connect the dots in order to advance the field of laser applications technology.

The Laser Institute of America has long been an organization of professionals focused on the innovative application of laser technologies. As such, it is important that we exercise the "inner fox" in all of us. Our LIA Journal—*Journal of Laser Applications® (JLA)*, and forums such as the International Congress on Applications of Lasers and Electro-Optics (ICALEO®), the Lasers for Manufacturing Event® (LME®) and Laser Additive Manufacturing (LAM®) Workshop have provided us access to those ideas that "are just there" and awaiting your insight for the next big breakthrough. I hope that you will join us, and become the next "Laser Fox" that the world celebrates. Happy Birthday, Dr. Townes!

Robert Thomas, President
Laser Institute of America

# Executive Director's Message



I am writing this just as we return from Laser World of Photonics in Munich, an excellent event as expected from our friends at Messe Munich International.

The show continues to expand, particularly in the area of lasers in manufacturing. The forum on International Laser Applications covered the field, and there were interesting demonstrations at many of the stands. All indications are that our industry is healthy and growing.

Now it is time for our European friends to take some vacation and enjoy the unusually warm weather. I wish all of our members and readers a safe and pleasant summer.

See you at ICALEO Oct. 18-22, 2015, in Atlanta, Georgia.

Peter Baker, Executive Director
Laser Institute of America

# The Laser's Founding Father

## Remembering Charles H. Townes

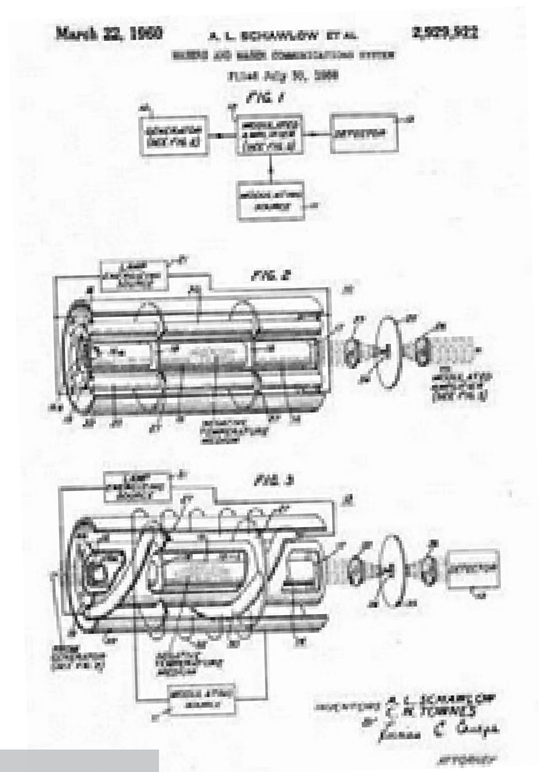
**BY GEOFF GIORDANO**

In his 1999 book *How the Laser Happened*, the late Charles Hard Townes explained that, "Once invented, lasers found a myriad of uses" and noted that they had advanced to the point that "the smallest lasers are so tiny one cannot see them without a microscope."

A far cry from the heady days of the 1950s. Imagine Townes conceiving and building a maser (microwave amplification by stimulated emission of radiation) at Columbia University before the heated race to pursue a patent for an optical maser — the laser. Imagine the fevered discussion in the scientific community as Townes and Arthur Schawlow at Bell Labs beat Gordon Gould and Technical Research Group to that first laser patent — two months before Theodore Maiman built his ruby laser for Hughes Research Laboratories in Malibu, CA, in 1960.

Townes — who famously conceived the idea for the laser while sitting on a park bench in Washington, DC in 1951 — worked until his 99th year, maintaining an office at the physics department of the University of California, Berkeley. The campus honored him with a birthday celebration July 28, 2014; he passed away in January 2015.

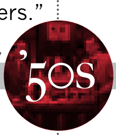
"He told me that if you are in the teaching game — especially with graduate students — that you have to try to put yourself




PATENT, FILED IN 1958

### TOWNES

Conceives maser at Columbia University in 1951, builds it in 1954; sketches optical maser in 1957 and describes it in 1958 paper "Infrared and Optical Masers."




The Maser, courtesy the American Physical Society

### LASER

Moscow-based researchers Nikolai Basov and Alexander Prokhorov attempt to design and build oscillators in 1955 and propose production of a negative absorption called the "pumping method"; Harvard's Nicolaas Bloembergen develops microwave solid-state maser in 1956; Columbia University graduate student Gordon Gould sketches ideas for building a laser — considered the first use of the acronym for light amplication by stimulated emission of radiation.

### TOWNES

Patents laser with Arthur Schawlow through Bell Labs; shares 1964 Nobel Prize in Physics for invention of the laser; initiates program of radio and infrared astronomy at University of California, Berkeley; writes "The Convergence of Science and Religion" for the IBM journal THINK.


The First Laser, courtesy HRL Laboratories, LLC

### LASER

Wave of first-ever lasers invented: ruby, neodymium glass, gallium-arsenide, yttrium aluminum garnet, red-light semiconductor, neodymium-doped YAG, $CO_2$, pulsed argon-ion, chemical, dye and tunable dye; laser sales hit $1 million; Q-switching invented; Laser Industry Association founded.

### TOWNES

Wins Niels Bohr International Gold Medal.


LAGEOS I, courtesy NASA

### TOWNES

Becomes Berkeley professor emeritus; serves on Committee on the Contributions of the Behavioral and Social Sciences to the Prevention of Nuclear War and as chairman of President Ronald Reagan's commission on the MX missile.

### LASER

Laser printers and bar code scanners invented; excimer laser developed; optical trapping invented; CW semiconductor laser commercialized; first free-electron laser; Gould awarded optical pumping patent and patent covering broad range of laser applications; LaserDisc enters home video market.

in their shoes a little bit," recalls Dr. Paul Goldsmith, a former Townes student and chairman of the group that organized a two-day remembrance of Townes just after what would have been his 100th birthday Aug. 1-2 at Berkeley. "You have a great responsibility to them, and you have to do your best to try to share any wisdom you might have with them and to inspire them to do their best to learn how to solve problems and overcome obstacles."

Goldsmith, of the Jet Propulsion Lab in Pasadena, CA, studied with Townes while pursuing his Ph.D. at Berkeley from 1971 to '75. "I found him then and since to be an extraordinary individual in terms of being able to be engaged and helpful with students even in the midst of having many students, colleagues (and) huge responsibilities. You could always get a chance to talk to him, and he would be able to answer questions and be an inspiration in a way that was just remarkable."

Encountering Townes throughout his career, Goldsmith "still always gained a great deal from hearing his thoughts on scientific questions and enjoyed interacting (with him) as a wonderful human being."

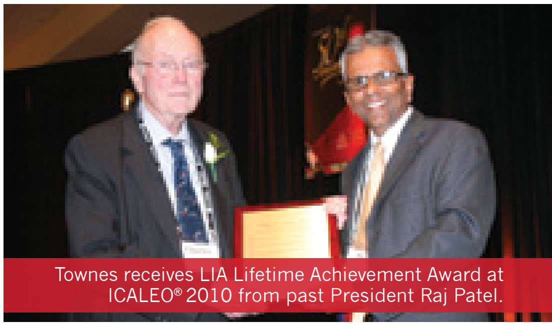
Such was Townes' impact that he received LIA's first Lifetime Achievement Award at ICALEO 2010 in Anaheim. Reflecting on the award in an email, Townes noted that "I am very privileged to receive the lifetime achievement award. And I feel my life has been very privileged by the opportunity to do research, discover new things, and particularly by the discovery of how a laser could be made. I am also delighted by the many contributions that colleagues have made in development of the laser and further associated discoveries. These have made the field of optics blossom with so many fascinating contributions to science and to technology. Many thanks for this honor, and more importantly many thanks for the many contributions other scientists and engineers have made towards the exciting growth of optics."

Townes gave a detailed portrait of his life in a comprehensive series of interviews in 1991 and 1992 as part of an oral history project for Berkeley's Bancroft Library. Townes candidly and vividly recounted everything from his pre-Revolutionary War ancestry to his boyhood in Greenville, SC, growing up with five siblings, his education and extraordinary career, his religious faith, and his views on everything from the importance of school grades to the uniqueness of Southern culture and the work of his peers.

No less a formidable presence in Townes' life was his wife, Frances, who recounted her experiences in her 2007 book *Misadventures of a Scientist's Wife*. In the program for the dedication of The Charles H. Townes Center for Science at Furman University in 2008, Frances Townes is described as a "champion of women's rights, friend of the homeless, environmental educator, and visionary community leader" who taught English to foreign students at Columbia University, organized career programs for MIT faculty women, and advocated for homeless youth for more than 20 years. (Townes earned bachelor's degrees in physics and modern languages from Furman in 1935.)

Married in 1941, the couple had four daughters, one of whom — Dr. Ellen Townes-Anderson — is a professor in the Department of Neurology and Neurosciences at Rutgers in Newark, NJ. She

## TOWNES' CAREER AND THE LASER'S DEVELOPMENT


Townes receives LIA Lifetime Achievement Award at ICALEO® 2010 from past President Raj Patel.

Compact Disc


### LASER

Schawlow and Bloembergen won the Nobel Prize in Physics for contribution to laser spectroscopy; titanium-sapphire laser developed; audio CD appears; Erbium-doped fiber amplifiers introduced.

### TOWNES

Became Officer of French Legion of Honor in 1990.

Blue LED, courtesy Gussisaurio


### LASER

Quantum cascade laser invented; quantum dot and single-atom lasers demonstrated; first pulsed atom laser; gallium-nitride laser appears.

### TOWNES

Wins Templeton prize for contributions to the understanding of religion; wins Nancy DeLoye Fitzroy and Roland V Fitzroy Medal; gave Karl Schwarzschild Lecture in Germany and Birla / Schroedinger lectures in India.

Fiber Laser, courtesy Fraunhofer ILT


### LASER

Laser market valued at nearly $6 billion; short-pulse lasers announced; diode lasers emerge in industrial materials processing applications; fiber lasers reach 30 kW to 100 kW in industrial applications; diode-pumped disk lasers achieve combined industrial powers of 20 kW to 30 kW; additive manufacturing applications for prototypes and parts surge as part of $4 billion global industry.

works not far from the Bell Labs facility in Murray Hill, where her father began working in 1939 to develop radar bombing and navigation systems.

Dr. Arno Penzias, a partner with venture capital firm New Enterprise Associates in Menlo Park, CA, and winner of a 1978 Nobel in physics for his work in radio astronomy, earned his Ph.D. under Townes in 1961 at Columbia University before taking a full-time job at Bell Labs.

Townes "was really honest… and never cut corners," Penzias remembers, "and he had scientific integrity. He had an amazing sense of humor; he was an extremely polite Southern gentleman."

Slated to open the August celebration of Townes' life and work with a presentation titled *Charles Townes as Catalyst*, Penzias — like the program organizers — remembers their former teacher for far more than the laser. "He's done so many things; I wouldn't say the laser (was most important)." Townes' repertoire ranged from low-energy experimental physics to spectroscopy, interstellar molecules, astrophysics and microwave technology. "Pretty much anything outside of nuclear physics he'd get his hands on." And, "he was a phenomenal user of scientific implements — which many people didn't realize were scientific implements."

But Townes also tried to live a balanced life, Penzias notes: "He was not a maniacal workaholic. He needed to rest his brain; he was in the office long hours and weekends, but he was doing scuba diving in the Bahamas when I didn't know anybody did scuba diving."

Ultimately, "he really was a teacher," Penzias concludes. "He was very empathetic if someone had a problem — as I did; he worked me through it. If it wasn't for him I wouldn't have gotten my Ph.D." ■

**Timeline Sources**

*"History of the Laser," www.photonics.com; Laserfest history, http://laserfest.org; "A History Of The Laser: A Trip Through The Light Fantastic," Photonics Spectra, http://www.photonics.com/Article.aspx?AID=42279; Encyclopaedia Brittanica, www.britannica.com/biography/Charles-Hard-Townes; Nobel biography, www.nobelprize.org/nobel_prizes/physics/laureates/1964/townes-bio.html; Templeton biography, www.templetonprize.org/tpctwtp.html.*



## More About Charles Townes

**LIA Exclusive Interview Video:**
www.youtube.com/user/LaserInstitute

**Oral History:**
Interviews conducted in 1991-92 by Suzanne B. Riess for the Regional Oral History Office of The Bancroft Library at University of California, Berkeley, http://tinyurl/ojnmtyb

**Video:**
Townes reflects on his career from his office at the University of California, Berkeley, www.youtube.com/watch?v=HLQkzAiNBEw

**Hometown Retrospective:**
Account of his life from The Greenville News, http://tinyurl.com/pqsheyz

**Read the Master Patent:**
www.google.com/patents/US2929922

**Column:**
LIA President Robert Thomas recalls Townes, Page 5

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# Laser Cutting of CFRP

## Using a 30 kW Fiber Laser

BY DIRK HERZOG, MATTHIAS SCHMIDT-LEHR, MARTEN CANISIUS, MAX OBERLANDER, JAN-PHILIPP TASCHE AND CLAUS EMMELMANN

Today, industrial usage of Carbon Fiber Reinforced Plastic (CFRP) is steadily increasing, with an amount of 67,000 t/year. Latest products such as the Boeing 787 and Airbus A350 in the aerospace sector, as well as the BMW i3 from the automotive industry, consist of more than 50 percent of CFRP in their structural weight. At the same time these products also have comparatively high production volumes, in the five-digit range per year in the case of the BMW i3. Therefore, a higher degree in automation and cost-efficiency is needed in production. Due to the highly abrasive carbon fibers, conventional machining processes result in short tool life and high costs.

For that reason laser cutting of CFRP as a wear-free alternative has become the focus of several research groups. Two different approaches are commonly chosen: Cutting by short- and ultra-short pulsed laser systems to reach a process regime of cold ablation, and cutting with continuous wave (cw) lasers at high cutting speeds. For the latter approach, it has already been shown that by increasing power and cutting speed, the heat affected zone (HAZ) can be reduced due to less time allowed for heat conduction.

A new approach presented here uses an ultra-high power fiber laser system of 30 kW to cut CFRP laminates in order to allow for highest-speed and lowest HAZ.

### Material and Set-up

The material for the process was chosen to specifications from typical automotive applications of CFRP. 2D specimens were manufactured using vacuum infusion technology, consisting of a total of six layers of non-crimp carbon fabrics and an epoxy resin.

A high power Yt:YAG fiber laser was used in combination with a special optical system that can handle the high intensities needed for the experiments. The laser beam was directed to the manufacturing cell in a 300 µm process fiber and then collimated and focused by an optical system with an image scale of 1:1.2 to achieve a theoretical focal diameter of 250 µm.

Normally in laser materials processing, relative movement is realized either by movement of the workpiece or the beam with the means of a linear axis, or alternatively by scanner systems. Commercially available scanner systems operate already with comparably high feed rates of several m/s. In order to allow for a detailed investigation on the influence of the number of passes in a multi-pass cutting strategy, the achievable feed rate should be high enough to enable a cutting process with $n \geq 30$ passes at highest possible intensity. Calculations of the required feed rate based on the necessary intensity for the sublimation of the carbon fibers yield a requirement for the relative movement system of 80 m/s, which is not achievable by today's scanner technology. To achieve these feed rates, a rotary plate was

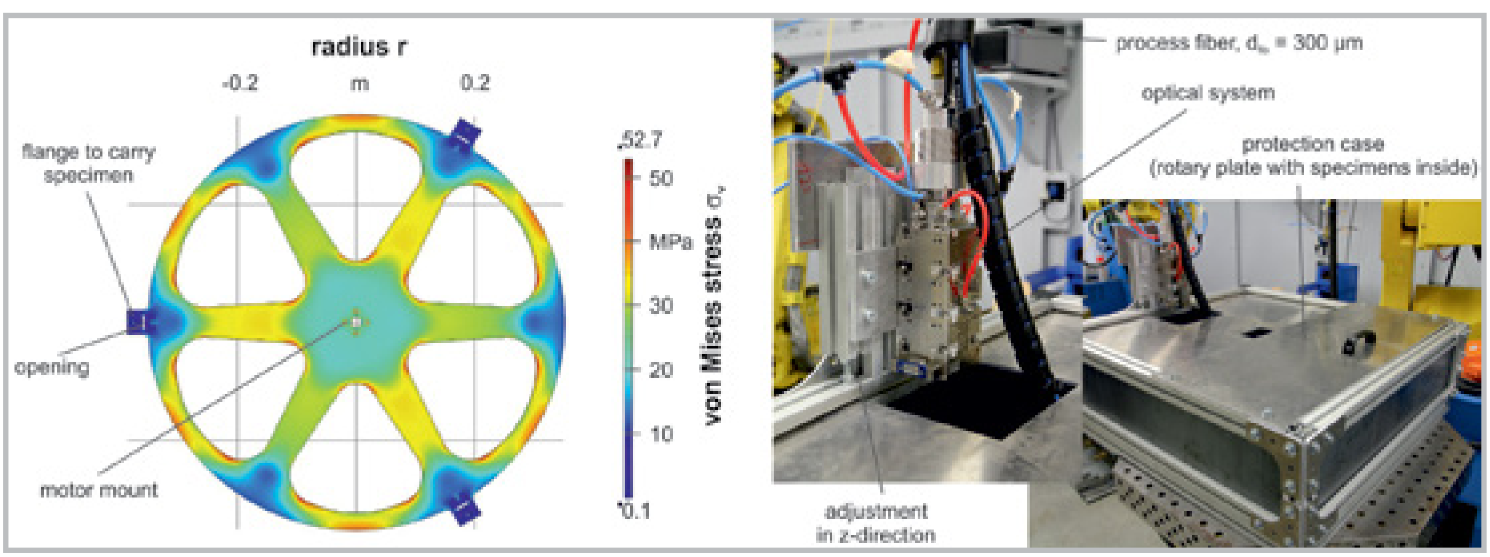


**Figure 1.** Overview of high-speed rotary plate and laser system

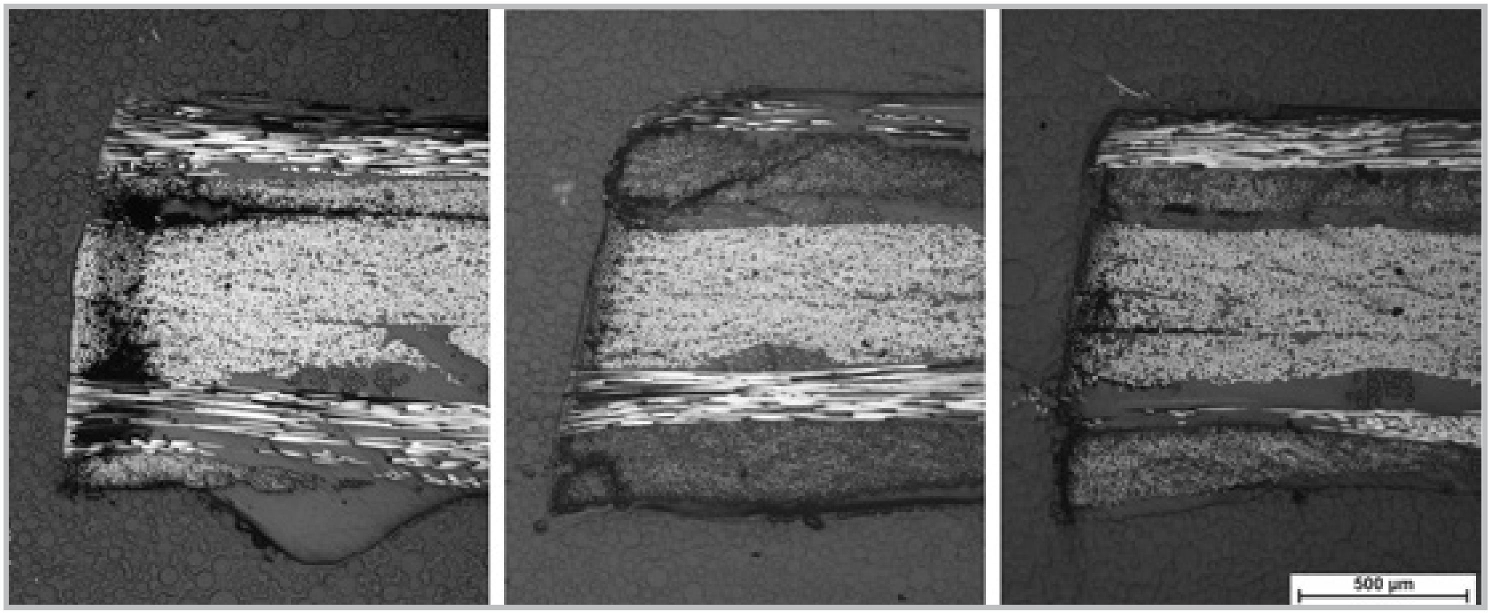


**Figure 2.** Cross-section of CFRP cut at 30.5 kW laser power, at a single laser pass (left), at 12 laser passes (middle) and at 16 laser passes (right)

manufactured and turned at high number of revolutions instead. An overview of the setup is given in Figure 1.

## Results

Using 30.5 kW of laser power focused down to a spot of 244 µm in diameter, it was possible to cut a 1.4 mm thick CFRP laminate in a one pass strategy at 1.2 m/s and with a mean HAZ of 139 µm (Figure 2, left). With a multi-pass strategy finding its optimum in a range between 12 to 16 passes, the HAZ was further reduced down to 78 µm at 12 passes (Figure 2, middle), and the energy input needed was reduced by approximately 26 percent.

The effective feed rate can be increased up to 1.63 m/s in the multi-pass strategy — 26 m/s per pass — at an optimum 16 passes (Figure 2, above), with the ultra-high power laser system. This makes it an attractive option for industrial applications with high production volumes and medium quality requirements. However, fissures and chipping behavior were observed especially close to the surface of the specimens, probably resulting from high process pressures. It is assumed that this behavior results from an insufficient absorption of the laser wavelength by the matrix, leading to fast energy deposition within the material, and finally to partial evaporation below the surface. Further investigations, e.g., cutting experiments with a laminate including absorbing particles such as carbon-black in the matrix, are needed to prove or disprove this theory. This approach has already proved to be very efficient at comparatively lower laser powers of up to 5 kW, as shown in Figure 3. At the current state, the process can be used to cut several mm of 2D CFRP specimens, Figure 4. By using a programmable focusing optic as well as modified exposure strategies such as parallel lines, laminates thicker than 10 mm can be cut with a maximum HAZ of 230 µm as well. ■

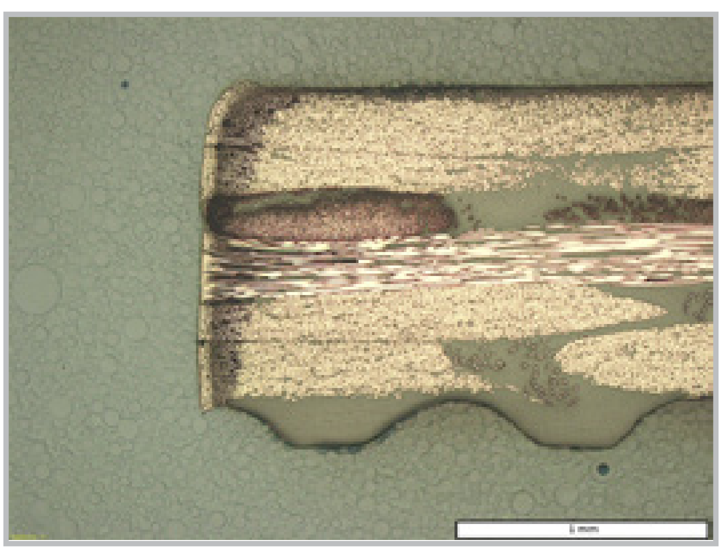

**Figure 3.** Cross-section of CFRP with laser wavelength-absorbing additives, cut at 5 kW laser power

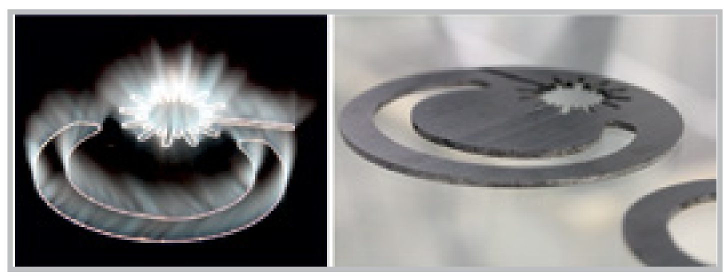

**Figure 4.** Laser-based CFRP cutting process (left) and cut specimens (right)

*The authors work for the Institute of Laser and System Technologies, Hamburg University of Technology, Hamburg, Germany. Part of this work was supported by the German Federal Ministry for Economic Affairs and Energy (BMWi) within the frame of the project 01 MX 12049. The authors would like to thank BMWi as well as PT-DLR project management agency for their support. Furthermore, the authors express their gratitude to Precitec Optronik GmbH for providing the optical system, and Rhein Composite GmbH for providing the carbon fiber fabrics.*

# Digital Laser Dyeing

## The Effect of $CO_2$ Laser Irradiation on Surface & Dyeing Properties of Wool for Textile Design

BY LAURA MORGAN

A digital laser dyeing technique for woolen textiles has been developed at Loughborough University. The technique was developed to explore potential sustainable design techniques using laser technology. The research examined the effect of laser irradiation as a pre-treatment to dyeing 100 percent wool and the potential to use this as a design tool for textile processing.

The textiles and clothing sector represents the second biggest area of global economic activity in terms of intensity of trade with an economic value of over one trillion US Dollars, so the sector's environmental impacts are hugely significant. The consumption of water, energy and chemicals used in current dyeing and finishing processes in the textile industry pose significant environmental concern and have been identified as key challenges to sustainability within the industry. By offering alternative solutions to traditional textile wet processing through laser technology, there is potential to increase environmental sustainability through significant reduction in energy and wastewater effluent.

Current industry standards for dyeing woolen textiles use high temperatures and long processing times to aid dye diffusion through the hydrophobic cuticle layers of wool fibers. Chemical pre-processing such as chlorination is regularly required for an optimum dye reaction to take place.

To examine the effect of laser treatment on the surface properties of wool, laser irradiation at increasing power outputs was performed prior to dying the wool with reactive dyestuffs. The laser system used for the study was a Synrad carbon dioxide source laser that operated at a wavelength of 10.6 µm in the far infrared spectrum with a maximum power of 100 W. Dyeing of the laser treated wool was performed in an Ahiba Infrared Dye Machine. In the machine, each fabric sample occupied its own airtight vessel where temperature and agitation could be controlled and maintained throughout the dyeing process.

The morphology of the irradiated surfaces was examined by scanning electron microscopy (SEM). SEM was carried out on an area of the wool fabric that had been subject to laser irradiation. The micrograph in Figure 1 shows the woolen fibers after laser irradiation. Two particular fiber strands of note,

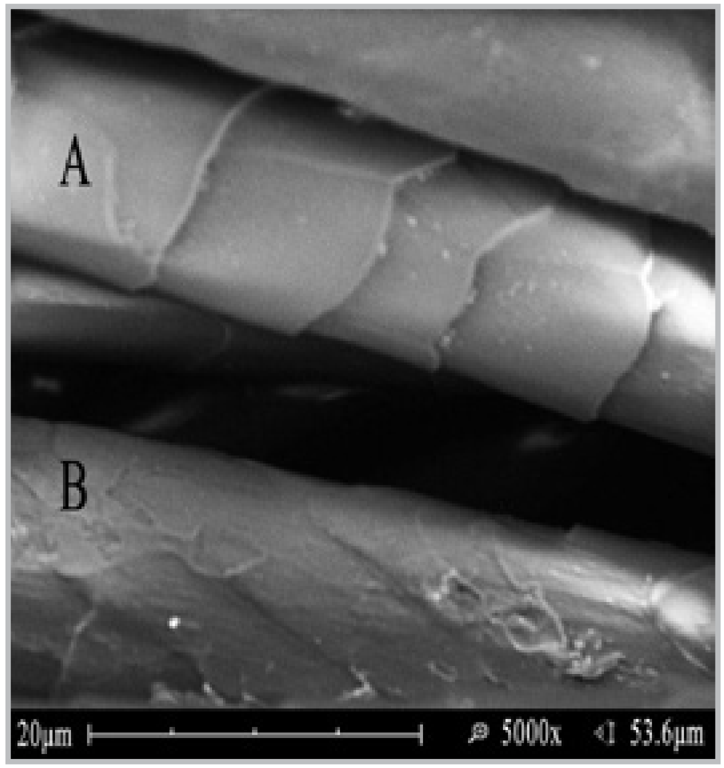


**Figure 1.** SEM Micrograph Laser Irradiated Wool

labeled A and B can be clearly seen. The characteristic scales of a natural wool fiber can be seen on Strand A, this strand had not been subject to laser irradiation. On Strand B however, the scales on the surface of the fiber appear less pronounced; they have been ablated by laser irradiation.

This laser modification of the outer cuticles of wool fibers, was found to remove and disrupt the hydrophobic surface. Removal of the scales, not only removes the covalently bond fatty layer of lipids to give a less hydrophobic surface, but also exposes more of the underlying hydrophilic cortex.

An increased rate of diffusion when dyeing may be expected, which has potential to be used as an alternative to wet, chlorination processes with the added advantages of the laser allowing accurate and targeted processing.

Figure 2 shows the schematic for dyeing wool. The red line shows standard optimal dyeing conditions used for

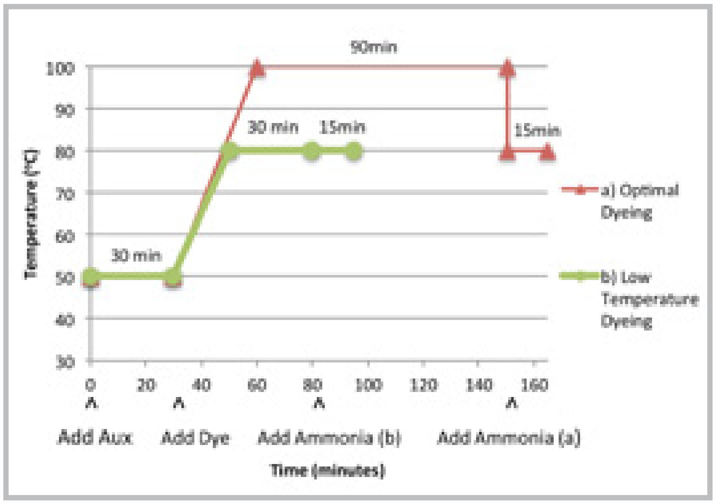


**Figure 2.** Wool Dyeing Schematic

dyeing wool in industry, where the dyebath is held at 100 °C for 90 minutes. Test temperatures of only 80 °C were used throughout this study, held for a reduced overall dyeing time as shown in green on the schematic in Figure 2. When these conditions are compared, some very significant energy savings can be seen, estimated at an approximate 54 percent saving.

The results of increasing power density on laser pre-treated wool, followed by dyeing are shown in Figure 3. Visually, a change in color can be seen between each of the laser treated samples (b to e) and the untreated control (a). As laser power increases, the color change appears to show increasingly darker shades of blue.

As well as an apparent visual effect, dye exhaustion results indicated that an increasing amount of dye uptake was achieved, by a significant 9-10 percent, as the laser power density delivered to the fabric increased. More dye was accepted into the laser treated fibers, despite the lower than optimal temperatures of 80° C, which is an excellent achievement for dye performance.

The CIE (International Commission on Illumination) L*a*b* Color Space System provides a system of coordinates which allow color to be quantified. The color difference between treated and untreated areas of the fabric substrate was measured using a Reflectance Spectrophotometer and the results found to be significant. By exploiting this color difference, potential was shown for CAD controlled laser treatment to be used as a design tool/technique. Up to an optimum power density, laser parameters can be chosen to achieve a variety of mark making and gradiated tonal graphics.

Geometric patterns consisting of solid, undulating and linear shapes were laser marked on 100 percent wool fabric, followed by dyeing with reactive dye. The resulting samples, shown in Figure 4, provide an all over pattern. The technique has the potential to be used on woolen textiles of varied constructions and weights, suitable for fashion or home interior applications.

When compared to the lack of current graphic capabilities of dyeing in industry, digital laser dyeing has the potential to open up a new way of patterning textiles. It is now possible to design with dye using the CAD controlled laser. High-resolution graphic capabilities can be achieved, which still meet important material performance properties.

Harmful chemical pre-treatments and further production processes could be eliminated by combining coloration and patterning in one, with an improved dye uptake resulting in a reduction in dye effluent and an approximated 54 percent energy saving using the laser technique.

As laser marking operates a remote, non-contact set up, the potential to place designs on finished products and across garment seams would allow manufacturers to customize

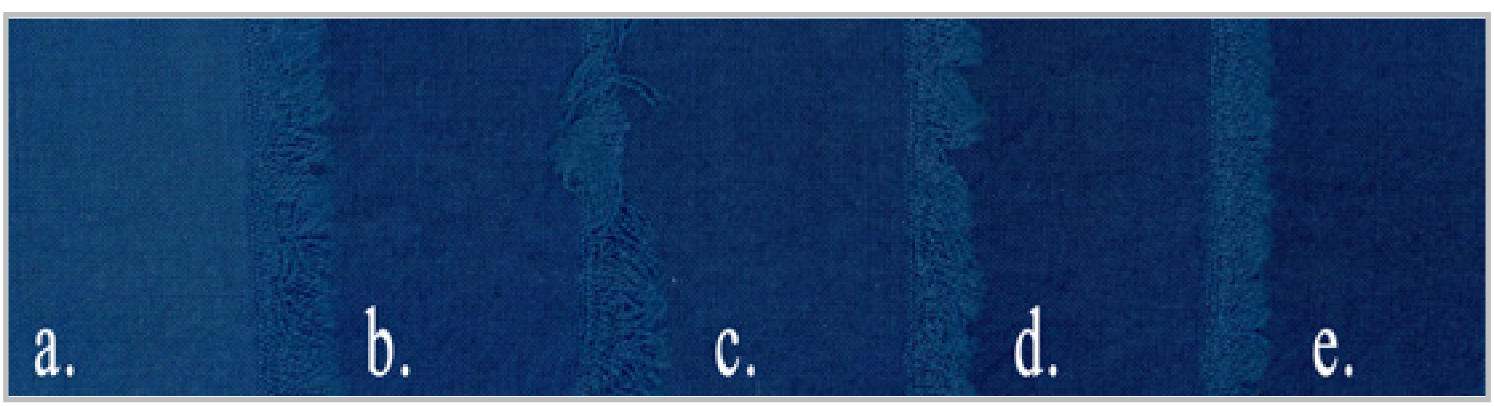


**Figure 3.** Laser pre-treated, dyed wool samples subject to power densities from 0 to 60 kW

*(Continued on page 14)*

blank products to meet the requirements of retailers and consumers. Furthermore, combining the functionality of the laser to perform multiple production tasks at once, such as pattern cutting as well as the laser dye technique, would allow additional environmentally sustainable benefits to the process compared to outsourcing each individual stage of the production process.

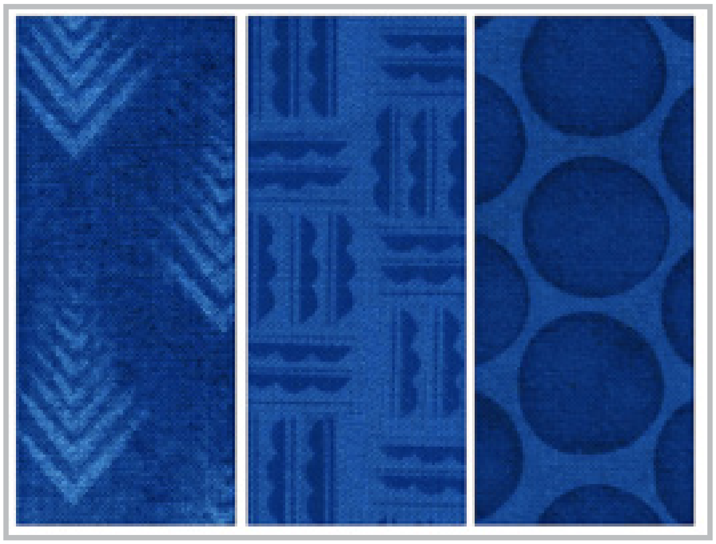

**Figure 4.** Digital Laser Dyed Wool Designs

Combining techniques in one stage has potential to offer fast response in today's fast changing market, with easily changed CAD files allowing smaller product runs than financially permitted by exposing individual screens for screen printing or die cutters for product pattern cutting.

The process can enable design innovation while developing and improving environmental strategies in the industry. Furthermore, these kinds of savings in a trillion dollar industry could see massive environmental and economical benefits. ■

*Laura Morgan is a current PhD candidate at Loughborough University, School of Art. Laura's current research addresses sustainability in textile production, establishing environmentally sensitive textile design techniques through the use of laser technology.*

# ICALEO 2015

## Presenting Revolutionary Laser Research

ICALEO 34th INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

**BY GEOFF GIORDANO**

When Silke Pflueger attended her first ICALEO® in San Diego in the 1990s, she was a bit overwhelmed by having to give a talk about her work.

"The first presentation is scary," she recalls. But that initial involvement has led Pflueger all the way to serving as congress general chair of ICALEO, the International Congress on Applications of Lasers & Electro-Optics, to be held Oct. 18-22 at the Sheraton Atlanta in the heart of the city. Now she is overseeing a team of conference chairs for the 2015 gathering, including:

- Laser Materials Processing Conference: Christoph Leyens, Fraunhofer IWS
- Laser Microprocessing Conference: Michelle Stock, mlstock consulting
- Nanomanufacturing Conference: Yongfeng Lu, University of Nebraska-Lincoln
- Business Forum & Panel Discussion: Klaus Loeffler, TRUMPF and Bo Gu, BOS Photonics

"With over 200 presentations and posters on the latest in laser research, strengthened by the peer-review process introduced last year, ICALEO will provide another outstanding opportunity to learn about advances in laser material processing," Pflueger notes in her welcome message for the ICALEO Advance Program (available online at **www.icaleo.org**).

Biomedical applications, "the newest addition to the ICALEO family," will kick off the scientific proceedings in the opening plenary, as well as being featured in the Microprocessing Conference. "We are hoping to inspire you beyond your daily work, to show you what lasers are already doing for our health, and what they will be able to do for us in the future," Pflueger explains. "Some of the laser material interaction will look familiar, and the lasers will look familiar. But be prepared to be surprised."

Likewise, the always-inspiring closing plenaries will diverge from the traditional, Pflueger says: "Two of the talks will touch on lasers that may impact your work in years to come — one at a wavelength that we have not had as an industrial laser, one a new type of diode laser that may revolutionize our world just like broad-area diode lasers did in the past 20 years. We will then hear about lasers that aren't built to cut or weld or microstructure, but that are built for other applications — applications that help us see the world differently."

The business forum, which traditionally provides entrepreneurial insights into the laser industry in general and job shops in particular, will feature five experts addressing some key themes:

- Status and Development of the Laser Market: Mark Douglass, Longbow Research
- Successful Start Up with Licensed IP: Michelle L. Stock, mlstock consulting
- Successful Business in Services for Lasers: Neil Ball, Directed Light
- Successes of Laser Welding in a Job Shop: Gordon McIntosh, Special Welding Services-Trimac Inc.
- Successful Business Model in Laser Additive Manufacturing/Job Shop: Dan Hayden, Hayden Laser Services

When not immersed in cutting-edge research, attendees at the 34th ICALEO will have an abundance of networking opportunities at the Sunday night Welcome Celebration, the Monday evening President's Reception, the Tuesday morning running club, the Tuesday evening Vendor Reception & Tabletop Display and Wednesday's Annual Meeting & Awards Luncheon featuring Dr. Keming Du, the recipient of the Arthur L. Schawlow Award. The Vendor Reception provides an opportunity to speak with key laser companies, like platinum sponsor IPG Photonics, gold sponsors TRUMPF and SPI Lasers, silver sponsors Laserline, JDSU and Altos Photonics, and bronze sponsors including Spectra-Physics and Fraunhofer ILT. ■

*To register for ICALEO 2015, visit* **www.icaleo.org**.

## Looking for More?

**Exclusive LIA Video**

Listen as 2015 ICALEO Congress General Chair Silke Pflueger describes some of her favorite ICALEO experiences: **http://tinyurl.com/o9a787w**

**ICALEO Reflects the International Year of Light**

How ICALEO 2015 reflects the goals of IYL 2015, see page 19.

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# SPI Lasers

## Leading Designer & Manufacturer of Fiber Lasers

SPI Lasers, a wholly owned subsidiary of the TRUMPF group, is a leading designer and manufacturer of fiber lasers for welding, cutting, marking, drilling and micromachining.

The company's product portfolio covers numerous application process areas across a wide range of industries including automotive, electronics and the medical device sectors. "SPI Lasers technology solves manufacturing problems; it moves the boundaries of what is possible, making good products better and enabling new designs," according to a company statement. "Operations can be carried out faster and more accurately with an SPI Laser for better reliability, less waste and improved productivity."

SPI Lasers sells its products globally and has its major business operations, including R&D and manufacturing, in the UK, US and Asia, as well as worldwide sales and customer support. Drawing on over 40 years expertise, SPI Lasers also provides post-sales technical support, staff training and sample processing in our own specialist applications laboratories.

SPI Lasers was established in 1999 to exploit technology developed by the renowned Optoelectronics Research Centre at the University of Southampton. Its core competencies and intellectual property in developing special optical fibers and Bragg gratings were initially applied to the manufacture of optical components for long-distance, high-speed telecommunications.

In 2002 the business was refocused on the design and manufacture of fiber lasers for industrial manufacturing. The company released its first commercial products at Laser Show 2003. SPI Lasers was listed on the UK stock market 2005. SPI Lasers was acquired by TRUMPF in September 2008. This year, SPI Lasers acquired JK Lasers, a leading manufacturer of high-power fiber lasers for industrial use.

SPI Lasers employs more than 300 people globally at manufacturing facilities in Southampton and Rugby in the UK; applications labs in Southampton, Shanghai and Santa Clara, CA; service centers in Southampton, Rugby, Santa Clara, Shenzen, Shanghai and Seoul; and with a sales presence in China, Korea, Europe and the US. "In addition we have a number of partner organizations and distributors spread across the globe who can support our customers," the company says.

SPI Lasers focuses on producing nanosecond pulsed fiber lasers from 10 W to 100 W and CW fiber lasers from 200 W up to 4 kW. The ns-pulsed lasers are used primarily for marking and micromachining, while cutting and rapid prototyping are done with the CW lasers.

The company "is always evaluating the intersection between our fiber laser technology and advanced applications with manufacturing application." Present developments include air-cooled pulsed lasers at >100 W and water-cooled CW lasers to 6 kW.

In recent years, "the number of suppliers offering basic fiber lasers for marking has exploded, with several new suppliers particularly in China offering 20 W marking lasers. This trend has driven base pricing down by a factor of two and has dramatically split the marking and engraving sector into a base market (which seeks a readable mark at the lowest possible price) and a premium market, where particular details of the marking are important for quality and product differentiation."

"SPI Lasers has responded to these changes by developing the most comprehensive portfolio of pulsed fiber lasers in the industry. Our product range allows our OEM customers to differentiate themselves from the generic marking machines with laser capabilities that create highly specialized marks, deep engraving or textures."

SPI Lasers joined LIA in 2004 and has been a Gold Sponsor of ICALEO® since 2006. "SPI Lasers has also proudly served with members on the LIA Board of Directors during most of our years of membership. We have also participated actively on various conference committees, educational offerings and initiatives."

LIA is "a vital membership organization for any company interested in the use of lasers for industrial applications. LIA puts us in touch with partner companies, academic institutions, industry colleagues and end users for industrial lasers. SPI Lasers has also invested its resources to help LIA launch and sustain the Lasers for Manufacturing Event® (LME® ) and Summit, "which is quickly becoming an essential forum for those looking to industrial laser technology as a means for reinvigorating manufacturing in the USA." ■

*To learn more, please visit* **www.spilasers.com.**

# International Year of Light

INTERNATIONAL YEAR OF LIGHT 2015

**BY GEOFF GIORDANO**

As the International Year of Light and Light-based Technologies enters the home stretch, LIA's flagship conference in October will highlight many of the key areas —including medicine, energy and communications — in which light plays a vital role around the world.

The 34th International Congress on Applications of Lasers & Electro-Optics (ICALEO®) Oct. 18-22 in Atlanta is where the rubber meets the road in terms of highlighting the research that drives the commercialization of the light-based applications that affect peoples' lives.

"Added to the program this year is a focus on lasers used in biomedical and life science applications," explains ICALEO Congress General Chair Silke Pflueger of DirectPhotonics in Los Gatos, CA. "I hope that it will not just expand (attendee) horizons, but I'm certain that there will be ideas that come out of looking just at what's on (their) plate every day."

Among the more than 200 presentations slated for ICALEO 2015 are talks like *Laser Surface Deposition of Nb/Ti-Nb on Ti6Al4V Substrate for Biomedical Applications* and *Characterization of Direct Laser Deposited Low Modulus Ti- 26Nb Alloy on Ti-6Al-4V for Biomedical Applications*. These presentations will be part of the Laser Materials Processing Conference chaired by Christoph Leyens of Fraunhofer IWS.

Meanwhile, the Laser Microprocessing Conference chaired by Michelle Stock of mlstock consulting in Ann Arbor, MI, will be replete with presentations on various laser treatments of glass, sapphire and various thin films for advanced electronics. Yet another medical session will focus on *Laser Surface Modification for the Prevention of Biofouling by Infection Causing Escherichia Coli*.

While these subjects likely appear rather arcane to the layperson, they are the fundamental beginnings of significant advancements for 21st century civilization. But as LIA Past President and current Treasurer Stephen Capp notes, "ICALEO has traditionally been the crystal ball that allows the laser industry to see into its future."

LIA "has been critical in the dissemination of information about where lasers are at and what's the future of lasers," Capp says. "I found early on that ICALEO was looking out ahead. You (can) really see what the universities are doing and be able to understand that and say 'OK, these are the things I'm going to have to be watching from an industrial standpoint as far as where the laser is going to make sure that my company is on the edge of where we need to be.'"

This is all vital knowledge to Capp, who serves as CEO of the job shop Laserage in Waukegan, IL. A key part of Laserage's business is medical prototyping and manufacturing — and understanding the role of newer ultrafast lasers is yet another reason ICALEO is on their radar, with numerous presentations focused on applications using lasers in the pico- and femtosecond regimes.

## Looking for More?

**ICALEO 2015 Preview**

Biomedical applications and more at LIA's premier conference, see page 16.

# Member Innovations

### Coherent's New Generation of CO Lasers

A new generation of carbon monoxide (CO) lasers from Coherent, Inc. (Santa Clara, CA) (Nasdaq: COHR) promise enhanced processing characteristics for materials processing applications ranging from glass cutting and via drilling to fractional skin resurfacing. While CO lasers were first developed decades ago, practical limitations in their lifetime and operating characteristics restricted them to a handful of niche low power laboratory applications. Now, technological breakthroughs at Coherent have yielded a new class of high power CO lasers with similar lifetime, reliability and maintenance characteristics as the company's highly regarded, slab discharge $CO_2$ lasers, opening up a range of possible uses.

CO lasers output at a wavelength of approximately 5 µm, as opposed to 10.6 µm for $CO_2$ lasers. Since some materials which transmit at the longer ($CO_2$) wavelength absorb at 5 µm, this leads to advantages in various materials processing applications.

*For more information, visit* **www.coherent.com**.

### Lasers for Fast Internet in Space – Space Technology from Aachen

On June 23, the second Sentinel mission was launched from the space mission launch center in Kourou with a critical component of Aachen on board. Researchers at the Fraunhofer Institute for Laser Technology ILT and Tesat-Spacecom have jointly developed the know-how for space-qualified laser components. For the Sentinel mission the diode laser pump module of the Laser Communication Terminal LCT was planned and constructed in Aachen in cooperation with the manufacturer of the LCT, Tesat-Spacecom, and the Ferdinand Braun Institute.

After eight years of preparation, in the early morning of June 23 the time had come: in Kourou in French Guiana, the European Space Agency launched the Sentinel-2A satellite aboard a VEGA launcher. It is the first of two satellites which will be used to improve environmental monitoring under the European Copernicus program. To transfer the extensive image data, a new technology is being used: The data are sent to a relay satellite with a laser beam and sent from there to the ground station.

Both Sentinel-2 satellites will monitor the status of forests and farmland from space. It should also provide data on the pollution of lakes and coastal waters.

*For more information, visit* **www.ilt.fraunhofer.de/en**.

# Members In Motion

### Annette Doyle Assumes Role of Managing Director at TRUMPF Limited, UK

Effective July 1, 2015, Annette Doyle took on the role of Managing Director of TRUMPF Limited, the UK subsidiary of the TRUMPF Group, located in Luton, Bedfordshire. She succeeds Mr. Scott Simpson who will leave TRUMPF after more than 20 years to pursue his own individual projects.

Annette Doyle leaves her position at TRUMPF Inc. in Farmington, CT where she most recently served as Assembly Manager for TRUMPF machines produced in the US. The department manufactures 350 machines a year and her production planning and lean manufacturing initiatives enabled the company to increase production and quality goals during the economic recovery. Prior to this position, she served as Training Manager. While at TRUMPF Inc., Doyle has been recognized by The Manufacturing Institute, Deloitte, University of Phoenix, and the Society of Manufacturing Engineers with a Woman in Manufacturing STEP (Science, Technology, Engineering and Production) Award for excellence and leadership in manufacturing.

*For more information, visit* **www.us.trumpf.com**.

### Rofin Announces Management Change & Stays Focused on Continued Growth & Innovation

ROFIN-SINAR Technologies Inc. (NASDAQ: RSTI), one of the world's leading developers and manufacturers of high-performance laser beam sources and laser-based solutions, announced that Thomas Merk, currently Chief Operating Officer of the ROFIN Laser Micro and Marking Group, will succeed Günther Braun as President and Chief Executive Officer of the Company, effective July 1, 2015. Also at that time, Mr. Braun will resign as a director of the Company and Mr. Merk will assume the vacant position and become a member of the Company's Board of Directors. Mr. Braun will remain with the Company for a period of time to assist with the transition of duties.

"We are very grateful to Günther for his contributions throughout his 26-year career with the Company," said Dr. Peter Wirth, Chairman of the Company's Board of Directors. "During his tenure, he made a considerable contribution towards strengthening ROFIN's strategic position and has led the company through many phases of technological innovation, most recently the successful introduction of our third generation of highpower fiber lasers."

*For more information, visit* **www.rofin.com**.


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## Update to ASC Z136 Procedures

Accredited by the American National Standards Institute (ANSI), ASC Z136 is required to adhere to procedures known as the "*ANSI Essential Requirements*." These requirements govern the consensus development process through openness, balance, consensus and due process. Due process is the key to providing that an American National Standard is developed in an environment that is equitable, accessible and responsive to the requirements of various stakeholders by assuring all interested and affected parties have an opportunity to participate in a standard's development.

The January 2015 revision of the *ANSI Essential Requirements* added an Antitrust Policy statement requirement for all ANSI accredited standards developers. To comply with this requirement, ASC Z136 chose to adopt ANSI's policy statement in its entirety. The *Procedures for the Development of Z136 American National Standards* is currently undergoing balloting for member approval.

Once member approval has been achieved, ASC Z136 Procedures will be submitted to ANSI for reaccreditation.

## On the Horizon

Following the revision of ASC Z136 Procedures, members expect to see a membership ballot circulated. Anticipating distribution in early fall, current requests on hand include a change of representation for the American Industrial Hygiene Association (AIHA), the addition of a secondary representative for Lawrence Berkeley National Laboratory, and a request for organizational membership by NoIR.

For information regarding membership on ASC Z136, please contact Barbara Sams at **bsams@lia.org** or visit the committee website at **www.z136.org**.

### *CLSO & CMLSO Review Boards Formed*

The BLS® Bylaws, which govern the Board of Laser Safety's internal affairs, provides for the formation of a CLSO® or CMLSO® Review Board to "*establish qualifications required to sit for an exam, determine exam content, and determine certification maintenance criteria for the corresponding certification.*" As mentioned in the last issue of the *LIA TODAY*, at its annual meeting in March the BLS Board of Commissioners recommended reconstitution of both boards to further the mission of the BLS.

The CLSO Review Board, chaired by Ben Edwards, is charged with revising the CLSO exam to comply with the ANSI Z136.1-2014 *Safe Use of Lasers* standard. Timing of the update is in line with the dissemination of the standard, now in circulation for roughly eighteen months candidates should be familiarizing themselves with this version of the document. It is anticipated work on the exam revision will commence in August.

On the medical front, Vangie Dennis kicked off the inaugural meeting of the recently revamped CMLSO Review Board. Chairing the group tasked with reviewing and revising current study materials for CMLSO exam candidates, Ms. Dennis rallied the team to "enhance program awareness" and "take the study materials to the next level." Patti Owens captured perfectly the viewpoint of so many candidates stating, "People are overwhelmed, there is too much to master [coming straight from an MLSO course] right before an exam." It is essential candidates realize the need to study prior to attempting the exam. Members discussed more elaboration on the standard's [ANSI Z136.3-2011] topics and principles, as well as including sample questions and best practices for worst-case scenarios. Once completed these study materials will be more than just a guideline to help prepare for the CMLSO exam, rather they will fill a void for the new MLSO by touching on all aspects related to the position, from common procedures to clinical specialties.

For more information on the Board of Laser Safety, or to learn how to join this elite group of certified laser safety officers, visit us at **www.lasersafety.org** or call us at +1.407.985.3810. Isn't it time you gain the recognition you deserve?

# OSHA | Update

LIA is committed to keeping the workplace safe from hazards associated with lasers. LIA formed an Alliance with the Occupational Safety and Health Administration (OSHA) to help achieve these goals.

OSHA and LIA recognize the value of establishing a collaborative relationship to foster safer and more healthful American workplaces. This Alliance provides LIA's members and others, including small businesses, with information, guidance and access to training resources that will help them protect employees' health and safety, particularly in reducing and preventing exposure to laser beam and non-beam hazards in industrial and medical workplaces. In addition, the organizations will focus on sharing information on laser regulations and standards, bioeffects lasers have on the eyes and skin, laser control measures and laser safety program administration.

**OSHA Issues Temporary Enforcement Policy for Confined Spaces in Construction**

The US Department of Labor's Occupational Safety and Health Administration announced a 60-day temporary enforcement policy of its Confined Spaces in Construction standard.

During this 60-day temporary enforcement period, OSHA will not issue citations to employers who make good faith efforts to comply with the new standard. Employers must be in compliance with either the training requirements of the new standard or the previous standard. Employers who fail to train their employees consistent with either of these two standards will be cited.

Factors that indicate employers are making good faith efforts to comply include: scheduling training for employees as required by the new standard; ordering the equipment necessary to comply with the new standard; and taking alternative measures to educate and protect employees from confined space hazards.

OSHA issued the Confined Spaces in Construction final rule on May 4, 2015. The rule provides construction workers with protections similar to those manufacturing and general industry workers have, with some differences tailored to the construction industry. These include requirements to ensure that multiple employers share vital safety information and to continuously monitor hazards – a safety option made possible by technological advances after the manufacturing and general industry standards were created.

*For more information, visit* **www.osha.gov**.

JLA
Journal of Laser Applications

The Laser Institute of America's official refereed publication, the *Journal of Laser Applications*® *(JLA)*, an online-only journal, is complete with new features for a broader audience. *JLA* is hosted on AIP Publishing's robust Scitation online platform, providing the journal with great functionality and the ability to leverage a wide range of valuable discoverability features. JLA features nine topic sections, a faster peer-review process and a more functional website (**jla.aip.org**) that makes content easier to access and more interactive. Readers will find full-text HTML rendering featuring inline reference links and the ability to enlarge tables and figures by clicking on them. Among the new features are enhanced search functions with more options and better controls to explore returned content in more useful ways.

### Study of Process Window Development for High Deposition-Rate Laser Material Deposition by Using Mixed Processing Parameters

BY CHONGLIANG ZHONG, ANDRES GASSER, JOCHEN KITTEL, THOMAS SCHOPPHOVEN, NORBERT PIRCH, JINBAO FU AND REINHART POPRAWE

For several years, the interest in additive manufacturing is continuously expanding, owing to the paradigm shift that new production processes, such as laser material deposition (LMD), provide over conventional manufacturing technologies. With LMD, 3D, complex components out of a wide range of materials can be manufactured consecutively layer-by-layer. However, aiming for the production of large components with LMD, the currently achieved deposition-rates of approximately 0.5 kg/h remain a major concern in regards to processing time and economic feasibility. In this respect, an experimental setup for high-deposition rate LMD is built up in the current work. Furthermore, an approach for developing a process window for resource efficient, high-deposition rate LMD is investigated in this paper. For the production of sound layers with LMD, the processing parameters need to be considered in an appropriate relation. Thus, by setting the main processing parameters: powder mass flow, traversal speed, laser power and laser spot diameter into proportion, the mixed processing parameters: energy mass density and energy area density can be defined. Based on the metallographic investigation of laser deposited Inconel 718 single tracks regarding dilution, aspect ratio of track (ratio of track width to track height) and level of porosity, upper and lower limits for these two parameters can be set which represent process window boundaries. With this approach, a processing parameter field can be defined, to deposit sound Inconel 718 single tracks with a deposition-rate of approximately 5 kg/h and powder capture efficiency higher than 90 percent.

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ICALEO

34th INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

**ICALEO 2015 Advance Program Available – Download Today!**

LIA's 34th annual International Congress on Applications of Lasers & Electro-Optics (ICALEO®) will take place on Oct. 18-22 in Atlanta, GA. ICALEO has a 33 year history as the conference where researchers and end-users meet to review the state-of-the art in laser materials processing and predict where the future will lead. This year's featured sessions include diode lasers for processing and pumping, laser process monitoring and control, laser processing of biological materials, lasers in nanotechnology and environmental technology, laser hybrid processing, laser manufacturing for alternative energy sources and laser business development. To learn more about the presentations and events scheduled for ICALEO 2015, view or download the Advance Program online at **www.icaleo.org**.

LAM®

LASER ADDITIVE MANUFACTURING WORKSHOP

**Mark Your Calendar for LAM 2016 & Discover the Advantage of Lasers in Additive Manufacturing**

LIA's eighth annual Laser Additive Manufacturing (LAM®) Workshop will take place on Mar. 2-3, 2016 in Orlando, FL. This Workshop brings together representatives from industries including power generation, aerospace, agriculture and automotive. Attendees hear case studies from large and small firms that describe successes in depositing wire or powder with lasers to prevent and repair corrosion on vital components. In addition, powder-bed and powder-fed additive processes allow the production of innovatively designed lightweight parts by exploiting the root power of AM. The workshop will draw dozens of experts from around the world to discuss not only traditional laser-based techniques like cladding but the revolutionary applications of AM in medicine and dentistry, the aviation and automotive industries, and even consumer products. For more information, visit **www.lia.org/lam**.

Now is the time to sign up as a LAM Sponsor or Vendor. Sponsorship of LAM 2016 is a valuable way to reach a highly-qualified target audience. Communicate directly with influential decision makers, provide solutions to technology challenges, promote brand recognition through high visibility and source new products to your target market with our exclusive packages. Don't miss this strategic opportunity for direct access to your customers! Please contact Andrew Morrison at **amorrison@lia.org** for more information.

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LASERS FOR MANUFACTURING EVENT®

**Save the Date for LME 2016 & Its Lasers for Manufacturing Summit**

LIA's Lasers for Manufacturing Event® (LME®) is moving to the Spring and will be held Apr. 26-27, 2016 in Atlanta, GA. LME is the place to see the latest in laser technology, network with the industry's elite and find solutions to current and future manufacturing needs. Our mission is to provide a one stop event for companies interested in integrating laser technology into their production. Attendees of LME can visit the show floor theater for keynote presentations on trending topics in the laser industry, attend expanded free educational sessions to understand why laser technology is the future of manufacturing and where and how it is applied, and connect with suppliers who can help you benefit from using lasers in your manufacturing.

Held in conjunction with LME, is its Lasers for Manufacturing Summit on Apr. 25, 2016. The Summit will bring together C-suite and other top executives who want to hear first-hand expert intelligence on how to use these powerful tools most profitably in a variety of high-value manufacturing applications. This one day event will provide a comprehensive market perspective that is unobtainable elsewhere, with market data segmented by applications and laser technology from the laser industry's leading resources. For more information as it becomes available, visit **www.laserevent.org**.

## WELCOME NEW CORPORATE MEMBERS

**Glowforge**
Seattle, WA

**LaserCoil Technologies LLC**
Napoleon, OH

**MidMichigan Medical Center – Midland**
Midland, MI

**The Cosmetic and Skin Surgery Center**
Frederick, MD

**Zapatat**
Arlington, VA

For a complete list of corporate members, visit our corporate directory at **www.lia.org/membership**.

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