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Focus:
MARKETPLACE

Laser Institute of America, the international society dedicated to fostering lasers, laser applications and laser safety worldwide.

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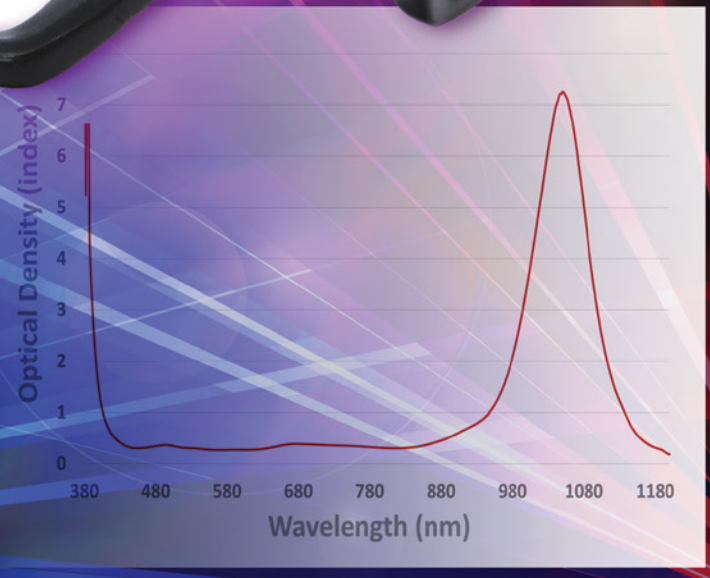

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ABOUTLIA

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.

CALENDAR OF EVENTS

Laser Safety Officer Training

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*

Jan. 29–Feb. 2, 2018	Orlando, FL
Mar. 5–9, 2018	Marina del Rey, CA
Jun. 11–15, 2018	Niagara Falls, NY
Sept. 17–21, 2018	Kansas City, MO

*Certified Laser Safety Officer exam offered after the course.

Industrial Laser Safety Officer Training

Feb. 14–15, 2018	Novi, MI
May 16–17, 2018	Novi, MI
Aug. 15–16, 2018	Novi, MI
Nov. 14–15, 2018	Novi, MI

Medical Laser Safety Officer Training*

Jan. 27–28, 2018	Orlando, FL
Mar. 3–4, 2018	Marina del Rey, CA
Sept. 15–16, 2018	Kansas City, MO
Oct. 13–14, 2018	Orlando, FL

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Laser Additive Manufacturing Conference (LAM®)

Mar. 27–28, 2018	Schaumburg, IL

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Sept. 12, 2018	Chicago, IL

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President's Message

It is hard to believe that 2017 is almost over and that I will be handing over the presidency in a little over a month. This will be my last message in *LIA TODAY*. If this is not the best issue, it is certainly the "busiest" issue of the year.

This issue's company profile is IPG Photonics. This company has come a long way in the last 20 years. With the vision and technical capabilities of its founder, Valentin P. Gapontsev, the laser industry was disrupted with the introduction of the fiber laser. With a fairly common core design that it has built off of, IPG Photonics has become a world leader in laser materials processing.

As usual in this issue, Dave Belforte will evaluate the laser market and forecast what to expect next year. This article is always interesting as it shows major trends in laser types, expansion and contraction of markets for lasers, and the health of not only the industry but the U.S. and world economies.

We have two outstanding articles on the current trends in laser materials processing. The first by Eric Mottay is on ultrafast laser processing and the use of modeling with the process. When ultrafast processing was first discussed and presented at ICALEO, it was not clear that this approach would ever be utilized in industry because of the complexity, limitation, and cost of the lasers and equipment. But today ultrafast processing is becoming more and more accepted and utilized for nanoscale processing for a wide range of products and applications.

There is also a wonderful write up by Jim Naugle on a successful ICALEO 2017. The conference, held in Atlanta, GA, this year was well attended and gets us ready for celebrating LIA's 50th anniversary back in Orlando, FL, next year.

As my presidency winds down, I look back at a very busy 2017. During my year as LIA President, we saw the retirement of our long-time Executive Director Peter Baker and the hiring of our new Executive Director, Nathaniel "Nat" Quick. The LIA staff this year brought the new website online. They are also working to have a searchable online database for all of the LIA conferences and workshops, and they have been working on making some of our laser courses available in Spanish. Look for both of these to roll out in early 2018.

Looking forward, LIA will be celebrating its 50th anniversary in 2018. While it is amazing to acknowledge you have reached the 50 year milestone, it is great to look forward to the next 50 years and what it may bring. I am excited to see the changes that Prof. Milan Brandt, the LIA 2018 President, has planned for us.

Thanks again to all of the LIA Staff, Officers, Board, and members who have made my presidency memorable.

Paul Denney, President
Laser Institute of America

Executive Director's Message

I welcome the opportunity to guide LIA during this transitional phase. LIA has been a tremendous knowledge base for my company, inspiring the creation of our patented laser-based technologies for new industrial applications. Now, I can repay the favor.

The LIA team is developing the means to better deliver data related to laser technology and innovative applications internationally. In short, we are striving to become the content provider for all laser-based technologies.

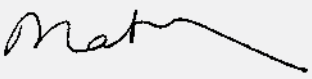
My preliminary review of past LIA initiatives has led to the identification of three core initiatives that are within the current capability of LIA and form a foundation for additional growth initiatives.

Information Technologies is our core operation and is undergoing modifications to service not only the external customer but the internal staff. Efficiency of all departments will improve as programs come online with the launch of our new website. We now offer online course content directly to mobile devices and can consider other cutting-edge, web-based solutions.

As we approach our 50th anniversary, we are expanding our online archives by adding all past conference and *JLA* papers, past event presentations, white papers, *LIA TODAY* articles, and more. This is the value we bring to the laser, materials processing, engineering and manufacturing communities. This "product" will be packaged in a variety of ways to serve our current membership. Additionally, this information will remain easily accessible to the most novice users and industry experts.

We are reviewing all course offerings and improving them to cater to a broader target audience. An example is the translation of the Laser Safety Awareness course to Spanish, thus testing the need for language diversity within our online course portfolio.

We will continue to explore all innovative business methodologies to complement the innovative technologies we have represented for several decades as we approach our 50th anniversary.



Nat Quick, Executive Director
Laser Institute of America

2017 Laser Market Review

Expect growth in 2018

BY DAVID BEFORTE

In last year's 2016 report, I opened with comments about the troubling times, political, cultural and economic, we lived in and then expounded on the industrial laser industry seeming to defy bad news with its own good economic news. Well, I could have copied that report, changed a few numbers, and saved a lot of time and effort in compiling this year's. I won't, however, because there are some changes, both good and bad.

First the bad—politically, socially, and culturally things got worse. In the United States, the socio economic gap widened and the country is more contentiously divided. Around the world, there continues to be terrorism, secular war and other strife. The fractious Brexit problem, still unresolved, leaves the economies of several countries in limbo. Furthermore, as the year ended, one stalwart, Germany, lost its economic luster, and as the *New York Times* proclaimed, this country "plunged into political crisis."

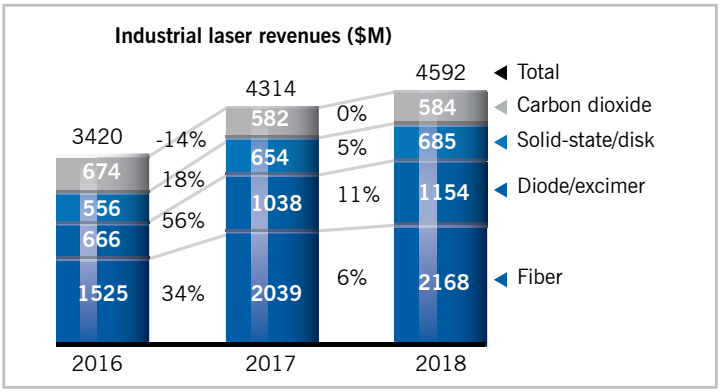
Despite this, most countries' economies improved in 2017 and the average GNP slightly increased. As a result, manufacturing, the backbone of these economies, improved.

In response, the industrial laser market experienced another growth year led by exuberant fiber and excimer laser revenues. Overall total market revenues tallied a whopping 26% increase, a level not seen since the early days of this almost-50-year-old industry sector.

I'm going to pause to explain how the market numbers are generated. *Industrial Laser Solutions* partner, Strategies Unlimited, compiles and prepares annual revenue data for us, primarily from public companies representing several of the largest industrial laser manufacturers, including IPG Photonics, Coherent, Inc., along with data from the largest company, privately held TRUMPF. Because of the timing of these reports, revenues for the final quarter of the calendar year are taken from the guidance offered in their reports. Consequently, adjustments made in prior year revenues may be made if fourth-quarter results published early in the next year are outside the limits of the guidance advisories. This happened last year in the case of industry leaders IPG Photonics and Coherent, Inc.

Okay, let's look at the numbers. After some adjustments in revenues, 2016 turned out to be a good year for industrial laser sales led by outstanding fiber laser growth and the beginning of deliveries of high-power excimer lasers for applications in manufacturing mobile phone displays. This trend continued in 2017 with two companies, IPG Photonics and Coherent, Inc., racking up outstanding first-half revenue growth. Processing of Micro materials gained 24%, most of it from a 56% increase in revenues from the face plate processing application. High-power processing of Macro materials shot up by 34% as sheet-metal -cutting growth of 30% was led by the market in China.

Most significantly, fiber laser revenues, up 34%, represented 47% of total laser revenues, further eroding CO_2 lasers' market share to 13% of total as CO_2 revenues in 2017 declined by 14%. Solid-state lasers, in prior years reducing market shares, experienced a rebirth as high-power disk laser revenues propelled a strong 26% increase, thanks to sales into the metal-cutting and welding markets. Making a notable contribution to overall laser revenue growth was the burgeoning markets for high-power diode and excimer lasers in the Other category.



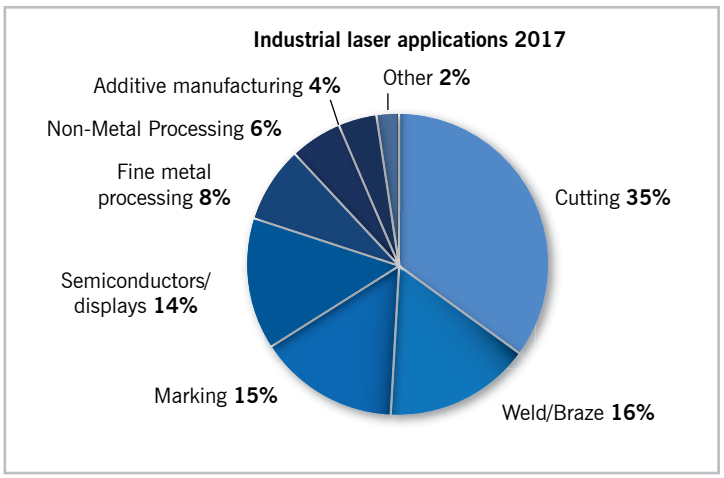
Source: Strategies Unlimited/ILS

Application markets

Marking (including engraving) represents about 15% of all industrial laser revenues. An increase of 7% in fiber laser revenue continues to eat away solid-state lasers' share as an unrelenting reduction in unit selling prices drove market growth, specifically in China. CO_2 lasers for engraving applications remained a positive area of growth for that laser.

In the Micro Materials sector, high value excimer laser sales for mobile phone and hand-held display applications showed a 56% growth as system deliveries peaked in 2017. Lasers with output power <500W found a growing market in Additive Manufacturing (a 30% gain) and Non-Metal Processing (up 9%), and Fine Metal Processing (fine blanking) showed two long-term growth opportunities.

Among the Macro (=> 1 kW) applications, Welding/Brazing tallied the strongest growth at 50% as fiber for welding and high-power diodes for brazing increased industry acceptance. Increasing demand for sheet-metal-cutting laser systems, primarily in China and other Asian countries, boosted growth



Source: Strategies Unlimited/ILS

from a modest single-digit growth pattern to a recent-year high of 29%. And a fast-growing market for production-rated Additive Manufacturing systems caused a spurt in high-power fiber, diode and CO_2 lasers.

The Future

Looking ahead to 2018, global companies in manufacturing project a repeat of 2017, all things being equal. Under these circumstances, industrial laser manufacturers are also bullish about market strength in the coming year, expecting a slightly diminished first-half growth, compared to 2017's ebullient experience.

Expect revenue growth in 2018 to return to a modest, but industry-acceptable, single-digit level of 7%. Two factors drive our expectations: the 2017 spike in laser cutting in Asia will cool down and return to a more-normal 5% growth pattern, and second-half delivery schedules for high-priced excimer laser annealing systems for display production will start to wind down.

We expect Marking, Micro and Macro laser revenues will experience single-digit growth, which has consistently been the trend in these markets. Lest readers see this as an overly cautious forecast, remember a simple marketing maxim — before you can have growth, you must match prior years' sales. For industrial lasers, the target is the superheated $4.3 billion market of 2017.

One cautionary note — the recession of 2008/9 will be 102 months old in January, and wise economists cite this as a strong aberration according to CNBC[1]. So a word of caution, typical economic cycles are 58 months, so it wouldn't be remiss to Google recession forecasts periodically. Those who were surprised by the start of the Great Recession of 2008/9 can speak to this suggestion. ■

David Belforte is Editor-in-Chief of Industrial Laser Solutions.

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Ultrafast Laser Processing benefits

from a Simple Modeling Approach

BY ERIC MOTTAY

Ultrafast lasers have gained wide acceptance over the past decade as a unique tool for high-precision manufacturing. The unique nature of the interaction process leads to a virtually athermal laser processing, without heat diffusion, cracks, recast, melted zone and other detrimental side effects. This allows ultrafast laser technology to cover a very wide range of processes and applications fields: We find femtosecond and picosecond lasers in clinics, treating cataracts, in small workshops doing advanced, custom manufacturing, in large semi-conductor and micro-electronics companies, and bringing to market new display technologies or computer chips. In terms of process, they can cut glass, ceramic and metal with unprecedented accuracy, drill holes with high precision and throughput, selectively remove thin film layers with nanometer-range resolution or confer new properties to materials by surface micro- and nano-texturing.

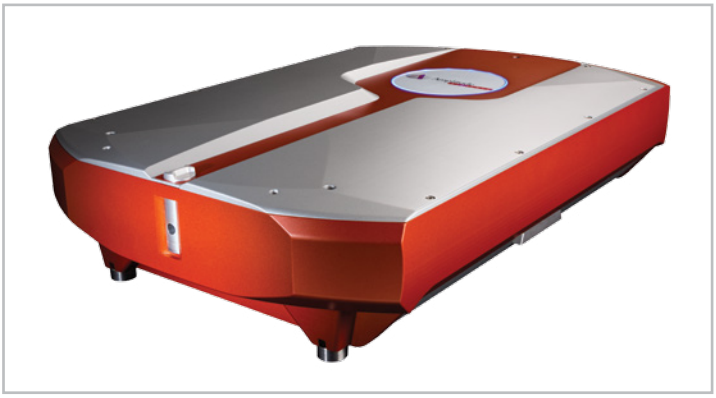

Figure 1. Tangor industrial ultrafast laser

The development over the years of successive generations of industrial lasers with ever-increasing average power has enabled the industrial throughput required for economic breakeven of innovative applications. Yet, challenges remain to further capture new markets. Among those is the process development time and effort required to bring to fruition new ideas. The ultrafast laser market is actually the superposition of multiple individual applications, each requiring specific laser, beam handling and process development. The knowledge gained from learning how to safely and reliably cut a thin layer of corneal tissue in a living patient cannot be easily transferred to the dicing of a thin, multi-layer semiconductor wafer. High-speed, high-quality cutting of a cell phone cover glass does not require the same process, laser or beam handling system as the drilling of a fuel injector nozzle.

An attractive approach to reduce the process-development time and leverage the knowledge gained from previous projects is the use of numerical models of laser ablation in the femtosecond and picosecond regime. Ultrafast laser matter interaction has been extensively studied in the academic community, and many sophisticated models have been developed.

From an engineering and process development perspective, however, these models present severe limitations. They are usually very complex and take into account many different physical phenomena. As a consequence, they are fairly difficult to use without extensive training. Present run time prevents easy on-site optimization and require a number of adjustable parameters. There is definitely room for a simple, user-friendly-yet-accurate-enough engineering model for process development, ideally running on a simple spreadsheet that one could run in front of the laser system.

To build such a model, we start with the well-known two-temperatures model of ultrafast laser ablation[1]. This model is a set of two coupled differential equations, describing first the heating of the electrons by the laser pulse, occurring typically on a sub-10 fs time scale, and the subsequent transfer of the heat from the electrons to the lattice, occurring in the picosecond time scale. One of the main outcomes of this model is a simple equation describing the ablation depth Z of a single laser pulse as a function the laser fluence F. It involves only two material-related parameter, δ and F_{th}

$$z = \delta \, ln \left(\frac{F}{F_{th}} \right)$$

δ has the dimension of a length and is usually described as an absorption length. F_{th} is the fluence threshold and is typically material-dependent.

Our approach in the development of a simple engineering model is to consider δ and F_{th} as adjustable parameters that we will measure for each material then consider as constant. We do not claim to model precise physical phenomena — we will just dump all the unknown physics in these two parameters by an experimental fit.

To obtain the required experimental data to perform this fit, we relied on an extensive database of laser ablation results, carefully performed and collated under rigorous experimental conditions by Dr. John Lopez from the University of Bordeaux[2]. As an example, Figure 2 shows experimental data and the experimental fit on stainless steel. The values of δ and F_{th} will then always be used when modeling interaction on stainless steel.

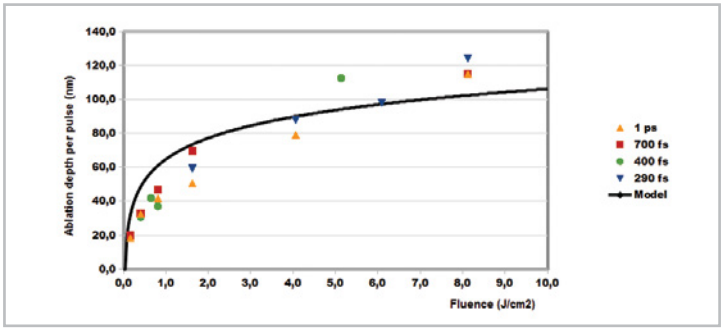

Figure 2. Stainless steel ablation depth per pulse modelling (model δ=18 nm, F_{th}= 0.055 J/cm^2)

This deceptively simple approach does not require additional fit parameters and can be applied to many real-life processes. As an example, we have studied the case of fuel-injector-nozzle drilling for the automotive industry.

Stringent emission requirements in the automotive industry drive the development and optimization of new industrial manufacturing technologies. In particular, injection nozzles require high-precision, high-aspect ratio holes to guarantee efficient fuel injection. Ultrafast lasers play a key role in this process, due to their high-quality microprocessing abilities. Ultrafast laser trepanning can drill high-quality, high-thickness holes (up to 1 mm) with arbitrary shapes, such as zero-conicity or even inversed tap. A clear understanding of all the processing steps necessary to optimize the processing speed is a main challenge for industrial development.

We have applied our engineering model to identify parameters of influence in high-aspect ratio drilling and cutting of stainless steel with ultrashort pulses[3]. We have modeled the drilling process (percussion vs trepanning), the beam shape (Gaussian vs flat-top), as well as drilling speed (pulse overlap vs scan speed). Figure 3 shows a typical result for a 900μm deep, 50 μm diameter, zero taper hole. The model predicts a drilling time of 5.4 s and a 0.15° taper, where the actual results are respectively 5s and 0°.

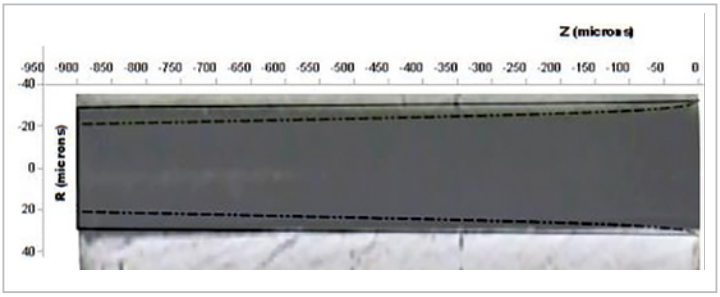

Figure 3. Example of trepanation result modelling (stainless steel)

We have also applied the same approach to different applications, such as line engraving, surface texturing[4], or even glass ablation. Applying an engineer viewpoint to complex scientific phenomena can provide valuable insights to solve real-life laser-processing challenges. ■

Eric Mottay is a current LIA Board member and is the president and CEO of Amplitude Systemes.

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Utilization of Laser Beam Oscillation

to Enhance the Process Efficiency for Deep-penetration Welding in Aluminum

BY MARTIN SOMMER

Laser beam remote welding is an established process in modern production plants. For instance, remote welding is used as a fast-joining technology with rather large structural welds in car body manufacturing. In particular, laser beam processing is characterized by numerous advantages such as non-contact machining and low process times. However, for an implementation in series production, each joining technology is assessed in terms of its process efficiency. In car body manufacturing, the efficiency of the keyhole welding regime has to be considered for the application of the laser beam as a tool. Therefore, the focus of this research is the improvement of the process efficiency for laser beam welding of the common aluminum alloy AlMgSi1.

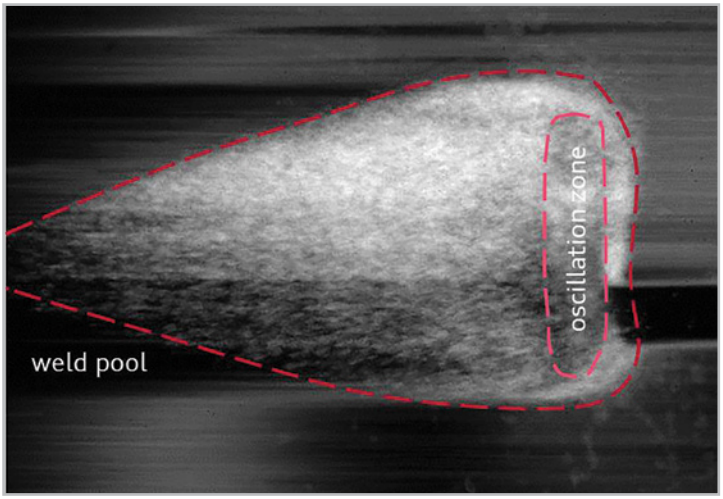

Figure 1. Visualized weld pool and transversal oscillation zone of the laser beam

The experiments were performed with a high-power diode laser with beam converter. The the scanning unit that was used allowed a lateral beam oscillation perpendicular to the feed direction. Thereby, a new process was developed on the basis of high frequent beam oscillation in order to obtain a continuous weld pool, illustrated by Figure 1. Hence, the sinusoidal beam oscillation enabled a defined heat input whereas the laser beam was accelerated and the molten pool was widened. As a consequence, the process design leads to a significant pre-heating of the process zone, while the material typically exceeds melting temperature. The relevant increase of the ambient temperature benefits the formation of a vapor capillary because of the reduced necessary laser power to overcome the deep-penetration welding threshold and also a concurrent increase of the temperature-based material's absorption for the laser radiation.

For the determination of the process efficiency, weld seams of different focal diameters and power levels by utilization of the laser beam oscillation were analyzed by the means of multiple cross sections such as illustrated in Figure 2. In comparison, specimens were welded with conventional laser beam welding at the same power levels. At welding with beam oscillation without adapted laser power modulation, the inertia of the scanning mirror affects the line energy along the lateral expansion. By doing so, the cross sectional shape in Figure 2 is affected from high deposited laser power on the edges of the seam and a rather small line energy at the centerline. For the focal diameter of 200 μm, the weld seam area is characterized by a molar-like structure. Compared to conventional welding, the weld caused by beam oscillation is less deep but much wider than conventional weld seams, which are characterized by a deep and slender formation as seen in Figure 2.

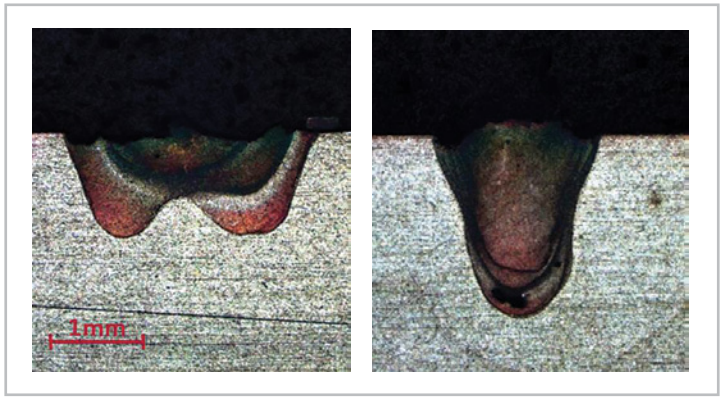

Figure 2. Cross sections of conventional laser beam welding (left) and welding with beam oscillation (right)

It is established to illustrate the weld seam area as a function of the line energy. The size of the weld seam area is linear depending on the line energy. Thereby, the specific molten volume is characterized by the derivation of the linear increase, which is represented by the slope of a balanced line passing through the origin and the maximum performance concerning the weld seam area and line energy. Subsequently, Figure 3 quantifies this behavior for welding with beam oscillation and conventional laser beam welding for a focal diameter of 200 μm.

The graphs in Figure 3 depict a trend to steeper balanced lines correlating with higher laser power. As a result of higher laser power, the penetration depth increases, which leads to higher aspect ratios. Consequently, the deposition of laser radiation enhances because of multiple reflections of the laser beam in a deeper capillary. Therefore, the process efficiency increases, correlating with higher laser power. For conventional laser beam welding, the specific molten volume results in 110 mm^3/kJ. Yet, welding by the means of beam oscillation results in a significantly higher specific molten volume of

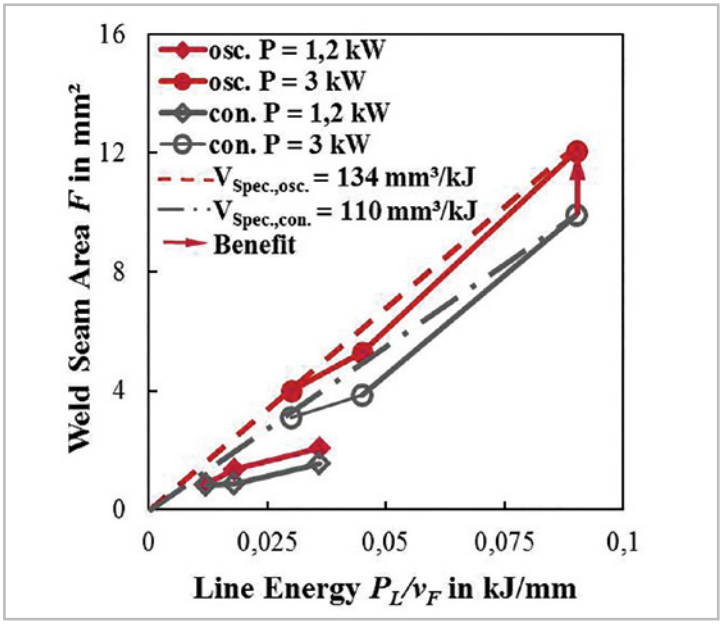

Figure 3. Weld seam area as a function of the line energy (PL = constant) for conventional laser beam welding and laser beam welding by means of beam oscillation with a focal diameter of df = 200 μm. The specific molten volume is characterized by the slope of the dashed lines.

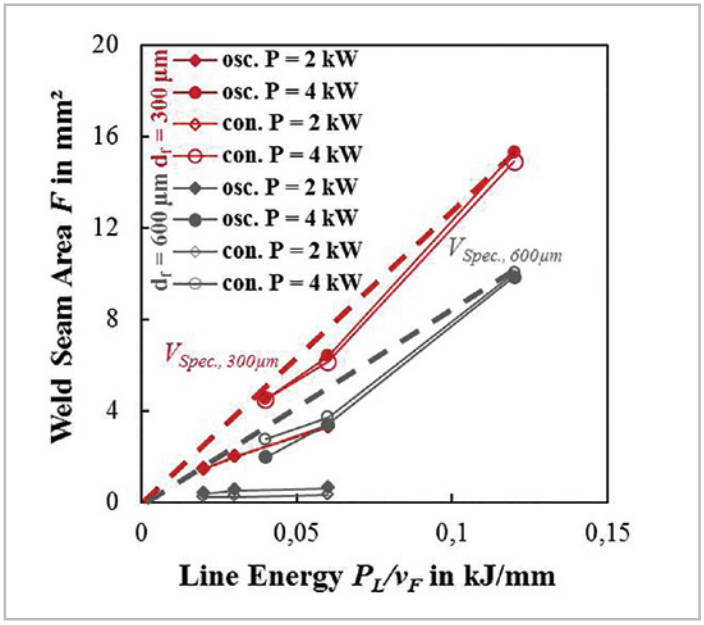

Figure 5. Weld seam area as a function of the line energy (PL = constant) for conventional laser beam welding and laser beam welding by means of beam oscillation with a focal diameter of df = 300 μm and df = 600 μm. The specific molten volume is characterized by the slope of the dashed lines.

134 mm³/kJ. For visualization, the major increase of beam oscillation is highlighted by a red arrow. Additionally, the graphs illustrate that high feed rates (implied in small line energy at constant laser power) approximate to the maximum slope.

Figure 4 indicates the impact of the feed rate on the approximation to the process efficiency. First, the graph demonstrates a rather fast approximation to the saturation of the specific molten volume for a feed rate of 6 m/min compared to 2 m/min. Consequently, high feed rates lead to high process efficiencies due to less thermal losses. Thereby, the amount of the specific molten volume remains constant after reaching the process specific saturation, which is derived by the slope of the dashed balance lines in Figure 3. Second, Figure 4 indicates the trend of the specific molten volume for laser beam welding with beam oscillation in relation to the

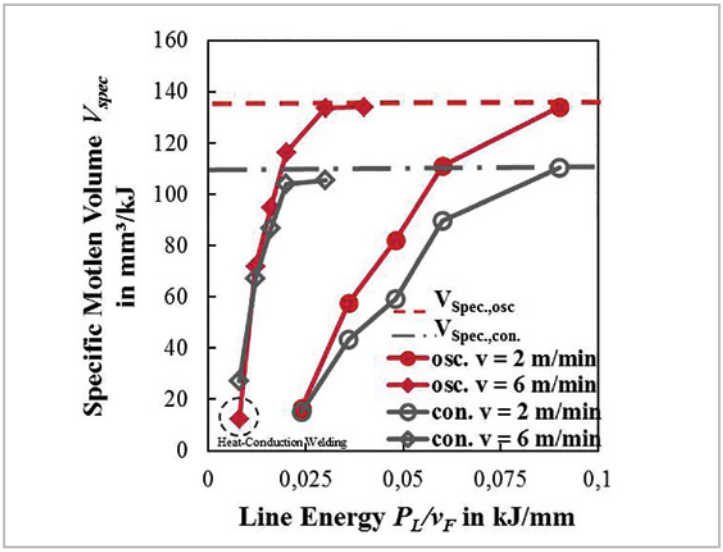

Figure 4. Specific molten volume as a function of the line energy (PL = constant) for conventional laser beam welding and laser beam welding by means of beam oscillation with a focal diameter of df = 200 μm. The specific molten volume is characterized by the slope of the dashed lines.

equivalent feed rates and parameters of conventional laser beam welding. In a stable parameter regime close to the saturation level, material processing by the means of beam oscillation led to a benefit of 21%.

However, for a focal diameter of 300 μm, the maximum slopes are concurrent and result in nearly 110 mm³/kJ for both process designs. Accordingly to Figure 3, this matches up to the specific molten volume of conventional laser beam welding with a focal diameter of 200 μm. In conclusion, there is no benefit for laser beam welding by the means of laser beam oscillation for a focal diameter of 300 μm regarding the process efficiency illustrated by Figure 5. Likewise, the focal diameter of 600 μm promotes a coherent slope for both process designs as seen in Figure 5. The application of laser beam oscillation is neither beneficial in this parameter range. Yet, for a focal diameter of 600 μm, it has to be considered that the specific molten volume results in about 82 mm³/kJ, which is 74% of the specific molten volume obtained by welding with focal diameters of 200 μm and 300 μm at conventional laser beam welding. Therefore, it has to be noted that in the case of welding with a focal diameter of 600 μm, material processing is inefficient for both process designs but limited by the experimental set up. A further increase of the laser power allows an additional increase of the feed rate, which together result in a larger weld seam area and furthermore in a higher specific molten volume.

By using a focal diameter of 200 μm, the pre-heated material is easily vaporized due to high-power densities in the focal spot. Accordingly, low laser power is necessary to generate comparably large molten pools by the means of laser beam oscillation. In particular, the chosen parameter set enhances the process efficiency and illustrates high potential of beam oscillation techniques. ■

Martin Sommer is a graduate from the University of Stuttgart's School of Excellence in Advanced Manufacturing & Engineering.

LIA Prepares to Celebrate 50th Anniversary

LIA Introduces New Brand

BY LINDSAY WEAVER BURT

In 2018, Laser Institute of America (LIA) will commemorate its 50th year as a professional society dedicated to fostering lasers, laser safety and applications. In 1968, the company was founded by a passionate group of academics consisting of scientists, developers, and engineers who desired to turn the emerging laser world into a valuable and practical industry.

LIA has always believed in the importance of developing a culture of innovation, ingenuity, and inspiration within the laser industry. As a professional society, it serves industrial, educational, medical, research, and governmental communities internationally.

"We are very excited to launch into LIA's 50th anniversary," said Nat Quick, LIA's executive director. "We want to celebrate this significant milestone and take the opportunity to reintroduce LIA as the face of laser safety and applications."

In its anniversary year, LIA will update its brand with a new logo and new look for its print and electronic newsletters. Additionally, the association is introducing exclusive LIA gear with the release of its 50th anniversary pins and shirts.

LIA TODAY, its bi-monthly, full-color print magazine that publishes articles on the latest industry news, will be revamped. Readers can expect a new look for both the print magazine and LIA's monthly eNewsletter. The new overall appearance will be modernized and consistent with the look and feel of LIA's newly launched website.

"Our team is looking forward to refreshing the LIA brand," said Jim Naugle, LIA's marketing director. "Additionally, we have a number of events planned commemorating advances in laser technology, our history, and our valued LIA members."

LIA has scheduled four conferences/exhibits in 2018 — LAM, LME, Industrial Laser Conference, and ICALEO. Special events will take place at each of the conferences/exhibits. Details will be announced on event pages and upcoming issues of *LIA TODAY*.

With so much to look forward to in the coming year, the company as a whole is grateful to the laser community for its consistent support and contribution. To learn more about LIA and its upcoming celebrations, visit **www.lia.org/50years**.

As the LIA team reflects on the last five decades, they will develop a timeline marking significant industry-related benchmarks. Once established, this timeline will be available digitally and at conferences throughout the year. You are encouraged to contribute notable events and achievements. For submission details, visit **www.lia.org/50years/timeline**. ■

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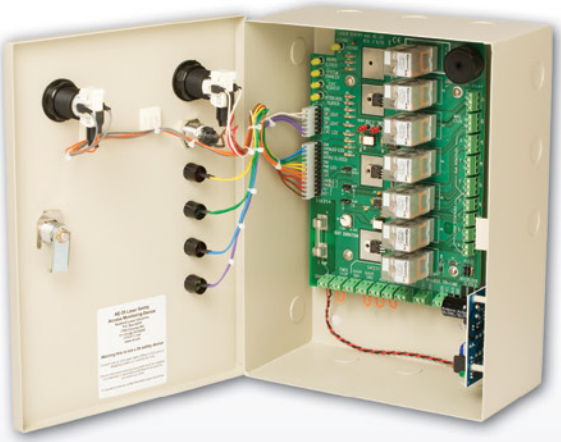

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ICALEO 2017

Accepting the Challenge

ICALEO®
36th INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

BY JIM NAUGLE

Held in the Sheraton® Atlanta Hotel, the 36th International Congress on Applications of Lasers and Electro-Optics (ICALEO®) once again brought together many of the best and brightest of laser and optics professionals to network. Scientists and scholars reviewed the state-of-the-art in laser materials processing and predicted where the future will lead. With activities spanning five days, including the pre-conference Welcome Celebration held poolside at the Sheraton Hotel, ICALEO 2017 provided a platform for the current issues at the forefront of laser materials processing.

Attendance

ICALEO 2017 included over 350 participants representing approximately 19 countries. Attendees filled rooms for over 180 presentations including scientific papers, poster presentations and panel discussions. Of course, none of this would have taken place without our 38 sponsors and vendors lending their support.

Plenary Session

The ICALEO 2017 Plenary Session, "Light at Work: Laser Applications Beyond Imagination," was presented to a full complement of attendees, many of whom were attending ICALEO for the first time. The plenary session began with a keynote presentation by Dr. Mark Schnitzer, an associate professor at Stanford University, and investigator at the Howard Hughes Medical Institute. He spoke about his work in neural circuit dynamics and optical imaging. Schnitzer described how lasers are pushing the field of brain imaging forward, and his presentation included fascinating videos of his optical trials with mice.

The Plenary Session pushed the limits regarding traditional views of laser applications and provided attendees with information on other medical and climate laser advances.

Dr. Henry Kapteyn, from the University of Colorado's Department of Physics, discussed how he builds tabletop x-ray laser light sources, which help develop corresponding applications.

"X-rays emerge as very short bursts of light that can capture the fastest processes in our physical world, including imaging the motions of electrons," Kapteyn said. "The same revolution that happened for visible light sources that made it possible to create laser-like beams of light for widespread use instead of multidirectional light from a light bulb, is now happening for X-rays."

Jeff Deems, a researcher at the National Snow and Ice Data Center in Boulder, Colorado, where he also serves as the liaison for the NASA Airborne Snow Observatory, spoke about his work with laser mapping snow packs and developing lidar applications for avalanche forecasting and climate applications.

"My research included snow depth data that was collected using a terrestrial laser scanner during 11 periods of snow accumulation and melting over three snow seasons on a Pyrenean hillslope," Deems said. "These hillslopes were characterized by large elevational gradient, steep slopes, and frequent avalanche occurrences."

The results indicated that in most cases there was temporal consistency in the spatial distribution of the snowpack, even in different years. The results also highlighted that elevation and the Topographic Position index (TPI) were the main variables explaining the snow distribution, especially during periods dominated by melting. Lastly, the intra- and inter-annual spatial consistency of the snowpack distribution suggests that the geomorphological processes linked to presence/absence of snow cover act in a similar way in the long term, and that these spatial patterns can be easily identified through several years of adequate monitoring.

(left to right) LIA President-Elect, Milan Brandt, LIA President Paul Denney, LIA Secretary Minlin Zhong and LIA Past-President Lin Li

Laser Materials Processing Conference
Co-chaired by Klaus Kleine from Coherent Inc and Friedhelm Dorsch from TRUMPF Laser-und Systemtechnik GmbH, the staple conference at this event did not disappoint. There were so many exciting papers presented that it is hard to choose just one example - but Fabian Teichmann's peer reviewed presentation, "Investigations of Dual Laser Beam Welding of Aluminum High Pressure Die Casting at Reduced Ambient Pressure," reemphasized how laser beam welding under vacuum conditions has several distinct advantages, such as the increase of penetration depth, the enhanced degasification, and the overall calming effect on the melt pool when welding ferrous metals. Teichmann pointed out that while using this technique with welding speeds between 2 and 6 m/min, the overall weld bead porosity can be reduced and mechanical strength can be improved when welding under both atmospheric and vacuum conditions using a certain dual beam configuration. Furthermore, it is reported that specific dual beam configurations can influence the occurrence of porosity when ambient pressure and welding speed are kept constant.

Other notable presentations included: "Evaluation of 3D-Printed Parts by Means of High-Performance Computer Tomography" by Elena López and "Experimental Analysis on Melting and Solidification Process of Titanium with Synchrotron X-Ray for Development of Sputter-Less SLM" by Yuji Sato.

Laser Microprocessing Conference
This year's conference focused on hot topics in the areas of micro-welding, micromachining and ultrafast processing. However, with the growing market of health-related lasers, we find new and innovative processes to expand the reach of laser microprocessing beyond biomedical applications. Co-chairs Michelle Stock, from mlstock consulting and Cather Simpson, from the University of Auckland, organized a high-level technical track that stimulated the audience and focused on these growing applications.

"This year's conference highlighted the use of short- and ultrashort- pulsed lasers as they expand the horizons of laser material processing at the micro-level in commercial and biological applications", said Stock. "The LMF conference is an integral part of the ICALEO experience."

This was emphasized in Jyi Sheuan Ten's presentation, "Femtosecond Laser-induced Chemical Vapor Deposition of Tungsten Quasi-Periodic Structures on Silicon Substrates". Sheuan Ten described using a femtosecond laser for a rapid, mask-less deposition technique which can be used for a range of applications, one example being writing conductive tracks for the construction of micro-electronic devices. Sheuan Ten went on to say that this technique can be used for direct deposition of tungsten tracks on silicon substrates from metal organic tungsten hexacarbonyl precursors.

Other notable talks included "Combination of Short and Ultrashort Pulse Laser Processing for Productive Large Scale Structuring of 3D Plastic Mould Steel", by Andreas Brenner and "Femtosecond Laser Structuring of Graphite Anodes for Improved Lithium-ion Batteries" by Jan Habedank.

Nanomanufacturing Conference
The Nanomanufacturing Conference presented papers relevant to laser technologies highlighting research in emerging technologies in 3-D micro/nanofabrication, as well as laser synthesis and diagnostics of nanomaterial.

"The Nanomanufacturing conference created a forum where fundamental science and industrial applications met to address nanoscale processing needs in near future," said Conference Chair Yongfeng Lu from the University of Nebraska—Lincoln. "This year, the conference featured a few special application topics on photovoltaics, battery materials, advanced energy devices, spectroscopy, and imaging."

Koji Sugioka and Daniela Serien's presentation, "Femtosecond Laser 3D Printing of Proteinaceous Micro and Nanostructures" revealed that focusing the femtosecond laser beam inside transparent materials confines the nonlinear interaction within the focal volume, which enables three-dimensional (3D) micro- and nanofabrication. This allows the construction of 3D micro and nanostructures of proteins by multiphoton cross-linking along the exposure pathway of the focused laser beam. Koji and Daniela went on to say that our ship-in-a-bottle integration technique was applied to integrate 3D proteinaceous micro and nanostructures inside 3D glass microfluidic chips.

Other presentations of note were "Laser-Based Synthesis, Processing, and Diagnostics of 2D Materials and Heterostructures," by Masoud Mahjouri-Samani and "Laser Forward Transfer of Nano-Inks and Nano-Pastes," by Alberto Pique.

Business Forum & Panel Discussion
Dave Belforte, the editor of *Industrial Laser Solutions*, anchored an excellent business review session titled "The Global Laser Market and Its Future Development." Co-chaired by Dr. Bo Gu, BOS Photonics and Klaus Loeffler, TRUMPF GmbH, this exciting half-day event provided valuable insight from a business standpoint regarding the global uses of lasers and where key applications are being developed. Mr. Belforte announced, "Fiber lasers are now 40% of the industrial laser market, a significant percentage that certainly drives laser applications." Interestingly, laser annealing face plates for the iPhone is the driving application in the laser market which stresses the importance of consumer product applications to the industry.

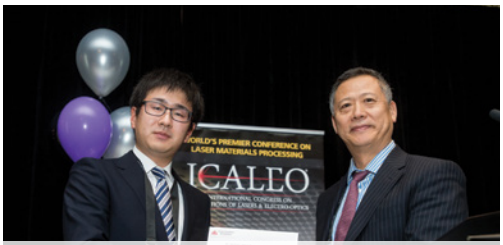
(LEFT TO RIGHT) LIA PRESIDENT PAUL DENNEY, LEADERSHIP AWARD WINNER PROF. DR. REINHART POPRAWE, LIA PAST PRESIDENT LIN LI AND LIA'S EXECUTIVE DIRECTOR NAT QUICK

LIA PRESIDENT PAUL DENNEY WELCOMES THE ICALEO AUDIENCE

PROF. DR. REINHART POPRAWE ACCEPTING THE PETER M. BAKER LEADERSHIP AWARD

LIA'S EXECUTIVE DIRECTOR NAT QUICK WITH STUDENT PAPER AWARD WINNER EDUARDO CASTILLO-OROZCO AND HIS MENTOR DR. ARAVINDA KAR

JEFFREY DEEMS SPEAKS ABOUT HIS WORK WITH LASER MAPPING OF SNOW PACKS



POSTER AWARD WINNER MASANORI SENGOKU FROM JAPAN OSAKA UNIVERSITY IS GIVEN HIS PRIZE BY PAST-PRESIDENT LIN LI

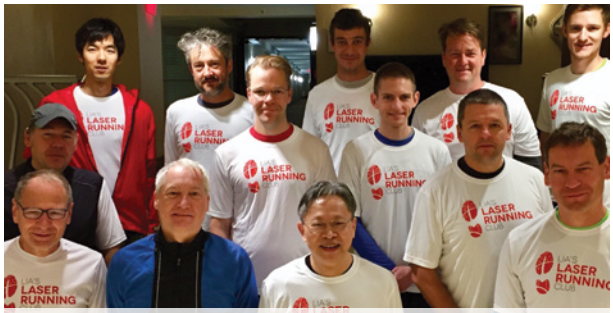
JACK GABZDYL OF SPI LASERS ACCEPTS HIS FELLOWSHIP PLAQUE

LIA PRESIDENT PAUL DENNEY WITH CONGRESS GENERAL CHAIR CHRISTOPH LEYENS

ICALEO CONGRESS GENERAL CHAIR CHRISTOPH LEYENS SPEAKS TO THE AUDIENCE

PLENARY SPEAKER, DR. MARK SCHNITZER, AN ASSOCIATE PROFESSOR AT STANFORD UNIVERSITY, SPOKE ABOUT HIS WORK IN NEURAL CIRCUIT DYNAMICS AND OPTICAL IMAGING

CONGRESS GENERAL CHAIR CHRISTOPH LEYENS AND MICROPROCESSING CO-CHAIR MICHELLE STOCK

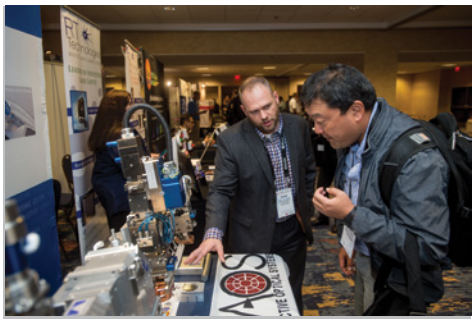
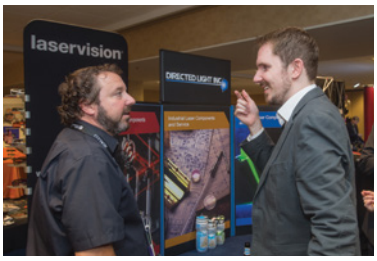


LIA'S LASER RUNNING CLUB, STARTED IN 2013 BY PAST PRESIDENT KLAUS LOEFFLER



ICALEO 2017

Hosted many social events that provided a platform for global networking








Gu provided the audience with a realistic view of the market, stating that "China installed more than 60,000 laser systems last year." He then remarked that this could be an opportunity for the non-Chinese laser businesses, but not for long.

Other topics discussed were: Business Model of an Applied Not-for-Profit Research Center, Laser Market in Japan, and a round-table discussion that completed the forum.

Arthur L. Schawlow Award
This year's Arthur L. Schawlow Award, named after 1981 Nobel Prize Laureate Arthur L. Schawlow and founding father of LIA, was bestowed upon Dr. Paul Seiler. At the ceremony, which Seiler was unable to attend, Ruediger Brockmann from TRUMPF GmbH in Germany stepped in to present his work recognizing Seiler as the father of industrial solid state lasers in Germany and accrediting him with having a significant impact on the growth of users including Philips, Osram.

"Paul combined his mechanics and engineering expertise with his passion for lasers to pioneer laser systems for diamond die drilling, fine welding of watch flat spiral springs, welding cathode components for television and invention of the laser light cable," Brockmann said.

Now called fiber optics, Seiler initiated and drove rapid expansion of solid state lasers into high volume manufacturing applications. Dr. Seiler joins the world-renowned list of recipients including Arthur Schawlow, Arthur Guenther and Theodor Hänsch.

About Dr. Paul Seiler
Dr. Paul Seiler is a recognized pioneer in laser technology for industrial use. He studied precision mechanics at the University of Applied Sciences in Karlsruhe, Germany. From 1992 until 2003, Dr. Seiler was the managing director of TRUMPF Laser GmbH & Co. KG in Schramberg. In 2008, he received an honorary doctorate from the University of Stuttgart.

Peter M. Baker Leadership Award
New to the awards program was the Peter M. Baker Leadership Award which was established last year. The award is given annually to an individual who has demonstrated outstanding leadership in an organization or a company that has significantly benefited the world laser community or has led to major global impacts in the advancement of laser science, technology, engineering or applications.

This year's recipient Prof. Dr. Reinhart Poprawe, Director of the Fraunhofer Institute in Aachen, Germany was recognized for his outstanding leadership in the international laser community.

"There is no question that Professor Poprawe richly deserves this award. In our world of lasers, he is a leader on the grand scale, technical, organizational, political and social," Baker said. "He is a fine gentleman, courteous, thoughtful, generous and funny. I consider it an honor to be his friend."

LIA newly elected Executive Director Nat Quick with 2017 Peter M. Baker Leadership Award Winner Prof. Dr. Reinhart Poprawe

Clearly, Prof. Dr. Reinhart Poprawe was surprised with being chosen to receive this prestigious award. In his remarks at the ceremony, he described the opportunities and challenges of leadership in the 21st century for all organizations.

"There are so many ingredients for a successful organization," Poprawe said. "Vision; mission; research and product portfolios; roadmaps; SWOT-analysis; and education of the employees. Industry or even better societal use and implementation of our research results is what we do everything for, especially the development of the demanding competencies in the very fundamentals of Laser Technology and application Physics. The award is from one of the most important laser communities in the world. It is a great honor to receive this award as the first recipient after the original, Mr. Peter Baker himself."

Laser Industry Vendor Reception
This year's Vendor Reception showcased many products and services offered by the many sponsors and vendors. Dozens of tables were covered with everything from lasers and various facilitating tools to information about services, societies and research facilities. Filling the entire ballroom, the reception put vendors and end users together to share product ideas and uses for some of the new cutting-edge laser tools and services available. The relaxed yet inviting setting created an atmosphere in which attendees and vendors alike could network and form relationships for future projects and alliances. ICALEO would not be possible without the vendors who participate and our generous Sponsors. This year's Sponsors included IPG Photonics, TRUMPF Inc. Edgewave GmbH Innovative, Laserline, Inc., Light Conversion, Lumentum, Spectra-Physics, an MKS Brand, and SPI Lasers.

Closing Plenary Session
The 2017 Closing Plenary Session was a joint session which focused on how lasers drive innovations from nano- to macro applications, and covered a broad span of laser applications and techniques. The first presentation, an invited paper by Wayne King of Lawrence Livermore National Laboratory, "Achieving 'Just Press Print' for Metal Additive Manufacturing", kicked

off this closing session. Wayne presented the challenge of replacing the experience-based approach presently used to produce parts with a science-based, automated approach that can be implemented on the factory floor.

"The need for development of sufficiently accurate, rapid, reduced-order predictive models will be the key to wide application of the intelligent feed forward concept." said King. "That is a new challenge that will have to be met. In ten years' time, we believe that every metal additive manufacturing machine will have model-based intelligent feed forward capability, which will enable engineers and technicians to 'just press print' for metal additive manufacturing."

The intelligent feed-forward approach, when successfully implemented, will ensure right every time production or early automated rejection, thus buying down risk. The approach is meant to be agnostic to feedstock, machine, and geometry.

Prof. Minlin Zhong from Tsinghua University in Beijing presented the second presentation, "Diverse Nanostructures and Magic Nano-Functions Induced by Ultrafast Laser." Zhong spoke about the importance of graphene for electronic applications and how the laser must be used for patterning in this industry. He also noted that China provided funding for a five-year national project to develop ultrafast laser-based 2D manipulation technology for thinning the graphene with precise layer control for arbitrary patterning. This technique provides strong fabrication capability for graphene devices. He went on to discuss new types of graphene sensing that require high sensitivity which includes gas, liquid acoustic, touch, skin, strain and electromechanical sensors. According to Zhong, this can only be done with lasers.

The session closed with the presentation, "Accelerating the Additive Manufacturing Revolution" by Florian Bechmann of Concept Laser GmbH.

Student Paper Awards

LIA would like to extend congratulations to the ICALEO Student Paper Award Winners who receive a cash award, a certificate of achievement, and whose manuscripts will enter the Peer Review Process for publication in the LIA's *Journal of Laser Applications*®.

Poster Presentation Contest Winners

The Poster Presentation Gallery was another example of the variety of laser research prevalent today. The ICALEO 2017 Poster Presentation Contest winners are listed below.

Conclusion

ICALEO was the pinnacle laser conference for 2017; it was also a looking glass to the future of laser manufacturing and processing. The attendees were treated to some of the best Atlanta has to offer while pursuing their passion for lasers and optics. The papers presented and the insights, innovations and breakthroughs explored during the event show how the efficient and eco-friendly use of lasers is at the forefront of global technology. By staying at the forefront of the laser and electro-optics research and business activities worldwide, the Laser Institute of America and ICALEO are yet again leading the way by example. Join us next year as we celebrate 50 years of advancing laser technology! Happy birthday, LIA! ■

Jim Naugle is the Marketing Director at the Laser Institute of America.

ICALEO 2017

ICALEO® 36th INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

STUDENT PAPER AWARD WINNERS

1ST PLACE

Laser-matter Interactions in Laser Beam Melting of High Performance Oxide Ceramics
Liliana Moniz; Mines ParisTech, Evry, France

2ND PLACE

Comparative Study between CW and PW Emissions in Selective Laser Melting
Leonardo Caprio; Politecnico di Milano, Milano, Italy

3RD PLACE

Femtosecond Laser Structuring of Graphite Anodes for Improved Lithium-ion Batteries
Jan Habedank; Munich University of Technology, Garching, Germany

POSTER WINNERS

1ST PLACE

Superlens Focused Laser Electrospray Microprocessing of Nanoparticles
Eduardo Castillo-Orozco; University of Central Florida, Orlando, Florida

2ND PLACE

Study on Laser Multi-Focus Separation Technology for Thick KDP
Peng Liu, Wuhan; University of Science and Technology, Huazhong, China

3RD PLACE

Experimental Investigation on Temperature Distribution of Molten Pool for Copper with Blue Direct Diode Laser Cladding
Masanori Sengoku; Osaka University, Osaka, Japan

WELCOME NEW FELLOWS

Jack Gabzdyl, SPI Lasers

Rajesh Patel, Spectra-Physics

Koji Sugioka, RIKEN

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Image courtesy of Fraunhofer USA CLA / IWS

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Laser Institute of America
Laser Applications and Safety

IPG Photonics

As a leader and pioneer in developing and commercializing fiber lasers, IPG Photonics' diverse lines of low, medium, and high-power lasers and amplifiers are displacing traditional technologies in many current applications. Their lasers and amplifiers reach into numerous markets, including materials processing, communications, entertainment, medicine, and biotechnology.

Founded in Russia in 1991 by physicist Valentin P. Gapontsev, Ph.D., IPG originally produced and sold customized glass and crystal lasers, laser components, and wireless temperature meters for hyperthermia. In 1992, the company began to focus on the development of high-power fiber lasers and amplifiers.

IPG landed its first major contract with Itatel, a telecommunications carrier. The company then won a second major contract with DaimlerBenz Aerospace. In 1994, IPG opened a facility in Germany and established its world headquarters in the U.S. in 1998. In 2000, the company invested in new high-capacity production facilities in the U.S. to manufacture its own diode pumps—a major component of its fiber lasers and amplifiers. The company went public in 2006 and is listed on the NASDAQ Global Select Market as IPGP.

With more than 4,000 employees today, IPG has local sales and service in more than 20 countries worldwide. Its three major manufacturing sites are currently located in the U.S., Germany, and Russia.

IPG's vertically integrated development and manufacturing abilities allow the company to meet customer requirements, accelerate development, manage costs, and improve yields. The company is able to produce all critical components for its lasers and amplifiers, which it markets to OEMs, system integrators, and end users.

Being the first company to industrialize fiber laser technology, IPG has the broadest array of laser products in the industry. This includes high-power fiber lasers up to 100 kW for materials processing, pulsed fiber lasers for marking and engraving, and fiber lasers covering UV, visible, and mid-IR wavelengths.

Having displaced the traditional CO_2 and diode-pumped solid-state technologies as the preferred laser tool for industrial material processing, IPG's high-power CW fiber laser product line is arguably the most important offered by the company. These lasers are used in the cutting, welding, and drilling of metals within various industries ranging from automotive to aerospace to general manufacturing. Much of this product line's success can be attributed to IPG's in-house diode fabrication facility, which accounts for cost reductions.

In the next five years, IPG is looking toward the introduction of cost-effective, high-performance, reliable ultra-fast fiber lasers with a pulse duration in the 100 fsec to 10 psec range. With a higher efficiency, this laser advancement will enable smaller air-cooled packages. The company is also looking toward the expansion of fiber laser technology into the MID-IR wavelengths.

The improved reliability and increased efficiency of high-fiber power lasers as an accepted mainstream industrial tool has led to an increase in laser adoption in the automotive industry, a trend that is expected to continue with the push to adopt lightweight materials and electric or battery-driven cars. IPG has monitored these shifts in the industry and will continue to be a leading developer in this area.

IPG Photonics has been a member of LIA since 2002. For more information about the company and its products, visit **www.ipgphotonics.com**. ■

Written by Lindsay Weaver Burt in collaboration with IPG Photonics.

WELCOME NEW CORPORATE MEMBERS

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For a complete list of corporate members,
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Member Innovations

Air Cleaning Solutions at productronica 2017 — including easily inflammable Air Mixtures
At productronica in Munich/Germany, ULT AG demonstrated its unique state as a full-range supplier of extraction and filtration technologies for air purification within electronics manufacturing.

In November 2017, the company presented solutions for the efficient and economic removal of airborne pollutants, such as laser fume, soldering fume, gases, vapors, dusts, and odors. One focal point of ULT's trade show appearance was the capture and filtration of easily inflammable or explosive dusts and air mixtures, which may occur during surface processing of hard-to-handle elements, e.g. titanium. The particularly developed safe economic fume extraction and filtration method is based on special filtration and capturing concepts.

Additionally, ULT introduced the next development stage of its new device control. It allows for system remote control by means of LAN or WLAN via a webserver. Furthermore, users can read out specific device information, e.g. filter saturation state, performance figures, or the next maintenance date.

Utilizing extraction and filtration systems in electronics manufacturing is a statutory requirement. Companies should also be aware that employees, production equipment, and products must be protected from the impact of hazardous emissions. They are generated during the utilization of laser machines, soldering technology or throughout gluing and welding processes. ULT provides one of the most comprehensive range of turnkey and customized solutions — in particular for hard-to-purify fine dusts and particulates.

For more information, visit **www.ult.de**.

LPW Technology features new AM metal powder manufacture capabilities at formnext
LPW Technology is taking AM metal powder manufacture to a new level at its new factory. Formnext 2017 sees it unveiling its new ranges of clean powders manufactured exclusively for AM at its purpose-built "factory of the future" near Liverpool, UK.

LPW's new £20 million state-of-the-art facility will house atomisers capable of making small-to-medium volumes of very clean powders, primarily custom titanium, nickel, cobalt, aluminum, and steel alloys. The powder manufacturing facility has been designed to control contamination at every step of the process, with segregation of cells for specific material production. The powder manufacturing facility will be operated under cleanroom conditions with contamination controlled to a degree never before seen in the manufacture of AM metal powders.

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

Members In Motion

Montello Made Operations Manager at Prima Power Laserdyne
Industrial laser system manufacturer Prima Power Laserdyne LLC has promoted Aaron Montello to the position of operations manager.

Montello will be responsible for production, manufacturing engineering, project management, purchasing, inventory control and facilities.

"Aaron Montello has served as interim operations manager for the last four months and done very well in this challenging position," said Terry VanderWert, president of Prima Power Laserdyne. "He has earned this promotion, fulfilling our practice of promoting from within our organization whenever possible."

Montello began his time with Prima Power Laserdyne five years ago as a project engineer. Within three years, he was promoted to product manager. During his tenure, he was responsible for several important development projects including the company's next-generation Optical Focus Control and patent-pending SmartShield laser welding nozzle assembly, of which he is the inventor.

Montello holds Ph.D. and master's degrees in mechanical engineering from Ohio State University and a bachelor's degree in applied physics from Bethel University.

Prima Power Laserdyne is a developer of precision, 3D laser cutting, welding and drilling systems.

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

With more growth in the works, LaserStar celebrates 60 years of an evolving, dynamic business
LaserStar Technologies is celebrating 60 years of business in the perfect way: the leading manufacturer of jewelry laser systems is doubling the size of its facility in Orlando, FL, putting its Southern operations on par with its flagship facility in Providence, Rhode Island.

"One of the things we're most excited about is breaking ground in Orlando to build the new production facility next to our existing facility," says James Gervais, President and COO. "Our corporate goal is to establish the capacity to produce 1,000 lasers a year. We're excited that we should be breaking ground in the next 75 days."

The current Florida facility houses all aspects of manufacturing, engineering, production, service and support. "We've just maximized the space," Gervais says. "The products built there are in high demand. So we're building a new production facility next door. When completed this will provide us a facility that is approximately equal in total square footage to our Rhode Island facility, which is about 25,000 square feet."

For more information, visit **www.laserstar.net**.

As mentioned in the last issue of the *LIA TODAY*, balloting on ASC Z136 membership petitions received since the committee's annual meeting closed on Friday, October 27, 2017. All requests were approved, with the results of each as follows.

Subsequent to the International Laser Safety Conference (March 2017), the University of New South Wales Canberra accepted an invitation to join, of which ASC Z136 members consequently voted to approve, UNSW Canberra as an organizational ASC Z136 member. Trevor Wheatley, Chief LSO at UNSW, a longtime contributor to international laser safety standardization (IEC TC76, Standards Australia SF019), as well as chair and presenter at numerous conferences (ILSC, OSA, CLEO/QELS) has been named as its primary representative; Andrew Lambert, associate professor at UNSW School of Engineering and IT was named as alternate.

The Association of Surgical Technologists (AST) and the Food and Drug Administration, Center for Devices and Radiological Health (FDA/CDRH), each sought affirmation of appointments for alternate representation to the committee. Wanda Folsom (AST) and William Vogt (FDA/CDRH) were both unanimously approved.

A prominent figure in the laser safety community, as well as a past LIA president (1993), Robert Handren was nominated by fellow ASC Z136 members to emeritus member status. Bestowed upon those with long and distinguished service in support of ASC Z136 standards, emeritus member status includes lifetime membership in ASC Z136, recognition in the front matter of ASC Z136 standards, and all privileges as an ASC Z136 member with the exception of voting on committee matters and standards.

The final vote was removal of the American Dental Association as an organizational member of the committee. Sadly, members had little choice as ADA asked to be removed, having elected not to participate in Z136 standards development at the present time[1].

To apply for membership on ASC Z136, please contact Barbara Sams at bsams@lia.org or visit the committee website at www.z136.org.

Save the Date — The annual meeting of ASC Z136 is scheduled to take place in San Antonio, TX, on Sunday, March 4, 2018. Meeting details will be published in the next issue of the *LIA TODAY*.

Ancillary meeting space will be available on both Saturday, March 3, and Monday, March 5. Subcommittee chairs please contact Barbara to arrange meeting space, which will allocated on a first-come, first-served basis.

[1]Note that reinstatement is available to any former member who wishes to reapply.

Annual Reminder
When a laser safety professional chooses to become certified, the individual agrees to adhere to the BLS Code of Professional Conduct. One component of this code is to "*Strive to increase or improve [their] self-development, competence, professional knowledge and skills in the area of laser safety.*"

To demonstrate completion of sufficient professional development activities to ensure continued competency, CLSOs and CMLSOs are required to renew their certification triennially. This three-year cycle begins on January 1st of the year following the year in which the exam is passed and ends on December 31st of the third year. During the three-year period, the individual must obtain at least 10 certification maintenance (CM) points to renew certification.

For those who have achieved certification and are nearing the end of their certification maintenance cycle, now is the time to submit CM worksheets for renewal.

Certification Maintenance Categories
There are 10 categories from which to accrue CM points. Some are easily attainable, e.g., laser safety experience, one point per year of professional practice in the field of laser safety. Some take a conscious effort, e.g., publication of laser safety or application related articles. The following point opportunities may be overlooked:

- Attendance and successful completion of laser safety specific education/training — *this includes in-service trainings*
- Membership in a laser safety or application related professional/technical organization or society — *including but not limited to LIA, AIHA, ASLMS, AORN, ASSE, HPS*
- Attendance at laser safety or application related professional conferences or meetings — *points are determined based on length of related sessions attended*
- Related professional certifications — *e.g., CHP, CSP, CIH*
- Reviewing laser safety or application journal articles — *download and complete the Journal Article Verification Worksheet*

If unable to achieve the 10 necessary CM points, a CLSO or CMLSO may retake the applicable exam; however, the exam must be taken prior to December 31 (end of cycle) and must be passed to remain active.

For a thorough review of certification maintenance, please visit **www.lasersafety.org**. If you have any questions regarding activities for certification maintenance, please contact the BLS at +**1.407.985.3810** or email **bls@lasersafety.org**.

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**.

OSHA, ISEA Team Up to Distribute Safety Equipment to Protect Hurricane Cleanup, Recovery Workers

Although the hurricanes are over, their impact continues with hazardous and unstable conditions for both residents, and cleanup and recovery workers. OSHA and the International Safety Equipment Association (ISEA) are teaming up to coordinate and distribute much-needed personal protective equipment to hurricane-affected areas in Texas and the Caribbean Basin, including Puerto Rico. "OSHA's goal is to keep workers and volunteers safe while they perform cleanup and recovery operations, and the ISEA is an important partner in these efforts," said Deputy Assistant Secretary of Labor for Occupational Safety and Health Loren Sweatt. Information on specific safety equipment and how to stay safe during storm cleanup and recovery can be found on OSHA's Hurricane Preparedness and Response page.

OSHA Training Institute Celebrates 25th Anniversary of Education Centers

The OSHA Training Institute (OTI) is celebrating the 25th anniversary of its education center program this year. OTI Education Centers have grown from four to 39 non-profit organizations, offering training on OSHA standards, and occupational safety and health issues to workers and employers nationwide. During their 25-year history, the education centers have trained more than 600,000 students in areas of high injury and illness rates. To find the nearest education center, visit the OTI Education Center Locations page.

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

JLA Journal of Laser Applications

Evidence of Nuclear Fusion Neutrons in an Extremely Small Plasma Focus Device Operating at 0.1 Joules

BY LEOPOLDO SOTO, CRISTIÁN PAVÉZ, JOSÉ MORENO, LUIS ALTAMIRANO, LUIS HUERTA, MARIO BARBAGLIA, ALEJANDRO CLAUSSE, AND ROBERTO E. MAYER

We report on D-D fusion neutron emission in a plasma device with an energy input of only 0.1 J, within a range where fusion events have been considered very improbable. The results presented here are the consequence of scaling rules we have derived, thus being the key point to assure the same energy density plasma in smaller devices than in large machines.

The Nanofocus (NF)—our device—was designed and constructed at the P^4 Lab of the Chilean Nuclear Energy Commission. Two sets of independent measurements, with different instrumentation, were made at two laboratories, in Chile and Argentina. The neutron events observed are 20σ greater than the background. The NF plasma is produced from a pulsed electrical discharge using a submillimetric anode, in a deuterium atmosphere, showing empirically that it is, in fact, possible to heat and compress the plasma. The strong evidence presented here stretches the limits beyond what was expected.

A thorough understanding of this could possibly tell us where the theoretical limits actually lie, beyond conjectures. Notwithstanding, a window is thus open for low cost endeavours for basic fusion research. In addition, the development of small, portable, safe nonradioactive neutron sources becomes a feasible issue.

Subscription Information

BY PHONE	For non-members of LIA, call the American Institute of Physics at 1.800.344.6902 for subscription information.
ONLINE	Sign up at **jla.aip.org/alerting_services/table_of_contents_alerts** to receive your *JLA* table of contents email alerts.

SPIE. PHOTONICS WEST

Photonics West

Newly placed Laser Institute of America Executive Director, Nat Quick, will represent LIA for the first time at Photonics West, networking with the best in the industry. Our booth number at Photonics West is 3059, so be sure to visit us at the Moscone Center in San Francisco, California, Jan. 30–Feb. 1. We will offer information on all of our latest products and services including course content, publications and more.

Join thousands of your peers — scientists, engineers, and executives — at the most comprehensive technical conference and exhibition spanning biophotonics for brain research and healthcare, lasers for research and advanced manufacturing, sensors and camera systems, imaging and displays, communications and optoelectronics, plus the core optical components that enable many of today's consumer products.

ICALEO 2017 Proceedings now Available for Purchase

The 36th International Congress on Applications of Lasers and Electro-Optics (ICALEO®) 2017 Congress Proceedings includes all submitted manuscripts from ICALEO (Plenary Sessions, Laser Materials Processing, Laser Micro-processing Nano-manufacturing and Poster Presentations).

ICALEO 2017 Proceedings are available online only. After purchase, you will be emailed your username and password. Please allow 48 hours for access to the proceedings.

Visit **www.lia.org/store** to purchase the ICALEO 2017 Proceedings.

10 YEARS LAM LASER ADDITIVE MANUFACTURING CONFERENCE

LME 2018 LASERS FOR MANUFACTURING EVENT®

Registration is Open for LAM & LME 2018

Registration is officially open for Laser Institute of America's Laser Additive Manufacturing Conference® (LAM®) and Lasers for Manufacturing Event® (LME®), co-located at the Schaumburg Convention Center in Schaumburg, IL, in late March.

Celebrating its 10th consecutive year, LAM features presentations highlighting where and how to apply additive manufacturing concepts, with a distinct focus on laser technology March 27–28.

The two-day event will feature experienced keynotes and offer practical networking opportunities. Attendees will also have full access to the Lasers for Manufacturing Event® (LME®) exhibit — a solutions-focused event for those who seek to add lasers to their manufacturing processes.

LME, hosted March 28–29, is an interactive exhibit, created to increase the awareness and application of lasers in manufacturing. At LME, laser-specific solution providers are available to answer questions and provide demonstrations for those who may be new to laser technology or are looking to source new equipment for their manufacturing needs.

Complimentary educational presentations are offered as part of the exhibit on the show floor. Topics of interest at this year's LME include 3D printing, additive manufacturing, cutting, drilling, marking, and welding.

For more information on LAM and LME, please visit **www.lia.org/conferences**.

Announcing Yongfeng Lu as JLA's New Editor-in-Chief

Dr. Yongfeng Lu, 2014 LIA President and 2016 Arthur L. Schawlow Award winner, will once again work alongside the association as LIA's newest *Journal of Laser Applications (JLA)* Editor-in-Chief.

Prof. Lu graduated from Tsinghua University of Beijing, China, in 1984 with a degree in electrical engineering. He later earned his Ph.D., after study at Osaka University, Japan in 1991. Lu's research expertise lies in laser-based micro/nanoscale materials processing and characterization, which lead him to the development of various laser-based material processing technologies and their implementation in commercial markets. After earning his degrees, Lu spent several years in Singapore, where he served as faculty at the National University of Singapore and was able to establish an active group in laser microprocessing.

Lu has accomplished a lot over the years. In 2002, he established the University of Nebraska-Lincoln's Laser Assisted Nano Engineering group and has led several research projects for the university, funded by NSF, AFOSR, ONR, DTRA, DOE, DOT, NCESR, NRI, private companies and other foundations in Japan.

We would like to thank Prof. Dr. Reinhart Proprawe for his leadership as the editor-in-chief of the JLA over the years and we look forward to having Prof. Lu as the new *JLA* editor-in-chief.

For more information visit **jla.aip.org**.

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