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LIA TODAY

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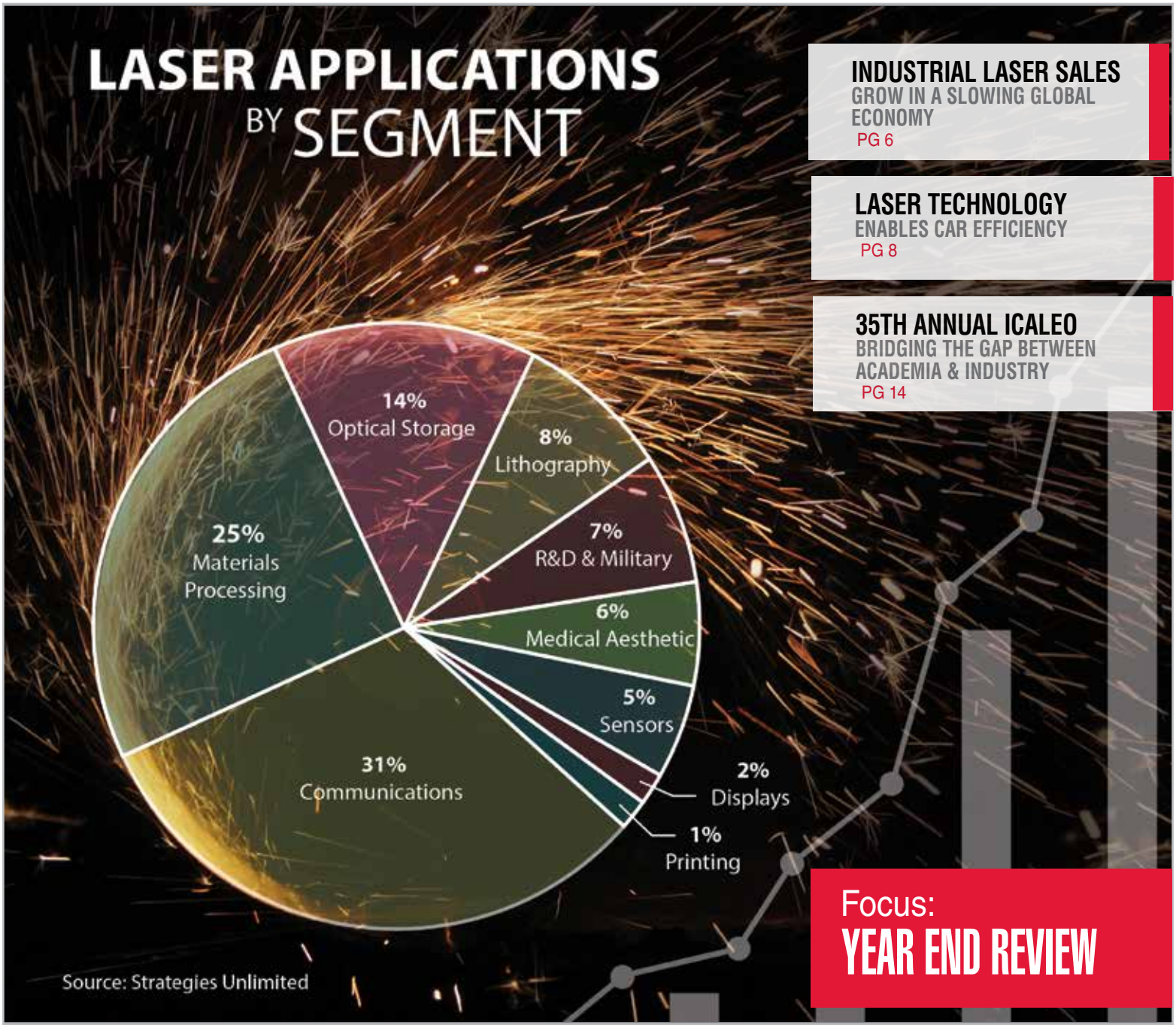

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LIA TODAY

THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

LIA TODAY is published bimonthly to educate and inform laser professionals in laser safety and new trends related to laser technology. LIA members receive a free subscription to *LIA TODAY* and the *Journal of Laser Applications*® in addition to discounts on all LIA products and services.

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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. 28 - Mar. 2, 2017	Las Vegas, NV
Jun. 6-8, 2017	Denver, CO

Laser Safety Officer with Hazard Analysis*

Jan. 30 - Feb. 3, 2017	Orlando, FL
Mar. 6-10, 2017	St. Louis, MO
Jun. 5-9, 2017	Denver, CO

*Certified Laser Safety Officer exam offered after the course.

Industrial Laser Safety Officer Training

Feb. 15-16, 2017	Novi, MI
May 24-25, 2017	Novi, MI
Aug. 16-17, 2017	Novi, MI

Medical Laser Safety Officer Training*

Jan. 28-29, 2017	Orlando, FL
Mar. 4-5, 2017	St. Louis, MO
Jun. 3-4, 2017	Denver, CO
Aug. 12-13, 2017	New York, NY

*Certified Medical Laser Safety Officer exam offered after the course.

Laser Additive Manufacturing (LAM®) Workshop

Feb. 21-22, 2017	Houston, TX

International Laser Safety Conference (ILSC®)

Mar. 20-23, 2017	Atlanta, GA

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President's Message

This is my last opportunity to provide a President's message to the *LIA TODAY*. Looking back on what LIA has achieved in 2016, I can give the following brief summary:

LIA launched a new desktop based version of *The EVALUATOR* laser safety hazard analysis system, held its innaugural Industrial Laser Conference, reduced the *Journal of Laser Applications*® publishing time from 230 days to 125 days, thanks to the great effort of the Editors-in-Chief Reinhart Poprawe and Yongfeng Lu and the editorial board members. LIA has also developed a new website that will be launched in 2017, with much improved user access functions. LIA held four major conferences and workshops in 2016 (LAM®, LME®, ILC and ICALEO®), developed an App for ICALEO, and reduced student memberships by half to $25 per year.

LIA launched a new *LIA Leadership Award* this year. The first recipient was LIA Executive Director, Peter Baker, for his outstanding leadership in developing LIA with worldwide impacts for promoting the advancement in laser sciences, technologies, applications and safe use of lasers. This was presented to him Oct. 19, in San Diego at the LIA Awards Luncheon. After 28 years serving as the LIA Executive Director, Peter Baker has announced his forthcoming retirement on Apr. 1, 2017.

LIA has developed several new education and outreach initiatives in 2016: Collaborating with Fraunhofer ILT to launch its first LAM workshop in Munich, Germany on Jun. 25-29, 2017, working with the Chinese Society for Optical Engineering and other societies to develop laser safety online courses in China and Europe, collaborating with CSOE to launch the first LIA laser safety conference in China in 2018. LIA is applying for grants to develop LIA STEM education programs in US states like Florida and California, creating a task group to investigate the development of LAM safety standards, and striving to develop WebEx and Apps for laser safety and user guides.

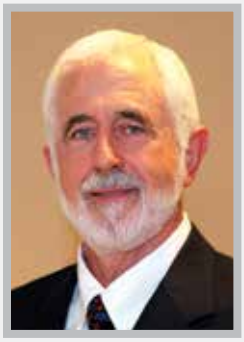
None of the above would be possible without the dedication and hard work of the LIA team, led by Peter Baker and the enthusiasm and support of the LIA Executive Committee, Board of Directors, Past Presidents, and Minlin Zhong and Eric Mottay. I take this opportunity to thank them for their support to me and the LIA during my presidency.

New LIA officers were elected for 2017: President Paul Denny, President-Elect Milan Brandt, Treasurer Gilbert Haas and Secretary Minlin Zhong. My sincere congratulations go to the 2017 LIA leadership team. I would also like to thank Past President Robert Thomas for his excellent leadership and dedication to LIA and his willingness to lead several new initiatives, and Stephen Capp for his excellent contributions as the LIA Treasurer for many years.

Finally, I would like to wish everyone a relaxing and enjoyable Christmas.

Lin Li, President
Laser Institute of America

Executive Director's Message



Thank you, Thank you, Thank you!
As you can see from President Lin Li's message, 2016 was a very busy year for LIA. Lin proved to be a visionary, flexible and effective leader for our society. In addition to the accomplishments listed, President Li raised the question of raising funds to fund our future growth and possibly provide us with a permanent headquarter and laser museum.

We learned that to accomplish this requires us to be clear about our vision for LIA and the strategies and projects needed to implement that vision. Accordingly, we will continue to develop the items in preparation for the LIA's 50th Anniversary in 2018. Our grateful thanks go to President Li for his leadership of LIA in 2016.

On the topic of leadership, my second thank you goes to President Lin Li and the Board of Directors for honoring me with the *LIA Leadership Award* at ICALEO and for naming this award for me in future years. It means a lot to me to be recognized and appreciated by you, the people I respect and admire — Thank you all!

My third thank you goes to LIA staff, who make everything possible. We are currently significantly understaffed and overloaded, yet the team leaders and staff continue to get the job done for everyone.

So, my thanks to all concerned. I wish everyone a Happy Holiday Season and a healthy and successful 2017.

Peter Baker, Executive Director
Laser Institute of America

New Leadership Search

With Peter Baker's upcoming retirement in April, the LIA Executive Committee has formed a search committee to find the next Executive Director to lead and carry out LIA's mission and goals. This is what Peter had to say about this position:

- This is a fabulous job
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If you or someone you know, is interested in the position and would like more information, submit your resume or request for additional information to **LIA.EX.DIR@gmail.com**.

Industrial Laser Sales

Grow in a Slowing Global Economy

BY DAVID A. BELFORTE

These are unsettled times for global manufacturing. Setting aside the normal up and down cycles of manufacturing — a number of global factors — ranging from Brexit concerns, to economic problems in China, turmoil in the mid-East and a new administration in Washington give cause for concern about economic growth prospects.

Trumping (pardon the pun) these concerns is the current status of industrial laser activity in the global manufacturing sector, that seemingly ignoring external effects, are enjoying another growth year (revenues up by more than 10 percent) led by strong double-digit sales of high-power fiber lasers, a surge in excimer laser revenues led by excimer laser silicon of displays and significant rises in uses for ultra-fast pulse lasers.

Fiber lasers at the kilowatt for metal cutting and joining operations, continue to outpace other laser types, representing 41 percent of the total industrial laser revenues in 2016. Fibers' 12 percent increase came, in part, at the expense of CO_2 (-4 percent) and solid-state (-1 percent) lasers. On a percentage basis direct-diode and excimer lasers in our 'Other' category enjoyed the largest annual revenue gain (54 percent) in recent years. These lasers have been recording strong gains based on their limited base numbers in several of our last reports. But one application, excimer laser annealing of silicon (FPE) used in mobile phone displays caused one company, Coherent, Inc., to book multiple orders worth several hundred million dollars for system's to be delivered into 2018.

The overall revenue growth for industrial lasers in 2016, estimated at slightly more than 10 percent, would in reality be more like 4 percent if we deduct the 2016 FPE revenues; leading to fiber lasers inexorable drive to 50 percent of total laser sales. US based IPG Photonics will have a record 2016 as their revenues from fiber lasers for nine months passed $726 million and, at the high end of guidance for the 4th quarter, could be pushing the $1 billion mark (admittedly not all revenues are generated by laser sales).

Joining IPG Photonics near the billion dollar level is Coherent, Inc., whose fiscal year closed in October at a bit more than $857 million, but strong excimer sales at the end of the year should assist them breaking the barrier (not all revenues are industrial laser related). Certainly after their merger with Rofin-Sinar they could be over the $1.5 billion.

Sitting atop the 'billionaires' club is industry giant Trumpf Group whose 2015/2016 approached the $2.8 billion mark, of this, laser technology (including some laser systems) alone topped a billion dollars.

The aforementioned is not intended to belittle a fine group of laser companies who also make up the industrial laser market, but it is these Big Three that dominate the news.

Laser Type	2015 Rev.	2016 Est.	%	2017 Proj.	%
Carbon Dioxide	910.1	873.8	-4	869.5	0
Solid State	428.3	424.8	-1	435.9	3
Fiber	1167.7	1304.8	12	1409.4	8
Other	359.7	553.9	54	717.4	30
Total	2865.9	3157.3	10.2	3432.3	8.7

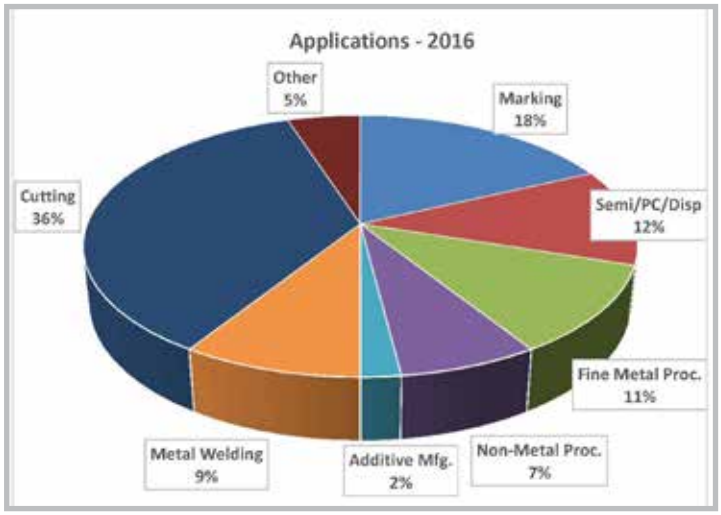
Table 1. Revenues by laser type - Source: Strategies Unlimited

As stated earlier, and shown in the table above, 2016 was another growth year for industrial lasers. In an otherwise moribund global capital equipment market, laser system sales grew in industry sectors that continue to show strength: automotive, aerospace, energy, electronics and communications (smart phones). We divide lasers into three major categories: the first is marking, including engraving, that contributes about 18 percent of all laser revenues and, because this is the most global of all laser markets, traditionally has shown solid growth in all non-recessionary years, continues the trend with a 3.9 percent growth dominated by fiber lasers at 49 percent of the total.

The second category is Micro, which includes all applications using lasers with < 500 W of power, which in 2016 climbed to 35 percent of the total laser market thanks to a 10.2 percent growth in the sector that included display applications requiring excimer lasers. Ultra-fast pulse (UFP) lasers are gaining adherents in the Micro sector and this technology will shore up otherwise decreasing solid-state laser revenues.

The laser category Macro, that includes laser processes requiring more than 500 W of power, is the largest, at 47 percent, of all industrial laser revenues, thanks to fiber lasers which make up 44 percent of all Macro revenues. In 2016, CO_2 lasers bore the

brunt of fiber laser's penetration into their largest revenue market, sheet metal cutting, resulting in a 4 percent decline in revenues with an almost 11 percent increase in high-power fiber laser sales. Additive manufacturing demand for more productivity has caused a spurt in higher power CO_2 laser demand at the kilowatt level which is factored into the Other category.



Source: Strategies Unlimited

Applications

Cutting as an industrial laser application is the most important on two levels: revenues generated and as a user of high-power fiber lasers. Globally over 70 integrators supply flat sheet cutters for metal fabricating. This sector is key among both industrialized and emerging nation economies, therefore its growth prospects are closely tied to a nations GDP. In 2016 global economic growth dipped below 2015 and is expected to expand only slightly in 2017. Thus sheet metal cutting, a key economy indicator, had an off year in terms of growth, with a concomitant softness in high power laser growth to 3.5 percent, which was irregular around the globe.

Fortuitously, expansion in global demand for laser welding (3.4 percent) led by the auto industry and boosted by pipeline and downhole oil pipe welding made up the difference.

Non-metal processing applications in paper converting and fiber reinforced polymers combined with fine metal processing (replacing mechanical fine blanking) to add 5 percent to total market growth. Additive manufacturing, more specifically laser metal deposition, grew 22.1 percent in 2016 spurred by acceptance in the aviation engine industry, with some growth in higher-power lasers accounted for in the Macro category. Both intermediate and high power CO_2 and fiber lasers are used depending on material selection. In 2016, other less advanced user industries moved more slowly on acceptance as realization of secondary post-LAM processing required ROI readjustment.

The Future

Economic projections for manufacturing in 2017 are a repeat of 2016 with pockets of sluggishness (East Asia, South America and Eastern Europe) continuing. For industrial lasers we are expecting a return to recent annual trends in total market growth with a projected 8.7 percent revenue growth. Marking laser sales are expected to show a decline as unit prices continue to erode mainly in the Asian markets.

Micro laser sales will be a bright light in the revenue picture as FPE laser shipments continue and non-metal processing grows in importance. This category will grow to 38 percent of total revenues.

Sales of laser in the Macro category level off to 47 percent of 2017 total revenues, with continued decreasing revenues in the CO_2 segment and a shift into high single digit growth in the fiber laser segment with a more typical 8 percent projection. Solid-state laser (buoyed by UFP lasers) should return to the plus side with a 3 percent growth for 2017. An anticipated shift to high-power direct diodes will pump up the Other category. ■

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

Laser Technology
Enables Car Efficiency

BY RALF KIMMEL

Laser technology is an important key to letting CO_2 emissions be reduced in passenger cars. A multitude of laser-based innovations in automobile production contributes to achieving this goal. The following article provides an overview.

Coming generations of vehicles will be far lighter than their predecessors. Laser-based manufacturing processes play an important part in this progress. Examples include parts without flanges, the increasing use of aluminum, CFRP and other high-performance plastics, thermoforming and joining plastics to metals. All these innovations help to reduce vehicle weight, in turn extending the cruising range and shaving CO_2 emissions.

Lightweight Vehicle Construction Thanks to Lasers

When joining sheets with conventional spot welding it is necessary to overlap the edges. By comparison, welding with a laser beam makes possible flangeless designs. Here the individual sheets are first assembled by way of tongue-and-groove joints and then welded by the laser. This offers several advantages: processing time drops when compared with spot welding; the elements thus joined can be of differing materials and thicknesses; the resulting structures have no redundant material and thus save weight. In addition, the prepositioning of the parts one with another reduces the – otherwise enormous – effort for clamping technology, permitting simple and cost-favorable clamping aids.

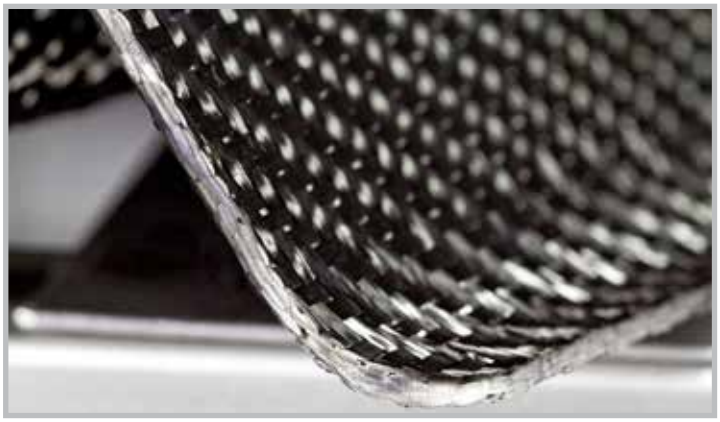
Non-flanged structures, when compared with conventional spot welding, offer many benefits in regard to processing time, material use and the weight.

Where greater loads demand additional stability, reinforcing structures can be attached as needed. The corresponding structures – such as the underbody of a vehicle – can be made up with less tooling. Neither are any special tools required for this purpose, which have to be manufactured in an elaborate process when preparing for production. Instead, all the required steps in processing can be carried out by a standard laser welding robot.

One outstanding example of this process is the “StreetScooter” deployed by the German Post Office. It was engineered by an academic spin-off of the Rhenish-Westphalian Technical University at Aachen, Germany, and is built on an underbody made up without flanges. At present about 40 of these microvans are in trial use, which has been thoroughly successful to date.

Using Lasers Permits Innovative Mixes of Materials

CFRP – carbon fiber reinforced plastic – is also being used more frequently in lightweight vehicle engineering, especially in vehicles powered solely by electricity. Laser technology also offers clear advantages when cutting and processing materials like this. In this way the incisions are made without touching the material or exerting any force whatsoever, ensuring that the shape and structure of the material remain unchanged. This eliminates all risk of warping, even in non-reinforced materials. Depending on the production process being used, cutting and processing can take place either before or after the CFRP parts have been shaped. When cutting blanks from carbon fiber materials, TRUMPF offers the laser systems in its TruFiber series; spatially shaped, 3D parts can be cut with the TruDisk beam sources made by TRUMPF. If CFRP – or a glass or carbon



Carbon fiber reinforced plastics can be cut with the laser either before or after shaping. If desired, the pure carbon fiber mats can be cut prior to or after filling with the binding polymer.

fiber mat already embedded in the binder – is to be cut, then the TRUMPF TruFlow series is an excellent choice. Here the laser melts away the fibers cleanly.

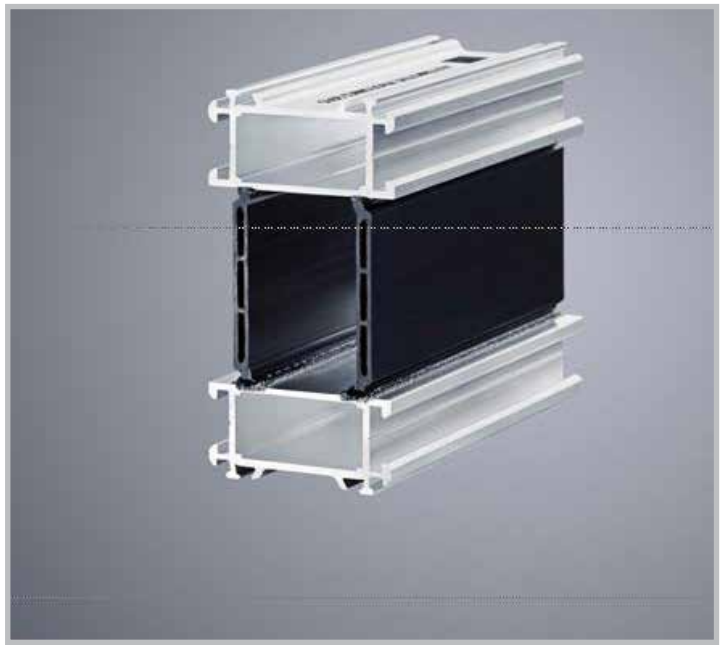
Cutting a hardened CFRP part: for materials less than four millimeters thick, the laser works two to three times faster than a water jet or milling tool and produces a higher-quality cut.

Laser light enables woven parts to be smoothly cut to near net shape. No finishing work is required for the cut edges.

A further way to improve the production processes using laser technology is thermal joining of plastics to metallic materials – without the use of adhesives. Since metals and plastics have widely differing melting points, this would not be possible with traditional welding technology. Using a short-pulse laser makes it possible, however, to create a defined pattern of undercuts in the metal, into which the heated partner, made of plastic, is pressed. Once the plastic has cooled and hardened, the two materials are joined by a form-fit connection. Examinations of the tensile strengths in such connections show that the union once again attains the strength of the basic material. Connections made this way are pressure-proof and waterproof and remain stable even under dynamic loading.

The Use of Lasers in Hotforming

Hot stamping processes allow for considerable reductions in the weight of body parts. However, the hardened steels are



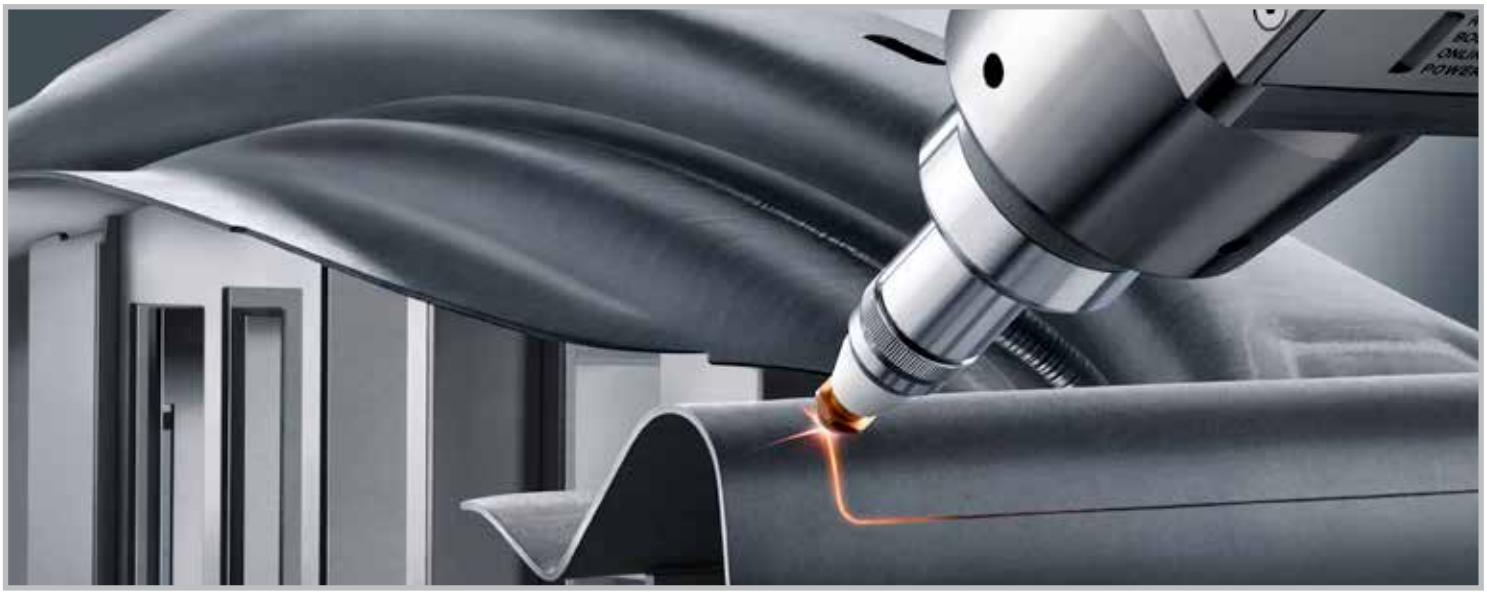
Securely joining metal and fiber composites: an ultra-short pulse laser creates an undercut in the metal part, ensuring that the polymer and hot metal fuse together properly.

too strong to be cut in a press. Laser technology presents an elegant solution for this problem, too. The parts are cut out by 3D laser cutting, without wear and without applying force. This tremendously productive technology can also be used for 2D cutting of the feedstock material prior to its being shaped in the press. Here optimized cutting patterns can save material. If model facelifts or derivatives require subsequent modifications, these can be effected simply by reprogramming the laser robot. No new punching tools need to be engineered and manufactured.

Conversely, laser light can also be used to induce partial softening to improve the formability in a closely defined area or to reduce the hazard of the material becoming brittle or breaking. The RF generators in the TruHeat series offered by TRUMPF are ideal for this purpose.

The beam of a laser can also be utilized to remove coatings from areas in the steel sheet in preparation for later welding. In other words, ablating an aluminum-silicon coating 10 to 25 microns thick. The process can be regulated so finely that the amount of aluminum remaining is adjusted exactly, enabling precise control of the material properties. The laser systems used here, such as the TRUMPF TruMicro series, can undertake the ablation described here with a velocity greater than 30 meters per minute.

(Continued on page 10)



3D laser cutting makes it possible to cut parts without wear and without applying force – and at high productivity.

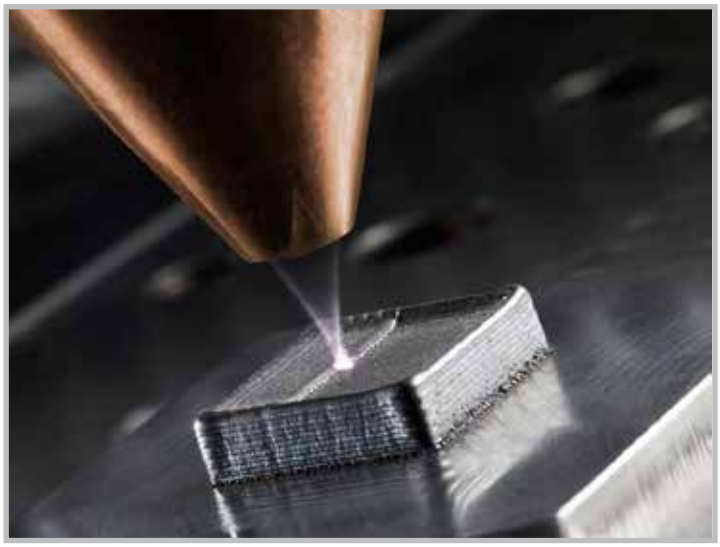
In the following phases in the work, lasers can also apply lettering, marks, QR codes and the like. And lasers also serve to subsequently weld parts prepared by thermoforming.

Laser Technology Opens the Way for New Production Processes

Even other approaches are offered by the techniques known as laser metal fusion (LMF) and laser metal deposition (LMD). Both processes are based on concepts such as those made familiar by 3D printing and additive manufacturing. They make it possible to produce parts that could not be manufactured at all with conventional processes. Complexity is free. This is true both in regard to their shape and in regard to the properties of the materials, especially since these innovative processes even permit combining differing materials within a single workpiece.

In laser metal fusion (LMF) an extremely fine metallic powder is applied uniformly to a metallic substrate and then melted or fused selectively with laser energy and allowed to harden. When using this process to create a workpiece, the 3D engineering data are "sliced" into individual layers 20 to 100 microns thick. The 2D image of each layer is the basis for the additive build-up of the workpiece. Exact control of the laser makes it possible to fuse each new layer of powder to the layers below – at the desired places and at the required material thickness.

In the case of laser metal deposition (LMD), the laser beam generates a weld pool on a metallic substrate, into which another material such as titanium, nickel, cobalt, tungsten-carbide or steel alloys is introduced as a powder. The powder melts and forms a layer which then coalesces with the substrate. LMD even makes it possible to create multi-layer workpieces which, if desired, can comprise several different bonded alloys.



Laser metal deposition (LMD) makes it possible to create multi-layer workpieces which, if need be, may comprise differing alloys which are bonded one with another.

The additive processes described here are already available today and in the coming years may be on par with conventional processes from an economic point of view. They can, by the way, also be used to apply structural reinforcements or additional

structures to workpieces manufactured with other techniques. This adds flexibility to production processes in regard to the placement, geometry and size of the supplementary structure. And since additional material is attached only wherever it is really necessary, this technique once against saves weight in the finished part.

Perspectives for Novel Concepts

But even the processes introduced up to this point by no means exhaust the options for using laser technology in vehicle engineering. Rather, they form the basis for numerous novel concepts. Only a single example is described at this juncture.

Remote fillet welding makes it possible to weld two workpieces at an overlapped seam. When compared with the laser welding normally used today, the amount of material can be further reduced by shortening the flanges in the overlapping zone. The seam is then welded by the laser beam direct in the fillet created here, requiring no additional filler material. One example of an application is welding seams in the frames for vehicle doors.

This process does, however, require the highest positioning accuracy for the laser beam. This can be achieved by using appropriate sensors to register the orientation of the workpiece and continuously re-regulate the position of the laser beam.

To summarize, laser-based processes make it possible to produce vehicle bodies with lower weights and to do so in different ways. This makes laser processing an important advance along the way to reducing emission levels, increasing cruising ranges and beyond this, to speed up, reduce the costs for, and add flexibility to automotive production. ■

Ralf Kimmel is with TRUMPF Laser- und Systemtechnik GmbH.

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35th Annual ICALEO

Bridging the Gap Between Academia & Industry

ICALEO
35th INTERNATIONAL CONGRESS ON APPLICATIONS OF LASERS & ELECTRO-OPTICS

BY DEBBIE SNIDERMAN

The 35th International Congress on Applications of Lasers & Electro-Optics (ICALEO®) took place at the Sheraton® San Diego Hotel and Marina this October, 2016. With a highly engaged group of attendees and a great mix of veterans in the field, students and new attendees, ICALEO met its goals of bridging the gap between academia and industry, highlighting new developments in laser technology, and providing a platform for global networking.

"This year's ICALEO exceeded all expectations once again," said Jim Naugle, Marketing Director of LIA. "The great location helped increase attendance from 2015. With 415 attendees from 20 different countries, with around 80 percent from academia and 20 percent from industry, you can see why this conference is so unique."

Congress Technical Highlights

Congress General Chair Silke Pflueger put together unquestionably the best plenary talks ever delivered at an ICALEO conference so far.

Nina Lanza from Los Alamos National Laboratory linked all humanity together in her opening plenary talk about the laser riding around in a vehicle on Mars. Since 2012, the laser in the ChemCam instrument aboard the Mars Science Lab 'Curiosity' rover has brought Laser-Induced Breakdown Spectroscopy (LIBS) analysis capabilities and chemical analysis data back to Earth. Along with a Remote Micro Imaging camera, the ChemCam data has provided good signs for habitability of the planet. With its small 350-500 µm spot size, it is able to measure features up to 7 meters away from the rover and ablates material to perform depth sampling by pulsing, revealing "big results" that smectite clays are present underneath the red rocks on the surface of Mars and that dust all over the planet is hydrated. It is also showing the presence of methane, indicating that Mars is not a dead planet; it is active and full of surprises.

Next, Jim McBride from Ford Motor Company talked about the challenges of sensing on fully autonomous vehicles. Ford is developing a fleet of vehicles where a driver has no responsibility of driving, with the goal of having commercially available fully autonomous vehicles in 2021 and cost affordable vehicles in 2026. He explained the three types of sensors used on autonomous vehicles: Radar, cameras and Light Detection and Ranging (LiDAR) scanners. He showed videos of the Ford Fusion Hybrid research vehicle driving completely autonomously on a recent successful 125 mile highway test through the Arizona/California desert using only the LiDAR scanners to image surroundings in a 360 degree view around the car at all times.

McBride showed how 95-99 percent of autonomous driving can be done with input from LiDAR scanners alone. Reading what he calls the pavement's unique fingerprint: manhole covers, lane markings, tar strips, cracks and all details in a road, localizing the vehicle, the road, and obstacles, centering it within a few cm on the road, tracking obstacles and avoiding collisions is simple for LiDAR. Its data is overlaid on top of high definition 3D maps with road data that has the rules of the road, crosswalks, road signs and other important features, to make sure the road is traversable, using prior knowledge to identify what's coming ahead and difficult topologies. It has its own light source and isn't susceptible to shadows and the sun, unlike monocular cameras. And it is much better at tracking other vehicles than with Radar alone, which is noisy. Redundancy helps filter out echoes from challenges such as snow or heavy rain that may obscure the ground plane. With real-time planning without GPS, the laser scanners calculate where to go. But, there are some areas where it doesn't suffice.

Sensor fusion helps in challenging situations: high closing velocities on two-lane highways when it's hard to see objects coming, adverse weather and lighting, snow obscuring optics preventing the laser from making it to the ground plane, road debris, and human-negotiated arrangements like four-way stops and merge ramps. In merge scenarios with line of sight issues, sensing has to look in 360 degrees. When turning left or accelerating on a highway on ramp, thousands of possible trajectories are calculated, looking back in time for decision making. But, when fusing LiDAR scanners with other sensors, each still sees only part of the picture.

Albert Lazzarini, Deputy Director of LIGO Laboratory at California Institute of Technology presented the exciting new results about black holes made from the first gravitational waves detected by LIGO. The system involves an extremely stable laser injected into a complex cavity of a Fabry-Perot interferometer

with ultra-pure super-polished suspended mirrors coated with forty quarter-wave layers to have reflectivity better than five 9's. Servo-controlled ground isolations systems stabilize, attenuate and filter out ground motion with input from seismometers, so the laser light that makes about 140 bounces per second is sensitive enough to be considered a transducer for gravitational waves at the output of the interferometer.

All LIGO science data is publicly available on the center's open website, and since it came online, a total of three events have been observed that are bringing new information – that black holes in binary systems exist. Two identical signals were seen simultaneously by systems in two locations in eastern Washington State and near Baton Rouge in Louisiana. After correcting for differences in orientation and background noise and removing the few-second offset between the locations, it was determined that the gravitational wave signal seen here on Earth corresponded to events that occurred 1.4 billion years ago between two black holes of 29 and 36 solar masses respectively. Signals show how they behave when they interact and provide an estimate of where the event was located in the universe.

Laser Materials Processing (LMP) Conference Technical Highlights

The LMP Conference, chaired by Christoph Leyens from Fraunhofer IWS, brought together laser, manufacturing and materials science disciplines and presented talks on laser drilling, cladding, cutting, welding, additive manufacturing/3D printing and materials for lightweight construction.

A highlight of the lightweight construction talks was about carbon fiber reinforced plastics (CFRP), which are used in many industrial sectors. Sven Bluemel from Laser Zentrum in Germany presented information that will help optimize laser cutting processes in his talk *Time Resolved Analysis of Nanosecond Pulsed Laser Processing of CFRP* (LMP8-803). Bluemel synchronized a CMOS camera and strobe light with a fiber guided nanosecond pulsed laser to analyze the plasma plume during laser cutting of 3D CFRP parts with different processing parameters. Analysis of pictures of the cutting process and resulting plume showed how the plume varied with pulse energies and changed during processing so ablation thresholds and process boundaries could be set.

Ti6AL4V is the major industrial alloy used in aerospace, medical implants, automotive fuel nozzles and many other applications, and many talks and posters mentioned 3D printed devices using its power feedstock. Dirk Herzog from Hamburg University of Technology, Germany, spoke about how different powder feedstocks affect the quality of parts produced by laser melting or laser fusion in his talk *Relationship Between Powder Characteristics and Part Properties in Laser Beam Melting of Ti6AL4V and Implications on Quality* (LAM1-705). His work characterized the three forms of Ti6AL4V powders IGA, PA and ICP, from several manufacturing sources by SEM, particle size distribution, chemical composition and flowability from five different methods that test static and dynamic states. He created laser beam melted parts and measured properties such as density, static strength, yield strength, ultimate tensile strength, elongation and Vickers hardness. He found that all three powders produced dense specimens and can be used, and he presented the differences between them and made recommendations.

Laser Microprocessing (LMF) Conference Technical Highlights

"2016 was another great year for the Microprocessing Conference," said LMF Conference Chair Michelle Stock, from mlstock consulting. "We heard about applications as diverse as wearable electronics and writing skin by 3D printing cells with ultrafast lasers. We gained more insight into how to improve processing speed and precision with new beam delivery and beam shaping techniques."

A highlight in the smart and wearable gadget area was Alan Conneeley's invited talk *Laser Micromachining of Contactless RF Antenna Modules for Payment Cards and Wearable Objects* (LMF5-M501) involving work at the National University of Ireland in Galway. Conneely presented several successful applications of laser ablation for next generation contactless payment cards and flexible wearable devices. Antennas were formed from copper laminated epoxy tape on plastic and flexible substrates as well as on copper PCBs. Laser processing allowed much smaller resolution antenna features to be designed and fabricated compared to chemically etching copper. New antenna designs using this process have a higher density of turns in a given area enabling contactless cards and payment systems to meet design goals for Europay, MasterCard and Visa (EMV) industry standards.

Two talks on how lasers interact with transparent materials were another conference highlight. Thomas Hermann from Photonik-Zentrum Kaiserlautern, Germany spoke about a new laser technique to modify the surface of bulk glass in his talk *Selective Glass Surface Modification with Picosecond Laser Pulses for Spatially Resolved Gloss Reduction* (LMF4-M402). Specular gloss, sheen and haze are important in devices such as automotive headlamps and mobile screens. His work investigated how the surfaces change with single, double and more than two pulses per location, pulse energy, line distance and the influence of substructures. He demonstrated that glass with dramatic gloss reduction by direct laser structuring still had high transmission, and the process uses no chemicals, no masking, is fast and flexible, and leaves sharper features on the surface compared to chemical etching.

In another transparent material talk, Geoffrey Lott from Electro Scientific Industries in Portland, Oregon, covered *Enhanced*

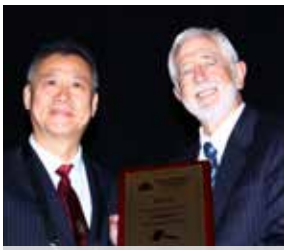
(Continued on page 18)

PAST LIA PRESIDENTS & SCHAWLOW AWARD WINNERS (FROM LEFT TO RIGHT): YONG-FENG LU, BILL SHINER, DAVID BELFORTE, RAJESH PATEL, LIN LI, ANDREAS OSTENDORF, EXECUTIVE DIRECTOR PETER BAKER, REINHART POPRAWE, DAVID SLINEY, JYOTI MAZUMDER, ROBERT THOMAS & MARSHALL JONES

CONGRESS GENERAL CHAIR SILKE PFLUEGER WITH KEYNOTE PRESENTER NINA LANZA

SHERATON® SAN DIEGO HOTEL AND MARINA IN SAN DIEGO, CALIFORNIA

ECKHARD BEYER PRESENTS PETER BAKER WITH A SPECIAL GIFT FOR HIS UPCOMING RETIREMENT



PETER BAKER PRESENTS LIN LI WITH PRESIDENT'S PLAQUE

PETER BAKER WITH ILS EDITOR-IN-CHIEF DAVID BELFORTE

EXECUTIVE DIRECTOR PETER BAKER, SECRETARY MILAN BRANDT, NEWLY ELECTED FELLOWS NEIL BALL & SILKE PFLUEGER, SCHAWLOW AWARD RECIPIENT YONGFENG LU PRESIDENT LIN LI & PAST PRESIDENT ROBERT THOMAS

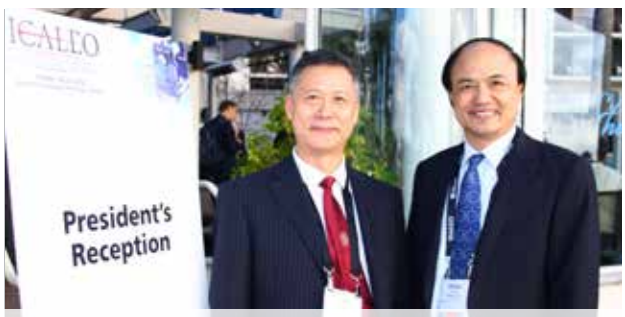
PAST PRESIDENT ROBERT THOMAS PRESENTS YONGFENG LU WITH THE 2016 ARTHUR L. SCHAWLOW AWARD

EXECUTIVE DIRECTOR PETER BAKER (LEFT) WINS FIRST LIA LEADERSHIP AWARD

PETER BAKER CELEBRATES WITH HIS WIFE SUNNY, SON SCOTT & DAUGHTER-IN-LAW DANIELLE

OPENING PLENARY SPEAKER ALBERT LAZZARINI

OPENING PLENARY SPEAKER JAMES MCBRIDE



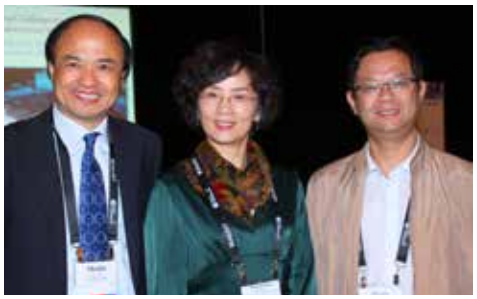
LIA PRESIDENT LIN LI (LEFT) GREETS ATTENDEES AT THE ANNUAL PRESIDENT'S RECEPTION

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











ICALEO 2016

Hosted many social events that provided a platform for global networking









Drilling of Transparent Materials with Ultrashort Laser Pulses (LMF4-M407) and found that using a water bath improved the taper while performing bottom-up percussion drilling of sapphire. In addition to optimizing the laser-only ablation process, the back side only water bath removed ablated material that was recast onto the sidewalls more efficiently than drilling without one, reducing the biggest process limitation, and allowing higher maximum drilling depths. The water bath's enhanced debris removal through capillary action also removed the taper and any dependency on drilling speed, so the process was demonstrated on CT90 glass as well with similar excellent results.

With numerous talks on battery applications this year, one of the most well-attended talks was Joanna Helm's from Fraunhofer ILT, *Connecting Battery Cells by Aluminum Ribbon Bonding using Laser Micro Welding* (LMF8-M802). She presented her work that integrated a laser welder with a conventional wire bonder complete with automated ribbon supply and integrated cutter for high speed, efficient bonding when connections to large numbers of battery cells are needed. She demonstrated initial results of connecting 6082 aluminum alloy ribbon with two welds on the two poles of a battery pack using an SPI 400 W fiber laser with different process variables such as weld depths, weld lines, overlap, laser power and pulling angle. Mechanically robust connections were made, and characterization and optimization for defect reduction is ongoing.

Many talks featured medical applications, and Togo Shinonaga's invited talk from Okyama University, Japan, *Control of Surface Profile in Periodic Nanostructures Produced with Ultrashort Pulsed Laser* (LMF6-M601) showed how creating structures on the surface of a biomaterial with lasers may eventually be able to control cell spreading. He demonstrated that cells aligned to grooves that were cut with 100-1000 nm periods in titanium plates, and determined the optimal laser properties for creating favorable directions, aspect ratios and heights of the channel structures.

Nanomanufacturing Conference Technical Highlights

The Nanomanufacturing Conference, chaired by Professor Yongfeng Lu from the University of Nebraska-Lincoln, had many talks on using lasers for nanoscale manufacturing, and had sessions on photovoltaics, advanced energy devices, battery materials and 2D materials.

Costas Grigoropoulos from the University of California Berkeley gave an invited talk, *Laser-Assisted Processing of Layered Dichalcogenide Semiconductors* (Nano1-N101) about their new laser-assisted doping process that allows high performance devices to be fabricated from ultra-thin films of 2D transition metal dichalcogenides (TMDCs). The laser-assisted Chemical Vapor Deposition process used multiple lasers at different wavelengths and standard dopant gases to dissociate gas molecules and create vacancies in the thin film to be doped. Thin film transistors were formed on a flexible polymeric substrate with single and bilayer flakes of MoS_2 and single crystal WS_2 and WSe_2 materials as the active semiconductor channel. The successful doping process was selective and tunable, and device performance was reliable and stable for months.

Another invited talk addressed the topic of 3D IC fabrication, important as more microelectronic devices become smaller, lightweight and lower power. Koji Sugioka spoke about his research team's work at the RIKEN Center for Advanced Photonics in Japan in his talk *Tailored Femtosecound Bessel Beams for Fabrication of High aspect-ratio through Si Vias* (Nano1-N102). To create small holes in 50 µm and 100 µm thick silicon that are taper free and almost taper free, the group used laser drilling in air with two different Binary Phase plates (BPP) that filter the bessel beam's phase and reduce the amount of energy needed to fabricate TSVs. Compared to Gaussian-shaped beams and Bessel beams that used an Axicon lens alone, SEM images before and after cleaning confirmed the vias could be produced with superior profiles.

A well-attended talk from the Advanced Energy session on generating flexible printed "batteries" for the next generation of bendable, wearable and portable devices was given by Anming Hu: *High Performance Hybrid Supercapacitors on Flexible Polyimide Sheets using Femtosecond Laser 3D Writing* from the University of Tennessee Knoxville. He demonstrated writing 3D battery-style supercapacitor cells by laser radiating nanoparticles on Kapton insulator tape that produced porous carbonized structures that changed their conductivity from insulating to conducting. After charging to 3.7 V for 3 minutes, they powered 1 cm x 1 cm LEDs and retained 97 percent efficiency over 2000 cycles for more than a month, behaving similar to a coin-style battery.

Networking and Access to Industry Leaders

ICALEO not only offers the industry's most comprehensive technical content but also offers access to influential leaders at Fortune 500 companies across manufacturing industries in Automotive, Aerospace, Commercial Electronics, Communications, Medical Device, R&D and Semiconductors.

The Sunday Welcome Celebration, complete with music from the industry's own Ron Schaeffer, Henrikki Pantsar and guest musician Matt Henry, and Monday night's President's Reception were well-attended opportunities to meet members of the LIA Executive Committee and Board of Directors, as well as connect with colleagues from around the world.

Dr. Kaushik Iyer, a first-time attendee from Johns Hopkins University Applied Physics Department, said the conference was the "perfect size, excellent content, global networking!" Mr.

Christoph Mittelstädt from BIAS, Bremer Institut für angewandte Strahltechnik GmbH, said ICALEO is "one of the best technical conferences I attend all year!"

The Vendor Reception & Tabletop Display hosted a pavilion full of sponsors and vendors where Ken Dzurko, General Manager of SPI Lasers, said "LIA does a great job creating a comfortable, relaxed mood right for exchanging ideas at this one-of-a-kind event that's really the world's premier gathering of scientists interested in laser applications."

Nikolas von Freyhold, Industrial Laser Product Manager from ICALEO sponsor JENOPTIK appreciates the fact that he can reach people who use lasers in both industry and academia at ICALEO. "This is a good place to spread the word about our application lab and interest in demonstrating what our newest femtosecond lasers can do," he says.

Neil Ball, President of Directed Light, Inc. and newly-honored LIA Fellow, calls ICALEO "bar none, the best networking opportunity and the best opportunity to look forward and see what applications are on the horizon. As a laser professional and exhibitor, there is only one event on my calendar that is a must exhibit every year, and that would be ICALEO. Nowhere on the planet do you have the opportunity to network with the industries' elite decisions makers."

LIA Awards

Highlights of the year mentioned at the LIA Annual Meeting and Awards Luncheon included launching the industry's first web-based Laser Safety Hazard Analysis system – *The EVALUATOR*, many education and outreach activities, and reducing student membership rates by 50 percent.

Executive Director Peter Baker was honored as the first recipient of the new *LIA Leadership Award*, and he received a standing ovation after his look back over more than two decades at the LIA and entertaining talk about life and leadership lessons. Retiring next April, Baker publicized the job opening and encouraged people to apply for Executive Director of the LIA, saying "it is a great job and you couldn't wish for better bosses. People crave a job that is meaningful, and at LIA we're saving eyesight, preventing skin damage, and helping create laser technologies, products and services that make the world a better place."

During the luncheon, the Arthur L. Schawlow Award was presented to Prof. Yongfeng Lu. This is LIA's highest achievement award, created to honor individuals who have made outstanding contributions in laser applications. Named after the Nobel Laureate and founder of LIA, it has been presented since 1982. The 2016 winner, Yongfeng Lu, an LIA Board Member, Past President, Treasurer, Fellow, Lott Distinguished Professor of Engineering at the University of Nebraska-Lincoln, with hundreds of published papers, research projects and products, presented the Honored Speaker Address, *A Small World With Lasers*. He took the audience on a journey through the past to witness his 25 years of laser processing and material characterization experience, and to all the countries where his work occurred, summarizing each with a single phrase.

LIA also honored Silke Pflueger and Neil Ball, elevating them to the highest level of membership as LIA Fellows.

By a unanimous decision, the first place ICALEO Poster Award went to Kohei Asano and his colleagues from Osaka University, the Industrial Research Institute of Ishikawa, and Yamazaki Mazak Corporation in Japan for their poster *Copper Layer Formation Produced with 100 W Blue Direct Diode Laser System* (P110).

The First Place Student Paper Award winner was Christian Hagenlocher from IFSW in Stuttgart, Germany, for his paper *Space and Time Resolved Determination of Thermomechanical Deformation Adjacent to the Solidification Zone during Hot Crack Formation in Laser Welding* (1202).

The closing plenary session highlighted lasers used in emerging areas with talks on paint stripping, the dairy industry, and a report from Magnus Bengtsson from Coherent, Inc. about the latest trends in the major electronics component market segments.

ICALEO 2016 proceedings are now available for sale online at **www.lia.org/store**. Visit **www.icaleo.org** for more information on ICAELO 2017, which will be held Oct. 22-26 in Atlanta, GA. ■

Debbie Sniderman is CEO of VI Ventures, an engineering consulting company.

ICALEO 2016 STUDENT PAPER AWARD WINNERS

1ST PLACE
Space and Time Resolved Determination of Thermomechanical Deformation Adjacent to the Solidification Zone during Hot Crack Formation in Laser Welding (1202)
Christian Hagenlocher, IFSW, Stuttgart, Germany

2ND PLACE
Laser Direct Writing of Multifunctional Micro/nano Devices using Carbon Nanotube-polymer Composites (N210)
Ying Liu, University of Nebraska – Lincoln, Lincoln, USA

3RD PLACE
Temperature Feedback Control of Laser Cladding using High Resolution Hyperspectral Imaging (1305)
Wim Devesse, Vrije Universiteit Brussel, Brussels, Belgium

ICALEO 2016 POSTER AWARD WINNERS

1ST PLACE
Copper Layer Formation Produced with 100 W Blue Direct Diode Laser System (P110)
Kohei Asano, Osaka University, Osaka, Japan

2ND PLACE
Development of Visible Ns-pulse Laser in a Pr-doped Double-clad Structured Waterproof Fluoride Glass Fiber using Semiconductor Saturable Absorber Mirror (P141)
Shota Kajikawa, Kindai University, Osaka, Japan

3RD PLACE
Novel Process for Butt-joined Plastic-metal Hybrid Compounds (P113)
Dennis Arntz, RWTH Aachen, Aachen, Germany

Inaugural Industrial Laser Conference

Highlights Lasers in Manufacturing

INDUSTRIAL LASER CONFERENCE 2016

BY JESSICA DAWKINS

Laser Institute of America held its first Industrial Laser Conference on Tuesday, September 13, 2016 at the International Manufacturing Technology Show in Chicago. Tailored exclusively to the future-forward industrial manufacturing professional, the conference showcased leading laser applications driving the evolution of manufacturing, and instructed manufacturing shops and industry professionals in how to leverage lasers into their manufacturing processes in a high-demand marketplace.

Thirteen experts in laser manufacturing, including technical directors, laser applications engineers, and program managers, presented a diverse program at Chicago's renowned McCormick Place. Hailing from leading manufacturing organizations such as IPG Photonics Corporation, SLM Solutions NA, Inc., TRUMPF Inc., FANUC America Corporation, Laserline Inc., Optomec Inc., Lincoln Electric Company, Fraunhofer USA - CLA, Alabama Laser, Mitsui Seiki (USA), Inc., and Imperial Machine & Tool Co., the presenters covered topics like technology advances in additive manufacturing, hybrid additive and subtractive tool technology, laser additive manufacturing in production, advances in welding with fiber lasers and novel beam delivery products, and the role of flexibility in laser automation.

These innovative techniques are emerging and revolutionizing the industry to meet market demands, all rooted in the field's collective understanding of conventional machining. From advancements in technology to expected challenges, the LIA's Industrial Laser Conference provided a newfound clarity on the present and future of industrial manufacturing.

"LIA was proud to deliver an elite lineup of laser experts in our first year of the Industrial Laser Conference, covering 360 degrees of lasers-in-manufacturing technology," said Jim Naugle, LIA's Marketing Director. "The opportunity to dive into a real machine shop's journey into metal additive manufacturing with lasers and cover new innovations in directed energy deposition (DED) systems in one day, all while receiving access to cutting edge exhibitions at the IMTS show, is a thrilling opportunity for manufacturing engineers, automation specialists, and sales managers."

From seasoned manufacturing experts new to lasers, to shops who have already begun reaping the benefits of laser technology, the conference offered something for everyone in the sector, including James Hail of L-3 Communications. "[The show provided] excellent information! I learned a lot," Hail said.

Attendees like Mansour Ashtiani of Huf North America hope to attend the event again. "It was a very professionally done conference," Ashtiani said.

The Laser Institute of America (LIA) is the international society for laser applications and safety. For more information about the Industrial Laser Conference, including presenters, programs and sponsor information, visit **www.lia.org/laserconference**. ■

Photo courtesy of TRUMPF Inc.

SAVE THE DATE

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Laser Institute of America
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ARCOR Laser

Passion for Precision & Customer Success

BY BETSY MARONE

A global leader in laser technology and innovation, ARCOR Laser ensures the success of its clients by building products that enhance the industry. Not only a provider of premier laser manufacturing services, ARCOR Laser also offers unique engineering problem solving that improves products, decreases costs and increases manufacturing efficiency. Playing an integral role in numerous industries – from medical, firearms, aerospace and sensor to power generation, semiconductor and commercial – ARCOR Laser provides customers with the finest engineering and troubleshooting expertise in its field.

In 2004, Gary Francoeur founded ARCOR Laser with the goal of helping clients succeed through the production of innovative technologies, materials and tools that create the best products. As the current owner and president of the company, Francoeur has used his more than 20 years of experience in the Electron Beam and Laser Beam technology field to lead his company to global success.

Located in Suffield, CT, ARCOR Laser encompasses a team of 80 employees who maintain the company's main model of contract services and design-systems integration. ARCOR Laser's contract services offer solutions for laser processing that range from R&D to production and include laser welding, cutting and drilling, additive manufacturing, laser marking and engraving, value-added services – cleaning, assembly and leak testing – and post processing. This service is accompanied by the second aspect of the company's model, system integration, which is met through ARCOR Laser's introduction of new and unparalleled material processing. This includes the development of unique tooling, custom software, automated vision tracking and techniques that differentiate ARCOR Laser from its competition.

The company processes the best quality products at its brand new, state-of-the-art facility in Suffield, which covers more than 15,000-square-feet of manufacturing space. Using the latest technology to process customer products, ARCOR Laser utilizes a variety of lasers including Pulsed ND: YAG, CW (Continuous Wave) Ytterbium Fiber and CO_2 Lasers. The company's many CNC integrated laser welding and cutting systems, as well as its full metallurgical laboratory, allow for quick and accurate process analysis. The facility also houses over 30 laser systems, ranging from 10 W to 4 kW.

Since its inception, ARCOR Laser has received approvals from numerous companies and organizations, including the National Aerospace and Defense Contractors Accreditation Program (NADCAP) and Siemens Westinghouse Power Corp Process Spec. Despite the company's successes, ARCOR Laser remains dedicated to serving its customers in the most effective way by continuously adapting to meet client demands. The company's team tackles new challenges and strives to improve projects by making them faster and more efficient – ultimately setting ARCOR Laser apart in its field as the company redefines precision.

Most recently, ARCOR Laser has been involved with the installation of a laser system on a Swiss turn machine. The Laser System L2000, which is now available for Cincom L20 CNC Swiss-type Lathes, offers nearly endless possibilities of geometric shapes, minimal burrs and a speed that exceeds that of EDM machining. Between the 400 W output power, 10 Micron delivery fiber and Internal Pulse Generator with limitless parameter possibilities, the Laser System L2000 continues ARCOR's tradition of striving for innovative solutions to meet customer needs. In addition, the system's optical head specifications include a CCD Integrated Camera for optical viewing and alignment, fine X, Y Beam adjustment for beam alignment to the nozzle and internal coaxial light built in for easy alignment. With 50-80 mm focal lengths available, the head assembly is completely liquid tight. Both the head and the laser are 100 percent supported in the USA.

L2000 Laser System

A member of Laser Institute of America since 2005, ARCOR Laser appreciates the organization's tradition of keeping companies apprised of the products, services, education and events available in the laser industry while also ensuring its members stay up-to-date on the latest technology and expertise in the field. ■

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

Member Innovations

High Speed Laser Sensors Now Available in a Lower Cost, "Meterless" Package
With the new PowerMax™ Pro USB/RS, Coherent, Inc. (Santa Clara, CA) brings their unique PowerMax-Pro sensor technology into a "meterless" format, substantially lowering the cost of ownership of this revolutionary, high speed laser power and energy sensor. PowerMax-Pro sensors, first introduced in 2014, utilize a novel, thin-film technology developed by Coherent, which yields a sensor having the broad wavelength sensitivity, dynamic range and laser damage resistance of a thermopile, combined with the response speed of a semiconductor photodiode. PowerMax-Pro sensors are more than one million times faster than conventional thermopile sensors; an ideal solution for fast CW laser power and rise time measurements, full modulated laser characterization, and pulsed laser energy measurements over the 300 nm to 11 µm spectral range.

PowerMax-Pro USB/RS sensors utilize state-of-the-art microelectronics miniaturization techniques to integrate an entire instrument within a USB 2.0 or RS-232 cable. Specifically, this puts all the signal processing and laser power measurement electronics normally contained in a Coherent LabMax standalone meter right into the sensor itself.

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

Precise Laser Drilling of CFRP Components in Large Quantities
In a new joint research project, four enterprises and the Laser Zentrum Hannover e.V. (LZH) aim at further developing the laser drilling of composites for series production in the aircraft industry. Their focus is on designing an efficient system and process technique that meets the demands of aviation.

Composites, such as carbon fiber reinforced plastics (CFRP), have a high potential for lightweight construction and are therefore already now widely used in aviation. These materials, however, have extraordinary properties, such as a low weight and high stability at the same time, but processing composites is quite complex. Here, mechanical processes lead to high tool wear and thus to quality problems.

For aviation in particular, the drilling of CFRP has an enormous market potential. The aircraft manufacturers produce increasing quantities with a high number of drilled holes for riveted and screwed joints. This requires reliable, fast and cost-efficient processes to withstand international competition. For this purpose, laser beam drilling is an ideal alternative to conventional processes.

F*or more information, visit* **www.lzh.de/en**.

Members In Motion

AMETEK Acquires Laserage Technology Corporation
AMETEK, Inc. announced that it has completed the acquisition of Laserage Technology Corporation, a leading provider of laser fabrication services for the medical device market. Laserage is a privately held company with headquarters and manufacturing operations in Waukegan, IL, and a manufacturing facility in Milipitas, CA. Laserage has estimated annual sales of $22 million.

Laserage offers precision tube fabrication of minimally invasive surgical devices, stents and catheter-based delivery systems. Its expertise includes laser fabrication of flat stock and tube for medical devices and specialty catheters.

Laserage joins AMETEK as part of its Electromechanical Group (EMG) — a differentiated supplier of electrical interconnects, precision motion control solutions, medical components, specialty metals, thermal management systems and floor care and specialty motors.

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

SCANLAB Successfully Undergoes DIN EN ISO 9001 Certification
SCANLAB GmbH, an OEM manufacturer of scan systems and photonics-industry 'Hidden Champion,' has received DIN EN ISO 9001:2015 certification. This certification demonstrates the company's successful quality management, efficiency of processes and dedication to continuous improvement. The resultant organizational transparency and consistency are further steps toward a comprehensive customer focus, simplified quotation and ordering processes. Furthermore, optimization of all the company's business processes lays the foundation for continued growth.

Successful DIN EN ISO 9001 certification often facilitates supplier accreditation in international commerce, particularly the automotive, mechanical engineering and medical technology industries. But that's only one reason certification is good for a company and its customers. Certification is primarily about the effectiveness and efficiency of all business processes and the presence of total quality management. Typical positive side effects of certification are increased corporate success (by uncovering efficiency losses and wastage), shorter throughput times (via optimized processes), and simplified control (by introducing performance indicators), as well as process visualization.

For more information, visit **www.scanlab.de/en**.

ASC Z136 | Update

Save the Date – The annual meeting of ASC Z136 will be held in conjunction with the International Laser Safety Conference (ILSC®) at the Sheraton Atlanta Airport, Atlanta, Georgia on Sunday, March 19, 2017. The meeting is scheduled to begin at 9:00am local time.

Hotel Accommodations – Committee members are asked to make their reservations prior to February 15 to ensure room availability and to receive the conference room rate of $129 per night. A personal online group page for making reservations has been created by the hotel; to register please go to **www.lia.org/conferences/ilsc/hotel_information** and follow the hotel reservation link.

Attend ILSC – While not mandatory to attend the conference in order to go to ASC Z136 meetings, the four-day conference addresses all areas of laser safety from bioeffects to hazard controls to what's ahead in standards and regulations. Complementing the scientific sessions are the practical applications seminars that focus on the everyday scenarios a LSO or MLSO may encounter. Early bird pricing is now available, register today and save!

Ancillary Meetings – Space is available Monday through Thursday for subcommittee or working group meetings on a first-come, first-serve basis. If you are interested in scheduling or attending an ancillary meeting, please contact Barbara Sams for further information.

ASC Z136 meetings are open to the public. If you have any questions regarding the annual meeting, would like a meeting agenda, and/or plan to attend as an observer, please email **bsams@lia.org** or call +1.407.380.1553.

BLS | Update

Annual Reminder – With the end of 2016 right around the corner, now is the time to remind those who have achieved certification and are nearing the end of the certification maintenance (CM) cycle to submit their CM worksheets for renewal.

After passing an exam, it is to the responsibility of the CLSO or CMLSO to maintain his/her certification by demonstrating completion of sufficient professional development activities to ensure continued competency. The CM cycle begins on January 1 of the year following the year in which the exam is passed and ends on December 31 of the third year. During this 3-year period, the individual must obtain at least 10 CM points to renew certification.

There are a number of different categories in which to receive CM points:

1) Laser safety experience (i.e., your job)

2) Attendance and successful completion of laser safety specific education/training

3) Publication of laser safety or application related articles

4) Teaching laser safety (outside of your company/ organization)

5) Membership in a laser safety-related professional/ technical organization or society

LIA offers a special 3-year membership to those who have achieved certification for only $235! This membership rate is only available to CLSOs and CMLSOs.

6) Active participation in a laser safety standards or regulations committee (outside of your company/ organization)

Join ASC Z136 or one of its subcommittees to ensure your voice is heard! Curious how the committees function? Observe a meeting while at ILSC.

7) Attendance at laser safety or applications professional conferences or meetings

Attend ILSC 2017 – THE conference for laser safety professionals!

8) Presentations or poster papers at laser safety professional conferences or meetings

9) Writing exam questions (accepted by BLS Review Board)

10) Related professional certifications; review of approved laser-related journal articles

Lastly, a CLSO or CMLSO may retake the applicable exam if unable to achieve the 10 CM points and wishes to maintain active certification status; however, the exam must be taken prior to December 31 (end of cycle).

For a thorough review of certification maintenance including CM categories in detail, please go to **www.lasersafety.org/certification-maintenance**. 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.

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

Assistant Secretary of Labor Dr. David Michaels Encouraged by Bureau of Laser Statistics Report on Occupational Injuries and Illnesses in 2015

Occupational injury and illness data released today by the Bureau of Labor Statistics showed a significant drop in the rate of recordable workplace injuries and illnesses in 2015, continuing a pattern of decline that, apart from 2012, has occurred annually for the last 13 years.

Private industry employers reported about 2.9 million nonfatal workplace injuries and illnesses in 2015, representing a decline of about 48,000 from 2014, despite an increase in total hours worked. The rate of cases recorded was 3.0 cases per 100 full-time workers – down from 3.2 in 2014. The rate is the lowest recorded since at least 2002, when OSHA recordkeeping requirements were modified.

Assistant Secretary of Labor for Occupational Safety and Health issued the following statement:

"We are encouraged to see the significant decline in worker injury and illness rates. This is the result of the relentless efforts of employers, unions, worker advocates, occupational safety and health professionals, and federal and state government agencies ensuring that worker safety and health remains a top priority every day."

"Despite the decline, approximately 2.9 million private sector workers suffered nonfatal injuries and illnesses last year. That is still far too many. At OSHA, we will continue to do all that we can to continue driving the rate down."

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

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

Conical Microspike Morphology Formation & Control on Various Metal Surfaces using Femtosecond Laser Pulse

BY DONG HYUCK KAM JYOTI MAZUMDER AND JEDO KIM

Formation of conical microspikes on various metal surfaces (316L stainless steel, Ti-6Al-4V, and Al5754) under femtosecond irradiation at high repetition rate is reported. Two types of microcone morphologies formed at these high repetition rates under high and low-fluence conditions were clearly distinguished. At low fluence (near the ablation thresholds), conical spikes with high aspect ratio and nonuniform distribution forms through random evolution. At high fluence, semiuniform conical spikes are formed through a simultaneous progressive evolution procedure with increasing the number of scans. Experimental results are presented showing the progression of random microspike formation to uniform microspikes as fluence increases and show how scan-speed affects the size of the spikes. Also, extraordinary absorption coefficient is measured for nonuniform conical spike covered 316L stainless steel formed under near threshold condition.

To continue reading more about this paper, visit **jla.aip.org**.

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.

ICALEO 2016 Conference Proceedings Available
The 35th International Congress on Applications of Lasers & Electro-Optics (ICALEO®) 2016 Congress Proceedings includes all submitted manuscripts from ICALEO (Plenary Sessions, Laser Materials Processing, Laser Microprocessing, Nanomanufacturing and Poster Presentations).

ICALEO 2016 Proceedings is available online only. After purchase, you will be emailed your username and password. To access the Proceedings, login with your username and password at **icaleo2016.conferencespot.org**. Please allow 48 hours for access to the Congress Proceedings.

Visit **www.lia.org/store** to purchase the ICALEO 2016 Proceedings.

LASER World of PHOTONICS 2017 – Home to the Future of Technology
The world's leading trade fair LASER World of PHOTONICS, from June 26 to 29, 2017 in Munich is setting new records: more than 1,250 exhibitors are anticipated, occupying 55,000 square meters of exhibition space to present visitors from around the world their ideas for the future of optical technologies. Right next door, leading researchers and industrial practitioners will be meeting for a technical dialog at the World of Photonics Congress 2017, one of the biggest trade congresses in the world of photonics.

With its focus on sensors, laser material processing, imaging and additive manufacturing LASER World of PHOTONICS 2017 is targeting dynamic growth areas in which optical technologies provide a clear boost to productivity and process reliability.

Five conferences will be taking place at the World of Photonics Congress 2017:

- CLEO®/Europe-EQEC 2017 - Conference on Lasers and Electro-Optics/Europe and the European Quantum Elec-tronics Conference
- Lasers in Manufacturing – LiM 2017, with a sub-conference on additive manufacturing
- EOS Conferences on Optical Technologies
- Optical Metrology 2017
- ECBO 2017 – European Conferences on Biomedical Op-tics

Application Panels – Added Value for Visitors
The practical lectures in the exhibition halls will again add value for trade fair visitors. The topics: Industrial Laser Applications, Optical Metrology and Imaging, Biophotonics and Medical Applications, Lasers and Optics.

LIA Offers More Affordable Student Membership
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 safety knowledge, expertise and career. As an individual member, you will qualify for significant discounts on LIA materials, training courses and the industry's most popular LIA events. We invite you to become part of the LIA experience — cultivating innovation, ingenuity and inspiration.

Your annual membership dues include a one-year online subscription to LIA's *Journal of Laser Applications®* and the *LIA TODAY* newsletter. In addition to discounts on all the products and services that LIA offers, Individual Members also receive a membership card and the opportunity to network through LIA conferences and workshops. As a student, becoming an LIA member has never been more affordable — we have reduced the annual fee over 50 percent to just $25 a year!

For more information and to sign up today, visit **www.lia.org/membership**.

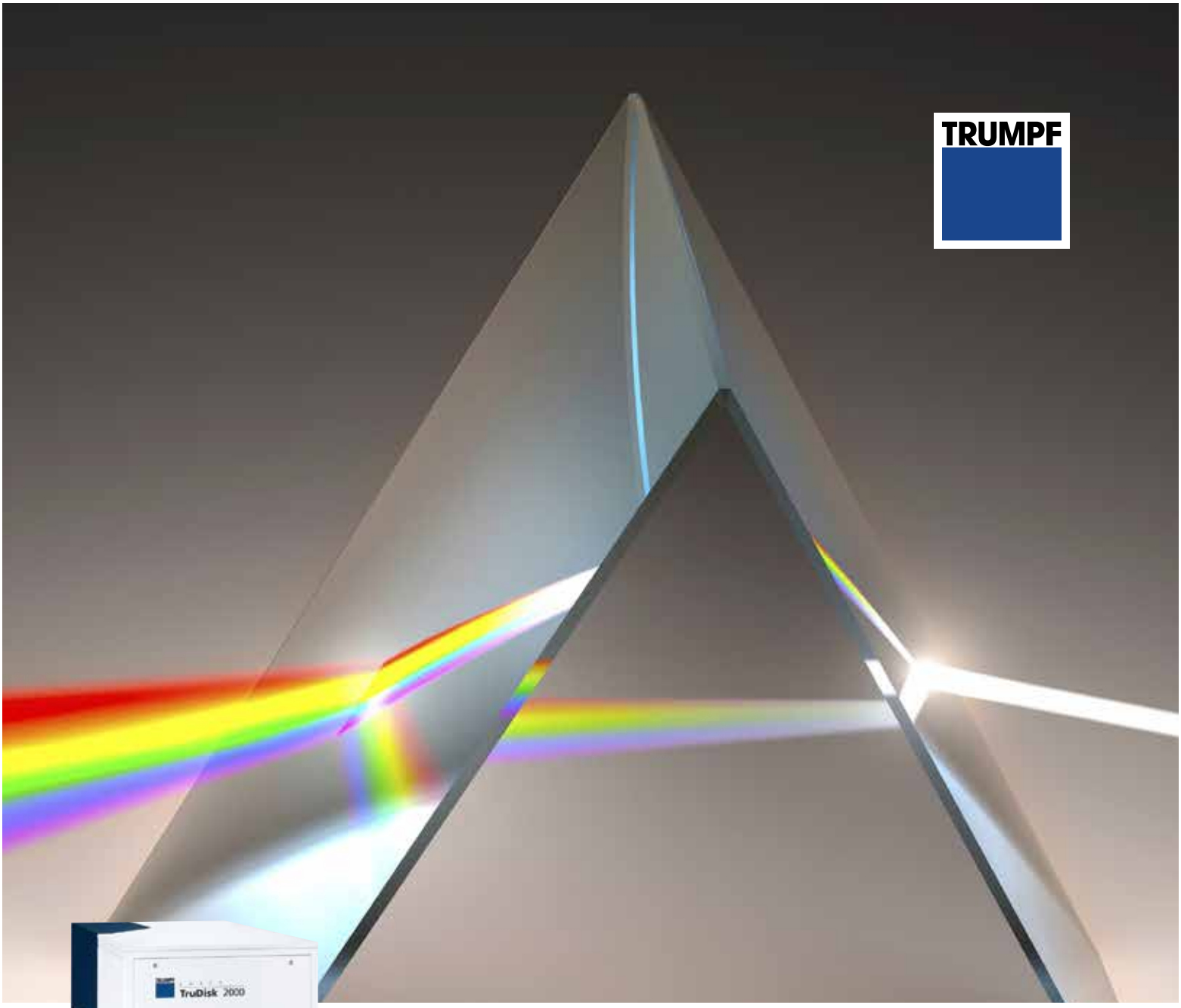
LIA's New Website Coming in 2017!
We are improving the existing website to include many convenient features for members and non-members alike.

Along with a user-friendly, mobile-responsive design, look for the following new LIA website features in early 2017:

- Members only access area
- Improved search of LIA's technical archives
- Variety of free downloadable educational resources
- Improved international support
- Online resource guide for company's products and services

Additionally, the new LIA website continues to be the go-to source for laser information. Any laser professional, from beginner to advanced looking to educate themselves or their employees on the latest information, will see improvement with an updated search function. Laser enthusiasts will be able to easily register for our industry leading events, purchase industry publications and find the most current technical information available.

By streamlining this process, we hope to further our mission to promote laser technology and its safe use through education, training and symposia. You can learn more about LIA's new website features as well as a sneak peek soon at **www.lia.org**.



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