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LIA TODAY

THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

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The editors of LIA TODAY welcome input from readers. Please submit news-related releases, articles of general interest and letters to the editor. Mail to us at LIA TODAY, 13501 Ingenuity Drive, Suite 128, Orlando, FL 32826, fax +1.407.380.5588, or send material by email to lia@lia.org.

CALENDAR OF EVENTS

Laser Safety Officer Training
- Dec. 6–8, 2017 Orlando, FL
- Feb. 20–22, 2018 San Diego, CA
- Jun. 12–14, 2018 Indianapolis, IN
- Dec. 4–6, 2018 Orlando, FL

Laser Safety Officer with Hazard Analysis*
- Nov. 6–10, 2017 Miami, FL
- Jan. 29–Feb. 2, 2018 Orlando, FL
- Mar. 5–9, 2018 Marina del Rey, CA
- Jun. 11–15, 2018 Niagara Falls, NY
*Certified Laser Safety Officer exam offered after the course.

Industrial Laser Safety Officer Training
- Nov. 15–16, 2017 Novi, MI
- Feb. 14–15, 2018 Novi, MI
- May 16–17, 2018 Novi, MI
- Aug. 15–16, 2018 Novi, MI

Medical Laser Safety Officer Training*
- Nov. 4–5, 2017 Miami, FL
- Jan. 27–28, 2018 Orlando, FL
- Mar. 3–4, 2018 Marina del Rey, CA
- Sept. 15–16, 2018 Kansas City, MO
*Certified Medical Laser Safety Officer exam offered after the course.

Laser Additive Manufacturing Conference (LAM®)
- Mar. 27–28, 2018 Schaumburg, IL

Lasers for Manufacturing Event (LME®)
- Mar. 28–29, 2018 Schaumburg, IL

Industrial Laser Conference
- Sept. 12, 2018 Chicago, IL

Visit www.lia.org for all course and event listings.

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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Entering the fall season means it is time once again for the LIA’s International Congress on Application of Lasers and Electro-Optics (ICALEO®). ICALEO is a great event where the latest in research and applications are presented and you can network with world leaders in laser applications. I have lost count on the number of times I have participated in ICALEO. This year’s ICALEO is being held in Atlanta, GA, a hub for the expansion of manufacturing in the Southeast. This event has grown and changed with the laser industry, and many of the things we take for granted were first introduced at ICALEO.

Similar to ICALEO, this month’s edition of LIA TODAY looks to the frontier of laser research and applications. Both articles are looking at how lasers can be used as a “tool” for working on the smallest of scales. In “3D Printing of Conductive CNT-polymer Composite,” Ying Liu reports on how lasers are being used for smaller devices, which may alter how humans accomplish many tasks. Similarly, Yun Shin reports on how lasers are being used to alter the optical characteristics of materials using short-pulsed lasers in an article titled “High Speed Creation of Antireflective Nano Periodic Surfaces via Picosecond Laser Surface Treatment.”

This month’s LIA TODAY spotlights our corporate member PhotoMachining Inc. Many laser conference attendees may not recognize PhotoMachining but they may already know one of its founders—Ron Schaeffer, the lead guitarist and singer of “Beer’s Law Band.” Ron and John O’Connell founded PhotoMachining 20 years ago to provide laser services to customers for micro-processing. In addition to providing micro-processing services accomplished with a wide range of pulse/CW and wavelength lasers, the staff of PhotoMachining also provides its customers with engineered laser systems. Ron Schaeffer has supported the LIA by chairing sessions at LIA conferences and has been a board member. It is great that we can acknowledge PhotoMachining as this month’s corporate member and the contribution its staff has made to LIA and the laser industry.

Finally, as I am finishing this letter, the LIA Staff is recovering from hurricane Irma that swept through the Orlando, FL, area last weekend. Through text messages that I have been getting, it would appear that all of the LIA Staff members are safe and doing alright. We are very thankful for that. I would also like to say that I hope all of our LIA members in the Houston, TX, area are safe and that their families and businesses did not suffer from hurricane Harvey.

Enjoy your fall, and I am looking forward to seeing all of you in Atlanta.

Paul Denney, President
Laser Institute of America
Advanced three-dimensional (3D) micro/nanofabrication of functional devices represents a key research topic in modern nanoscience and technology and is critically important to numerous scientific and industrial applications. Among various existing 3D micro/nanofabrication methods, two-photon polymerization (TPP) based on laser direct writing is regarded as one of the most promising methods due to its unique combination of true three dimensionality and high spatial resolution.

The TPP technique is based on the nonlinear interaction of femtosecond laser pulses with photosensitive material, which induces a highly localized chemical reaction leading to polymerization of the photoresist with current resolutions down to 40 nm. The capability of the TPP technique is significantly determined by the properties of photoresists employed, which are electronic insulating in general. To increase the functionality and expand the applications of TPP, we used carbon nanotubes (CNT) as filling materials in the host polymers.

CNTs continue to deliver a huge impact on nanotechnology for their remarkable mechanical, electrical, thermal and optical properties. However, it is difficult to achieve both high CNT concentration and homogenous CNT dispersion due to the strong van der Waals interactions among individual CNTs. Moreover, the linear optical absorption of CNTs also limits the maximum doping level of CNTs in composite resins for nonlinear TPP lithography. The relatively low CNT loading concentration leads to limited performance of the composite resins. To overcome these limitations, a TPP-compatible composite material based on multi-walled carbon nanotubes (MWNT), thiol, and acrylic photoresist is presented in here. The schematic illustration of the composite preparation and 3D printing is shown in Fig. 1.

The TPP compatible composite polymer was prepared by directly mixing acrylic monomer, thiol, and photoinitiator with MWNT powder with various weight percentages. The resins prepared showed excellent dispersion of MWNTs through the composite resins and had a high stability last for one week under ambient conditions without obvious MWNT aggregation. Using TPP lithography, a fs laser beam was tightly focused into the composite resin to make 3D scans according to geometric user designs, resulting in solidified 3D micro/nanostructures with MWNTs simultaneously incorporated inside the polymer. After the TPP lithography, the samples were developed with the unsolidified resin rinsed away, leaving the 3D architectures of MWNT-based composite polymer on the substrates. A broad range of functional micro/nanostructures were fabricated, including micro-coil inductor, woodpile, spiral-like photonic crystal, micro-engine inlet fan, micro-car model and micro-gear, as shown in Fig. 2.

Figure 2. Functional micro/nanostructures fabricated using the MWNT-based composite resins by TPP lithography

We also studied the distribution and alignment of MWNTs inside the polymer matrix. As shown in Fig. 3, precise assembly of MWNTs was achieved by the combination of TPP fabrication and direct pyrolysis. The length of MWNTs is longer than the laser focal volume, so the trapped MWNTs were forced to align with the laser scan direction. Volume shrinkage can cause tensile strength along the wires, which also contributes to the alignment.
By incorporating MWNTs into the acrylic polymer, the composite resin changed from an insulator to a conductor with greatly enhanced mechanical strength. With 0.2 wt% MWNT concentration, the electrical conductivity of the composite resin increased over 11 orders of magnitude and reached 46.8 S/m, as shown in Fig. 4(a). The superior conductivity of the MTA composite polymers originated from the high MWNT concentration and the uniform MWNT dispersion. Moreover, to utilize the alignment effect of MWNTs in composites, two bar-shaped channels were fabricated with two orthogonal laser scanning directions and showed a three-orders-of-magnitude difference in electrical conductance, which matched with the high anisotropy in electrical conductivity of MWNTs in directions parallel with or perpendicular to the MWNT axis.

Two suspended microbridges in Fig. 4 (c, d) with the same design were fabricated using the acrylic and composite resins. Under the same fabrication condition, the bridge made by acrylic resin deformed seriously, while the one fabricated by the composite resin remained the straight shape without any obvious deformation, indicating the enhanced mechanical strength by the MWNT loading.

To demonstrate the potential of the composite resins, we fabricated a series of microelectronic devices, including arrays of capacitors (Fig. 5(a)) and resistors (Fig. 5(c)). Fig. 5(b) shows a typical hysteresis loop of a capacitor array containing 10 microcapacitors in parallel. Fig. 5(d) shows the frequency responses of a resistor array containing 20 zigzag microresistors in parallel. The impedance performance of the composite polymer transmission enables its application at high frequency range, such as RF electronics.

In summary, a TPP-compatible, homogenous composite resin with high MWNT concentrations has been developed. Various functional 3D micro/nanostructures using the composite resins have been successfully developed via the TPP lithography. Precise MWNT assembly of ~100 nm spatial resolution has been achieved by the combination of TPP lithography and thermal pyrolysis. The composites demonstrated to have increased mechanical strength and enhanced electrical conductivity. 3D printing of micro/nanostructures using highly conductive MWNT-based composites paves the way toward arbitrary precise assembly of MWNTs, which is promising for a broad range of device applications such as 3D electronics and MEMS/NEMS.

Ying Liu is a Ph.D student in Electrical and Computer Engineering at the University of Nebraska-Lincoln. Wei Xiong is a former UNL postdoctoral researcher and is now a professor at Huazhong University of Science and Technology (China). Lijia Jiang is a postdoctoral researcher in electrical and computer engineering at the University of Nebraska-Lincoln. Yunshen Zhou is a research associate professor of electrical and computer engineering at the University of Nebraska-Lincoln. Yongfeng Lu is Lott Distinguished University Professor of engineering at the University of Nebraska-Lincoln.
High-Speed Creation of Antireflective Nano Periodic Surfaces via Picosecond Laser Surface Treatment

BY YUNG C. SHIN

With the growing need for renewable energy sources, there is an increasing demand for cheap and high-efficiency solar cells. Although high-efficiency silicon solar cells with overall efficiencies higher than 25% \(^1\) have been fabricated in laboratories, the high cost involved in manufacturing these high-efficiency devices makes their commercial use not yet practical. Optical losses through front surface reflections lower the overall efficiency of solar cells since bare silicon reflects nearly 40% of incident solar radiation over the wavelength range of 200 nm to 1100 nm. Anti-reflective coatings have been used to improve solar energy absorption. A more economical alternate solution would be desirable. Texturing the surface of silicon wafers to suppress reflections has been commonly used to improve the efficiency of solar cells \(^2-5\).

Using high-speed, high-power picosecond laser pulse irradiation, low reflectance laser-induced periodic surface structures (LIPSS) could be created on polycrystalline Silicon. A decrease of 35.7% in average reflectance of the silicon wafer was achieved over the wavelength range of 400 nm to 860 nm when it was textured with LIPSS at high scan speeds of 4000 mm/s. A picosecond laser was used to create LIPSS on silicon wafers, which generates linearly polarized pulses with a pulse duration of 10 ps at 532 nm and the focal spot size of 10 µm with a variable repetition rate ranging from 10 KHz to 640 KHz. The period required to achieve the lowest surface reflectance was determined by finite difference time domain (FDTD) simulations, which showed that a period close to 450 nm was the most effective in suppressing reflections in the wavelength range of 200 nm to 1100 nm, which is the range of wavelengths in which silicon solar cells convert light energy to electrical energy. Therefore, the 532 nm wavelength of the laser was chosen with the repetition rate of 640 KHz and a scan speed of 4000 mm/s to create uniform LIPSS over an area of 4 cm by 4 cm. A computer-controlled precision 3-axis stage was used to position the silicon sample under the scanner head. The silicon samples used are 127 mm diameter, 525 µm thick polished wafers. The silicon is N doped with phosphorous and its crystal orientation is (111) with the electrical resistivity less than 0.006 ohm-cm. In order to create LIPSS, the laser was scanned over the surface of the wafer, which was positioned at the focal length of the objective lens. All experiments were conducted with ambient air as the irradiation atmosphere.

SEM images revealed that the LIPSS had a period of 532 nm and a fill factor of 75%. The depth of the channels was found to increase with increasing fluence. At 0.8 J/cm\(^2\), highly uniform structures were obtained with no surface material removal. The periodic structures appeared to have a flat top surface with filleted edges and deep, narrow valleys. The depth of the valleys was determined through atomic force microscope imaging and was found to range from 150 nm to 350 nm. Fig. 1 shows SEM images of the highly periodic LIPSS created at a fluence of 0.8 J/cm\(^2\). At higher fluence values up to 1 J/cm\(^2\), the valley depth increases.

Figure 1. SEM images of highly uniform LIPSS created at a fluence of 0.8 J/cm\(^2\). a) at 5000x magnification  b) at 8000x magnification
was found to increase and light was trapped more effectively. At a fluence of 1.1 J/cm², deep and continuous LIPSS were formed, resulting in an average reflectance of 23.1% corresponding to a 35.7% decrease in average reflectance compared to bare silicon. At even higher fluence values up to 1.2 J/cm², deep valleys were created with irregularities due to material removal. This resulted in even lower reflectance values due to increased scattering of light below the surface of the material. Beyond this fluence value, the structures no longer appeared periodic. Deep craters and surface irregularities were formed which further enhanced scattering and light trapping below the surface, thus decreasing the average reflectance. Fig. 2 shows the reflectance curves for structures created at different fluence values, across the wavelength range of 400 nm to 860 nm. A clear decreasing trend in reflectance is seen as the fluence is increased. Above this fluence, material removal causes severe damage to the surface.

In order to measure the broadband reflectance of the sample, a Perkin Elmer spectrophotometer was used. First, the sample was checked for opacity, and then the spectral reflectance (R) and transmittance (T) were measured over the wavelength range of 200 nm to 1200 nm. A monochromator was used to resolve the wavelength. Structures made with increasing fluence values exhibited a trend of decreasing average reflectance value. As the fluence was increased from 0.95 J/cm² to 1.4 J/cm², the average reflectance over the wavelength range of 400 nm to 860 nm decreased from 25.79% to 19.84%. Fig. 2 shows the reflectance curves for structures created at different fluence values, across the wavelength range of 400 nm to 860 nm. As compared to the reflectance of bare silicon which was measured to be 35.93% over the same wavelength range, a 44.8% decrease in reflectance was achieved for the case of texturing at 1.4 J/cm². This drop is attributed to the increasing depth of channels and increasing irregularities on the surface.

In summary, silicon wafers with average reflectance values of 23.1% were fabricated by texturing the surface with a picosecond laser. These structures were created at high laser scanning speeds of 4000 mm/s and low pulse overlapping ratios of 60%. Picosecond lasers, due to their lower power density, high rep. rate, and high pulse energy, were shown to be ideal for high-speed surface texturing. With the availability of high-power, high-repetition picosecond laser, the processing speed can further increase, offering the possibility of surface texturing during roll-to-roll manufacturing processes. This method provides an inexpensive and rapid process to create low-reflectance silicon wafers which can be used in photovoltaic applications.

Yung C. Shin is a professor and director at the Center for Laser-based Manufacturing for the School of Mechanical Engineering at Purdue University.

References:
ICALEO 2017: Presenting New Possibilities for Laser Applications

BY SARAH BOISVERT

Experts from manufacturing to medicine, chemical analysis to geology, and bio-photonics to nanofabrication, will convene at the Laser Institute of America’s ICALEO® 2017 at the Sheraton® Atlanta Hotel in Atlanta, Georgia, from October 22 to 26.

Attracting laser researchers, end-users, and equipment manufacturers, ICALEO has offered a unique intermingling of thought leaders for the past 35 years. Technical talks, panel discussions, and informal networking events will give attendees a chance to share knowledge. ICALEO will also facilitate collaborative initiatives between attendees and expose them to modern tools and ideas.

“It is an exciting time to be working with lasers,” said Congress General Chair Dr. Christoph Leyens, of TU Dresden and Fraunhofer IWS, Dresden, Germany. “Additive manufacturing has become reliable enough for industrial applications, medical lasers are pushing the envelope, especially in biotech work, and sensing and inspection makes the Internet of Things possible. Lasers are no longer a solution in search of a problem, as we used to say, but a robust tool used in a wide variety of industries for a broad range of applications. I am honored to have worked with the most innovative minds in laser applications to bring ICALEO’s program to life.”

ICALEO boasts a particularly lively program this year. Sessions delving into the specifics of laser applications were organized by:

- Laser Materials Processing Conference Co-Chairs: Klaus Kleine, Coherent Inc., and Friedhelm Dorsch, TRUMPF Laser- und Systemtechnik GmbH
- Laser Microprocessing Conference Co-Chairs: Michelle Stock, mlstock consulting, and Cather Simpson, University of Auckland
- Nanomanufacturing Conference Chair: Yongfeng Lu, University of Nebraska-Lincoln

Laser Materials Processing (LMP) Conference
The LMP Conference will feature the latest research in laser material interaction and how it is introduced into the industry. “An example of this is using the laser as a high-precision joining tool in welding and brazing of new car body joining techniques,” says LMP Conference Co-Chair Friedhelm Dorsch. “To facilitate these processes, adapted optics, beam guiding and process control are required.”

LMP will go beyond the traditional steel–based materials to cover dissimilar materials such as aluminum and copper. Hot topics such as laser additive manufacturing will be presented in four dedicated conference sessions.

“[LAM’s] impact on industrial production will certainly grow significantly in the upcoming years,” said Dorsch. “All together, we are facing an exciting ICALEO conference. With more than 80 presentations in 17 sessions about Laser Materials Processing, we will address the industrial needs of the short- and medium-term future. Presentations from industry will introduce the latest technologies that are ready to use.”

Laser Microprocessing (LMF) Conference & Nanomanufacturing (Nano) Conference
Kicking off the LMF Conference will be a joint session with the Nanomanufacturing Conference covering hot topics such as battery micro- / nano-structuring, laser direct writing for functional devices, and glass cutting and welding on the microscale.

“The number of contributions based on ultrafast lasers continues to increase, as the performance, availability and economic value of these lasers become more widespread,” said LMF Conference Co-Chair Michelle Stock. “Invited talks on glass decoration (Emma Verdier of Alphanov) and simulations of high-speed micro-welding (Andreas Otto of TU Vienna) prove that this conference has something of interest for all who wish to bring their knowledge of material processing on the micro-scale up-to-date. Cather Simpson and I, as LMF co-chairs, are very excited about the full program.”

Continuing with its focus on nanomanufacturing technologies, this year, the Nano Conference “features a few special application topics on photovoltaics, battery materials, advanced energy devices, spectroscopy, and imaging,” said Conference Chair Yongfeng Lu. “This conference will highlight research in emerging nanomanufacturing technologies in 3-D micro/nanofabrication as well as laser synthesis and diagnostics of nanomaterial.”

Business Forum & Panel Discussion
Last year China installed more than 60,000 laser systems. Is this an opportunity or a threat for the other laser businesses?
This question and more will be addressed at the Business Forum & Panel Discussion. This forum, co-chaired by Bo Gu and Klaus Loeffler, will highlight business-related topics including business models, NAFTA and the ever-evolving global economy.

Opening & Closing Plenaries

Dr. Leyens was responsible for formulating the thought-provoking opening and closing plenary sessions, providing laser applications insight from the following:

- Dr. Mark Schnitzer, associate professor at Stanford University and investigator at the Howard Hughes Medical Institute, works in neural circuit dynamics and optical imaging. His optical innovations are used to further neuroscience study worldwide.
- University of Colorado department of physics professor, Dr. Henry C. Kapteyn, builds new tabletop x-ray laser light sources and helps develop corresponding applications.
- Jeff Deems is a researcher at CIIRES, the National Snow and Ice Data Center in Boulder, Colorado, serves as the liaison for the NASA Airborne Snow Observatory. Deems specializes in laser mapping snow packs and developing lidar applications for avalanche forecasting and climate applications.

To close ICALEO, we will hear from the below invited plenary speakers from groups that are spearheading widespread industry adoption of additive manufacturing:

- Dr. Wayne King, Director of the Accelerated Certification of Additively Manufactured Metals Initiative at Lawrence Livermore National Lab, certifies 3D-printed materials for mission critical parts in the nuclear, aerospace and automotive industries. This allows designers and engineers to switch to additive manufacturing with assurance part performance is predictable and verifiable. It is materials certification that will bring about widespread adoption of the technology in mainstream industry, making this work both timely and important.
- Dr. Florian Bechmann, head of Engineering & Technology (Concept Laser brand) at GE Aviation, will explore technologies which advance manufacturing of jet engines and other airplane components using new tools such as additive manufacturing and advanced composites, both of which are important components of the new LEAP engine. GE’s revolutionary engine demonstrates reduced emissions and fuel savings, leading the industry in performance as well as in innovative manufacturing processes.
- Dr. Minlin Zhong is a professor at the School of Materials Science & Engineering at Tsinghua University. He serves as the Director of the Laser Materials Processing Research Center and is the President of the International Academy of Photonics and Laser Engineering. Zhong will focus his presentation on the main nanostructures induced by an ultrafast laser and its magic nano-functions.

Manufacturers clearly see the value of supporting ICALEO. This year, IPG Photonics Corporation; EdgeWave GmbH; Innovative Laser Solutions; SPI Lasers; TRUMPF Inc.; Laserline Inc.; Light Conversion Ltd.; Lumentum; and Spectra-Physics, A Newport Company, have all demonstrated a commitment to furthering laser utilization in real-world applications by joining us as ICALEO sponsors.

More than anything else, ICALEO is a community of innovators. It is the informal discussion at the many networking events that leads to brainstorming with old friends and new colleagues. There, creative ideas are formulated that foster an ongoing development of new laser applications. That is the power of ICALEO!

We invite you to join the ICALEO community! To register, visit www.icaleo.org.

Sarah Boisvert is the founder of the Fab Lab Hub, an MIT-based Fab Lab Network non-profit.

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Sarah Boisvert is the founder of the Fab Lab Hub, an MIT-based Fab Lab Network non-profit.
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RLI is excited to announce the next offering of the Measurements for Laser Safety course, hosted by Underwriters Laboratories and featuring equipment by Ophir Optronics.

This hands-on course will teach you how to perform laser safety measurements according to applicable laser safety standards. The course will focus on workshop exercises that are designed to make maximum use of laser output measurement equipment in solving real-world laser measurement problems.

The ANSI Z136.4 American National Standard Recommended Practice for Laser Safety Measurements for Hazard Evaluation, FDA/CDRH Laser Product Performance Standard, and the IEC/TR 60825-13 Ed. 2.0 will be the basis of measurement requirements presented in the course. The instructor is the Chair of the ANSI Z136 Measurements Standards Subcommittee (SSC-4) and the Convenor of the IEC TC 76 Laser Radiation Measurement Working Group (WG 3).

- **L-240 Measurements for Laser Safety:** This is a two-and-one-half-day intermediate level intensive hands-on course in laser output measurements tailored to meet the specific needs of laser safety. Classification concepts in the ANSI Z136.1 Standard For the Safe Use of Lasers, FDA/CDRH Laser Product Performance Standard and IEC 60825-1 will be reviewed in the course.

Attendees are eligible for 3.34 ABIH CM credits; and 2 recertification points BCSP Category 7. AAHP has awarded this course 20 CEC (2017-00-097). BLS has awarded this course 2.5 CM points (106-34501).

[Click here for more information.](#) List Price: $1,350 / $1200*

* Price reflects discount for early registration and payment 30 days prior to course.

**Course Topics Include:**
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In 1997, John O'Connell and Ronald Schaeffer founded PhotoMachining, Inc., a world leader in precision micromachining applications.

The company specializes in the use of Ultraviolet (UV) and Ultra Short Pulse (USP) lasers. Their lasers come in a wide variety of wavelengths, which enables them to provide the laser industry with laser micromachining, contract manufacturing, and laser micro machining systems for industrial applications specific to customer requests.

“The development of laser technology has occurred to a great extent over the last 20 years and we have always tried to have the newest lasers available,” said Dr. Ronald Schaeffer, Chief Executive Officer with PhotoMachining. “We were at the forefront of developing novel laser techniques using high-pulse-rate USP lasers with both fixed optics and galvo scanners.”

Their team of approximately 25 employees makes up two divisions: the Systems Division and the Job Shop Division. Both divisions work together to create innovative systems for their customers' unique industry needs. The company’s services reach a large variety of markets, which include medical devices, microelectronics, and semiconductors. They have even collaborated on projects related to aerospace and defense.

“We are proud to deliver products to our customers that give them a competitive edge,” said Schaeffer. “We are particularly proud of the processes we have specifically developed for some of the leading medical device manufacturers, which have greatly reduced costs and downtime for our clients.” PhotoMachining, Inc. is continuously trying to innovate and grow. “Our staff is highly motivated to tackle some of the most difficult manufacturing processes regarding precision and economic viability in a production environment,” Schaeffer said. “It requires multiple talents in laser material interaction, systems integration, automation and software to produce highly reliable laser machining systems.”

Based out of Pelham, New Hampshire, the company is looking forward to exploring new initiatives. According to Schaeffer, one such initiative is, “3D printing in optically clear materials through Selective Laser Etching (SLE) with LightFab.”

“The SLE process involves exposing hard, brittle and otherwise transparent materials like Quartz and Fused Silica to USP laser light and then chemically etching the exposed area away, where etching selectivity after laser exposure is enhanced over a thousand times,” Schaeffer said. “This method makes 3D precision parts by essentially 3D printing the pattern inside the bulk of the material. SLE is expected to play a major role in many manufacturing processes such as microfluidics.”
Welcome New Corporate Members

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

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LIMO GmbH
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Suresh Indu Lasers Pvt. Ltd.
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- Tables of Laser Cutting Speeds for Different Materials

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Published by: Laser Institute of America
**Member Innovations**

**“MuReA” Provides Quick and Large-scale Laser Applications**

The Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS developed the novel remote system concept (MuReA) for quick, flexible and efficient laser-processing tasks. IWS scientists combined laser remote systems, spindle drives and high-performance beam sources with each other.

As a result, this novel laser system enables large-scale, flexible and quick processing tasks for materials such as aluminum and stainless steel, as well as fiber-reinforced polymers. Working areas of up to one square meter can be processed at a laser beam speed of up to 10 meters per second. In particular, the automotive and the aerospace industry will benefit from possible applications.

For more information, visit [www.iws.fraunhofer.de/en](http://www.iws.fraunhofer.de/en).

**II-VI Incorporated Announces Optical Line Subsystem Platform for Datacenter Interconnects**

II-VI Incorporated (NASDAQ:IIVI), a leading provider of solutions for optical networks, today announced the introduction of its Optical Line Subsystem platform for datacenter interconnects (DCI), which is optimized for direct-detect DWDM transceivers, including the new COLORZ-Lite™ 100G PAM4 based on the COLORZ® silicon photonics platform from Inphi Corporation (NYSE: IPHI).

Cloud service providers require increasingly scalable, cost-effective and power-efficient solutions to meet the rapidly growing demand for DCI. II-VI’s Optical Line Subsystem multiplexes, amplifies and demultiplexes multiple wavelengths of COLORZ-Lite data streams to achieve a combined transmission rate of up to 4 Tb/s over a 20 km reach in a compact one rack unit (1RU) form factor. This capability offers cloud service providers and enterprise customers a cost optimized direct-detect DWDM solution for these distances.

For more information, visit [www.ii-vi.com](http://www.ii-vi.com).

**Members In Motion**

**Dr.-Ing. Oliver Suttmann Receives WLT Prize**

Dr.-Ing. Oliver Suttmann, Head of the Production and Systems Department at the Laser Zentrum Hannover e.V. (LZH), received the Prize of the Wissenschaftliche Gesellschaft Lasertechnik e.V. (WLT). Alongside the Lasers in Manufacturing Conference (LiM) 2017 in Munich, WLT president Prof. Dr.-Ing. Michael Schmidt handed over the award.

The WLT Prize is awarded annually for outstanding accomplishments in the field of applied laser research. Dr.-Ing. Oliver Suttmann was honored for his contribution in the fields of fiber composite, glass and micro processing.

“Already in his PhD thesis, Oliver Suttmann has proven his ability to address and solve complex challenges in manufacturing technology on a scientific basis. Now, he is successfully using this ability while heading a fully third-party funded department, and thus promoting the scientific further development in the field of laser material processing”, explains Prof. Dr.-Ing. Michael Schmidt in his laudatory speech.

For more information, visit [www.lzh.de/en](http://www.lzh.de/en).

**Metal Powder AM Company Ranks in Top National Tech Company League**

LPW Technology has been included in The Sunday Times Hiscox Tech Track 100 for the second year running. The league table ranks Britain’s private technology, media and telecoms (TMT) companies with the fastest-growing sales.

As the global AM sector matures, LPW has consistently striven to anticipate the needs of the developing market. Its focus on customer service and metal powders optimized for individual applications has fueled its strong growth.

“To support our customers, we’re building a new, £20 million state-of-the-art facility in the UK to produce the next generation of premium, AM-specific metal alloys that the safety-critical sectors demand,” comments Dr.Phil Carroll, Founder and CEO of LPW. “Our ‘factory of the future’ will open in February 2018, enabling us to manufacture metal powders on-site in Liverpool, and in October this year our US operation will be moving to larger premises. These two new sites will allow us to process more materials and dispatch powders within 24 hours of receipt of order.”

For more information, visit [www.lpwtechnology.com](http://www.lpwtechnology.com).
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Available in print and digital formats.
As this issue of the LIA TODAY goes to print, Accredited Standards Committee (ASC) Z136 members are voting on a number of membership applications. Although the results of the ballot are yet to be seen (and will be reported in the November-December issue), it seemed an opportune time to review committee membership requirements.

Membership on the committee consists of individuals who may or may not represent an organization (private or public groups, e.g., government entities, educational institutions, other associations or for-profit companies). The individual or organization “shall have a direct and material interest in the activities of ASC Z136,” meaning the desire, ability and willingness to participate actively in the development of one or more Z136 laser safety standards. The applicant can request participation on a specific subcommittee or the main committee body.

A request for membership on the main committee body must be addressed to LIA, which functions as Secretariat to the committee. In addition to voting on main committee membership applications, responsibilities include proposing American National Standards within the scope of the committee, voting on the approval of proposed standards, and voting on revisions and reaffirmations of Z136 standards.

The vast majority of members on the main committee belong to one or more of the standards and/or technical subcommittees. It is here at the subcommittee level that primary development and subsequent maintenance of the standards actually take place. Membership on the subcommittees is open but may be limited by the subcommittee chair to attain balance. Requests for membership on a subcommittee are submitted directly through the Z136 website and directly responded to by the subcommittee chair.

In order to afford members the opportunity for fair and equitable participation without dominance by any single interest category, applicants are asked to specify a general base interest category from these established categories:

- Academia
- Consultant
- Consumer
- Dept. of Defense
- Directly Affected Public
- Distributor/Retailer
- Government (non-DoD)
- Government Contractor
- Health Care
- Industrial
- Manufacturer
- Professional Society
- Regulatory Agency
- Testing Lab
- Trade Organization

These interest categories are fully defined in the ASC Z136 Conventions, located on the committee’s website at www.z136.org or available through the LIA office.

If you have any questions regarding membership on ASC Z136 or any of its subcommittees, please contact Barbara Sams at +1.407.380.1553 or email bsams@lia.org.

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**Laser Safety Officer Training**

**GAIN MORE KNOWLEDGE IN LESS TIME WITH LASER SAFETY OFFICER TRAINING ONLINE!**

LIA’s Laser Safety Officer (LSO) online training course was designed for all levels of experience and involvement including industrial, military, educational or research applications of lasers. It is tailored to fit the needs of safety professionals, engineers, laser operators, technicians and other professionals assigned the duties of Laser Safety Officer who are not required to perform hazard analysis calculations.

This course meets all LSO training requirements outlined by ANSI, OSHA and ACGIH. You will earn 16 CECs by AAHP, 3.0 BLS CM Points by the Board of Laser Safety and is eligible for ABH CM Points.

**REGISTER TODAY!**

[www.lia.org/online-training/lsso](http://www.lia.org/online-training/lsso)  1.800.34.LASER

Presented by: Laser Institute of America

Laser Applications and Safety

The journey to become a certified laser safety officer begins with the desire of the LSO for continued professional development, perhaps to advance his or her career, perhaps as a personal accomplishment. The goals of the BLS are to provide for the assessment of the LSO – through attainment of certification; support continuing education – in order to maintain certification; and recognize the LSO’s achievements – from earning the designation of CLSO or CMLSO to receiving an industry award.

It is only right to acknowledge the original group of laser safety experts who participated in the writing and assembly of the first CLSO exam, as well as the medical laser safety experts who did the same for the first CMLSO exam (see the infographic below for the full list).

Kudos to Ken Barat, Joe Greco, Tom Johnson, Wes Marshall and David Sliney, who have continually maintained their active certification status since that first exam.

Occasionally an LSO will be employed in a facility that bridges the gap between medical and industrial lasers. Each area requires appropriate laser safety guidance, dependent upon the system’s application. In these instances, the LSO may choose to earn both certifications.

This unique group of laser safety professionals shares one thing in common — all are dually certified and currently hold both the CLSO and CMLSO designation: Ben Edwards, Bill Ertle, John Gough, Richard Harvey, Myung Chul Jo and Mark Pflug.

Over the course of the past 15 years, BLS CLSOs and CMLSOs have made significant contributions to the laser safety community. Working with LIA staff, these professionals authored CLSOs’ Best Practices in Laser Safety, followed by CMLSOs’ Best Practices in Medical Laser Safety. From session programming to paper presentations, they have played a major role in the establishment of the Technical, and later Medical, Practical Applications Seminars of the International Laser Safety Conference (ILSC). Assisting in the development of the Z136 laser safety standards, more than half of ASC Z136 membership are certified. Many provide continuing education opportunities, lecturing at other venues such as the DOE LSO Workshops or the Health Physics Society annual meetings.

Join us in celebrating 15 years of BLS. If you have the responsibility of laser safety officer, consider certification. Visit www.lasersafety.org, email bls@lasersafety.org or call us at +1.407.985.3810 for more information.
OSHA to Hold Second Public Meeting to Solicit Suggestions for Growing, Strengthening Voluntary Protection Programs
WASHINGTON, DC – The U.S. Department of Labor’s Occupational Safety and Health Administration (OSHA) held the second of two meetings Aug. 28, 2017, in New Orleans, LA, to continue the discussion on the future direction of the agency’s Voluntary Protection Programs (VPP). The discussion included a review of the July 17, 2017, meeting along with comments and suggestions from the public on potential avenues for action.

OSHA invited stakeholders to provide new ideas on three broad categories which included:
• Overall VPP process and flow;
• Corporate/long-term participant involvement; and
• Special Government Employee activities.

OSHA is seeking to reshape VPP so that it continues to represent safety and health excellence, leverages partner resources, further recognizes the successes of long-term participants, and supports smart program growth.

OSHA Issues Proposed Rule to Extend Compliance Deadline for Crane Operator Certification Requirements
Today issued a Notice of Proposed Rulemaking to extend the employer’s responsibility to ensure crane operator competency and enforcement for crane operator certification to Nov. 10, 2018.

OSHA issued a final rule in September 2014, extending the deadline by three years for crane operator certification requirements in the Cranes and Derricks in Construction standard. The final rule also extended by three years the employer’s responsibility to ensure that crane operators are competent to operate a crane safely.

The agency is now proposing an extension of the enforcement date to address stakeholder concerns over the operator certification requirements in the Cranes and Derricks in Construction standard.

Under the Occupational Safety and Health Act of 1970, employers are responsible for providing safe and healthful workplaces for their employees. OSHA’s role is to ensure these conditions for America’s working men and women by setting and enforcing standards, and providing training, education and assistance.

For more information, visit www.osha.gov/safeandsoundweek.

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. Learn more at www.lia.org/oshaalliance.

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Presented by:
Laser Institute of America
Multiphysics Modeling of Pulsed Laser Welding

BY VINCENT BRYUERE

Laser beam welding is largely used in industrial manufacturing because of the advantages it provides, such as high-quality welds. Nevertheless, depending on the operating conditions, porosities or unwanted deformations can be produced during welding operations.

In order to understand and control the responsible underlying mechanisms, numerical models are developed in a unique, finite element formalism. All models are based on experimental characterizations.

First of all, a thermal-hydraulic model is developed to predict the dimensions of the melted zones and the heat-affected zones, as well as the mechanisms of porosities formation for a Ti6VAl4 alloy. A thermal-mechanical model including metallurgical phase changes is then developed in order to predict the residual states of stress and strain. The heat source is calibrated with an optimization procedure based on thermal-hydraulic analysis. Indeed, an equivalent approach is used to reduce the computational time for thermal-mechanical computations. Finally, this model is applied to a study case and numerical results are discussed and compared with experimental data.
New & Improved Corporate Member Directory
The new and improved LIA website has a lot to offer, including an updated corporate member directory. This complimentary feature uses site traffic to generate a unique marketing opportunity for our corporate members. Viewers can scroll through the alphabetized listing to search through the database or type in a company name. Corporate members can show off their brands, around the clock by uploading their latest logos, contact information and company descriptions. The new site, featuring a vibrant background and a modern appearance, offers a robust corporate listing, which users can navigate with ease.

For more information, visit www.lia.org/membership.

Save the Date for LIA’s Industrial Laser Conference (held at IMTS)
The Industrial Laser Conference is a laser manufacturer’s dream come true. This bi-annual educational event is a co-conference, which will be held at the IMTS 2018, on Wednesday, September 12, 2018, in Chicago, Illinois. With several speakers from a variety of businesses, large and small, there is a session for everyone. Our conference focuses on educating companies about incorporating lasers within manufacturing processes and how they can remain competitive in a technology-based world. Our conference will include industrial applications of lasers, such as: additive manufacturing, cutting, welding, marking and more. Additionally, the speakers will explore ways that applying lasers may increase profits and efficiency by discussing business strategies and methods that have already worked for industry leaders around the world.

The 2016 Industrial Laser Conference included guest speakers representing a number of prominent companies within the laser community, such as Jim Cann from Optomec Inc.; Frank Geyer from TRUMPF Inc.; and Paul Denney from Lincoln Electric Company. Topics were diverse, but practical. Last year’s speech topics included: High-Power Diode Lasers and Innovative Industrial Applications by Oleg Raykis; Innovations in Industrial Laser Applications and Process Monitoring by Rahul Patwa; and Advances in Additive Manufacturing by Wayne Penn. In 2018, we hope to provide attendees with another insightful experience and want to formally welcome you to participate!

For more information, visit www.lia.org/laserconference.

Announcing Digifab Con Co-locating with LIA’s LAM & LME
LIA is excited to announce that DigifabCon will take place March 27–28 at the Schaumburg Convention Center in Schaumburg, IL, co-locating with our Laser Additive Manufacturing Conference and the Lasers for Manufacturing Event.

Digifab Con, produced by Fab Lab Hub, is an interactive, creative and inspiring event showing how anyone can change the world using the new tools of digital fabrication such as 3D printing, laser cutting, microelectronics, artificial intelligence, CAD software, robotics and so much more.

Digifab Con’s 2017 Program, available on their website, showcases the high caliber of their speakers and the format of the conference. The 2018 program will be similar in depth and breadth, with keynotes, a design session and breakout sessions dedicated to education and digital manufacturing.

For more information, visit www.digifabcon.org.
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