THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

LIA TODAY

VOLUME: 26 NO: 2 | MAR/APR 2018

LIA LASER INSTITUTE OF AMERICA 50 YEARS 1968–2018

FOCUS

INDUSTRIAL MANUFACTURING

TRUMPF's Smart Factory Chicago

ILSC

INTERNATIONAL LASER SAFETY CONFERENCE

March 18–21, 2019

Embassy Suites® • Kissimmee, FL USA

CALL FOR PAPERS AND POSTERS

ABSTRACT DEADLINE:
October 4, 2018

www.lia.org/ilsc

FEATURING:

- **Laser Safety Scientific Sessions**
- **Technical Practical Applications Seminar**
- **Medical Practical Applications Seminar**
  Earn contact hours while experiencing cutting-edge presentations

THE WORLD'S LEADING CONFERENCE ON LASER SAFETY

Presented by:

LIA LASER INSTITUTE OF AMERICA | 50 YEARS 1968–2018

ilsc@lia.org | +1.407.380.1553 | 1.800.34.LASER

XVT™ Technology

See in FULL COLOR.

Kentek's XVT™ *Extraordinary Visible Transmission* Technology

HIGH VLT LIGHT GRAY FILTER and EXCEPTIONAL NEAR-IR LASER PROTECTION

Laser Protective Eyewear for Nd:YAG Applications.
Meets ANSI Z136.1 and ANSI Z87 Standards.

OD 7+ @ 1064nm VLT = 60%

KENTEK®
"Laser People Helping Laser People"®

components accessories containment signs/labels education eyewear

Int'l: 1 603.223.4900 • Fax: 603.435.7441 • info@kenteklaserstore.com • kenteklaserstore.com

Inquire about our laser auditing, laser safety training, and laser consulting services presented by experienced laser experts.

IN THIS ISSUE:

FEATURES

DEPARTMENTS

ADVERTISERS

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.

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

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

Jun. 12–14, 2018	Indianapolis, IN
Dec. 4–6, 2018	Orlando, FL

Laser Safety Officer with Hazard Analysis*

Jun. 11–15, 2018	Niagara Falls, NY
Sept. 17–21, 2018	Kansas City, MO
Oct. 15–19, 2018	Orlando, FL
Nov. 5–9, 2018	San Antonio, TX

*Certified Laser Safety Officer exam offered after the course.

Industrial Laser Safety Officer Training

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

Medical Laser Safety Officer Training*

Jun. 2–3, 2018	Atlanta, GA
Sept. 15–16, 2018	Kansas City, MO
Oct. 13–14, 2018	Orlando, FL
Nov. 3–4, 2018	San Antonio, TX

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

Industrial Laser Conference

Sept. 12, 2018	Chicago, IL

International Congress on Applications of Lasers & Electro-Optics (ICALEO®)

Oct. 14–18, 2018	Orlando, FL

International Laser Safety Conference (ILSC®)

Mar. 18–21, 2019	Kissimmee, FL

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

FOLLOW US!

Visit www.lia.org/subscriptions to sign up for our social media outlets.

President's Message

Welcome to the second edition of *LIA TODAY* for the year. It seems like only weeks ago I was writing the message for the first issue. How time flies. As I write this message, I am preparing to attend and chair LAM® 2018 on March 27–28 in Schaumburg, Illinois, with my co-chairs Minlin Zhong from Tsinghua University, China, and John Hunter from LPW Technology. This is the 10th LAM conference, and it is now one of the premier conferences on laser additive manufacturing in the U.S., reflecting the growing interest and application of lasers for additive manufacturing globally. This year's LAM is co-located with DigiFab Con & Lasers for Manufacturing Event® (LME®) to bring you more insight and information on the latest additive and laser manufacturing technologies. The focus of LAM is on the whole manufacturing process chain from design to manufacturing to application. The keynote sessions will be delivered by a representative from America Makes, Prof. Ehsan Toyserkani, University of Waterloo, Canada, and Prof. Xiaoyan Zeng, Huazhong University of Science and Technology, Wuhan, China, on the networking through industry/government/researcher partnerships in additive manufacturing and the benefits to industry. Other presentations include the latest in design tools for additive manufacturing, new additive technologies, materials for additive, process monitoring, and modelling and applications. In addition to the technology presentations, there is also a presentation on the latest developments related to additive manufacturing standards. After the presentations, LAM attendees can visit the LME exhibit, where they can continue their discussions with the presenters, learn about the latest products, meet with industry representatives, and network with others in the laser additive manufacturing field. Read this year's conference & exhibit highlights starting on page 14.

As mentioned in my January message, LIA is transitioning and we need to respond to local and global challenges and pressures that are impacting us in order to keep providing value to you, our members. The executive director, Nat Quick, is working hard to develop a plan to take us forward into the future. All aspects of LIA operation are being examined. Some of these will be discussed at the Board meeting at LAM and further refined for discussion and presentation to members at the International Congress on Applications of Lasers and Electro-Optics (ICALEO) later in the year.

Finally, I strongly encourage you to attend ICALEO, which will be held on October 14–18 in Orlando.

Milan Brandt, President

M. Brandt

Laser Institute of America

Executive Director's Message

As we progress with our bottom-up business assessment and continue refining our value proposition, we are identifying areas for efficiency improvement using tools such as process flow diagrams showing interactions among computer-to-computer, computer-to-person and person-to-person. We have identified and incorporated new programs and removed others to streamline operations and identify cost reductions. For example, marketing project campaigns must contain all necessary information and be delivered to the conference department before work is commenced. This prevents interrupting intermittent process approvals, which accumulate as delays. A thorough evaluation by listing and grouping of all information technology (IT) major projects has allowed development of a more comprehensive strategy for staffing, executing and completing corrections. An additional programmer has been contracted, which frees up the project manager and IT manager to support innovative growth projects.

An update on new initiatives:
Digitization of LIA's archives by partnering with the American Institute of Physics (AIP) includes a submission of more than 230 conference proceedings and more than 7,500 manuscripts, and it is scheduled for completion this fall before ICALEO 2018. This archive creates a new benefit for both individual and corporate members.

A completed interactive prototype template supports new content development and a low-cost laser safety training platform. This update also supports marketing outside our current database.

Other news:
Since 1985, LIA has been the secretariat of the accredited standards committee (ASC) Z136, the principle source for our laser safety content. Because of the thoroughness and outstanding procedural accuracy demonstrated during the recent ANSI audit, we have earned an increase in our audit cycle from five years to six years—a real rarity!

Dr. Islam Salama, Senior Director of Packaging Technology and Ecosystem Development at INTEL Corporation, will be the chair for a special conference session at ICALEO 2018 titled "Advanced Laser Technologies for Microelectronics and Integrated Circuit (IC) Fabrication." Abstract submission remains open for this session.

I will continue to keep you posted on advances on both the business assessment/turnaround and the impact of new initiatives as we continually address the question "what problem is LIA solving?" in the industry.

In preparation for our 50th anniversary, please submit your ideas for a timeline to *www.lia.org/50years* today. Also be sure to sign up now for ICALEO 2018 and ILSC 2019 vendor packages and sponsorships.

Nat Quick, Executive Director
Laser Institute of America

Added Value by Hybrid Additive Manufacturing

and Advanced Manufacturing Approaches

BY ANDRÉ SEIDEL, ARIANE STRAUBEL, THOMAS FINASKE, TIM MAIWALD, STEFAN POLENZ, MAXIMILIAN ALBERT, JONAS NÄSSTRÖM, AXEL MARQUARDT, MIRKO RIEDE, ELENA LOPEZ, FRANK BRUECKNER, ECKHARD BEYER, AND CHRISTOPH LEYENS

Additive Manufacturing (AM) has proven the potential of producing complex parts or components that cannot be manufactured by the use of conventional processes. However, there is often the need to carefully consider critical material properties like a brittle-to-ductile transition. This implies that the process window for high-performance materials is frequently rather constricted. As a matter of fact, the low fracture strain of 2-3 % of γ-TiAl alloys at room temperature is such a restriction.

This changing failure behavior can be explained with the brittle-to-ductile transition temperature (short BDTT), which usually ranges from 600 to 820 °C, depending on chemical composition and microstructure of the alloy.

In order to overcome the limited ductility and damage tolerance at room temperature, it is mandatory to assure the material processing be above the BDTT. Selected examples for suitable processing strategies are the preheating of the powder bed with an electron beam in a high vacuum condition or the interaction of energy sources by the combined application of a focused laser beam and induction heating (Hybrid Laser Metal Deposition), as addressed in the present paper.

Comparison of Electron Beam Melting (EBM) and Hybrid LMD with Regard to Temperature Control

Although the aforementioned additive manufacturing techniques allow the processing above the BDTT, they are differentiated by their specific characteristics in temperature control.

The electron beam represents a high-temperature heat source, which is able to exceed the melting and even evaporation temperatures of all materials. Via the magnetic deflection and rapid scanning at high frequencies, the electron beam can be effectively directed at the powder bed and thus enable preheating temperatures significantly above the BDTT. However, the produced temperature field is in general homogeneous in the lateral direction and rather nonhomogenous in the vertical direction with the maximum temperature in the working plane (see Fig. 1).

In contrast to the closed process of EBM, the Hybrid-LMD can be classified as highly flexible. With LMD, the filler metal is delivered into the process zone, subsequently preheated in the laser beam, and finally reabsorbed in the laser-induced melt pool (see Fig. 2).

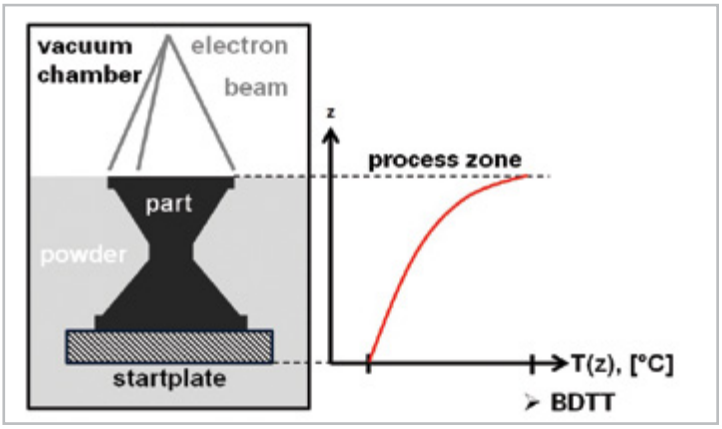


Figure 1: Exemplary illustration of a representative temperature regime for the suitable processing of gamma titanium aluminides (γ-TiAl)

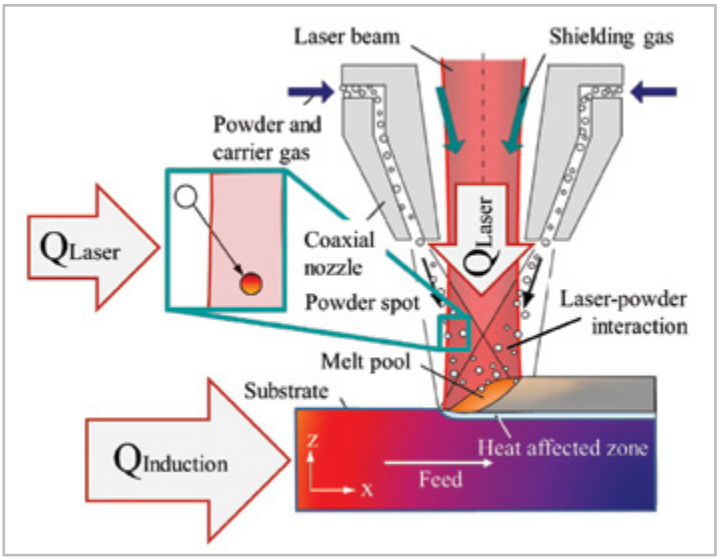


Figure 2: Schematic illustration of the laser material deposition process zone with schematic illustration of the laser-powder interaction and the energy input via inductive heating [cf. 10]

After solidification, the via LMD deposited material is generally characterized by a low dilution in combination with strong metallurgical bonding to the subjacent substrate, almost complete avoidance of porosity and precisely adjusted material properties. In order to customize temperature gradients and solidification conditions, additional energy sources like inductive heating can be applied. This controlled interaction of energy sources gives a greater degree of freedom, and most importantly, it enables a selective temperature tailoring.

As-built Condition of the via EBM Manufactured Gamma Titanium Aluminide Nozzles

First of all, gamma titanium aluminide (γ-TiAl) nozzles were manufactured via electron beam melting. During processing, the temperature was kept significantly above the BDTT. In this way, thermally induced stresses were mastered and lamellar-interface cracking was avoided. This was proven for the as-built condition via X-ray computer tomography with a detection limit of 10 μm. The results show no macropores and very limited micropores in regions close to the outer surface (see Fig. 3).

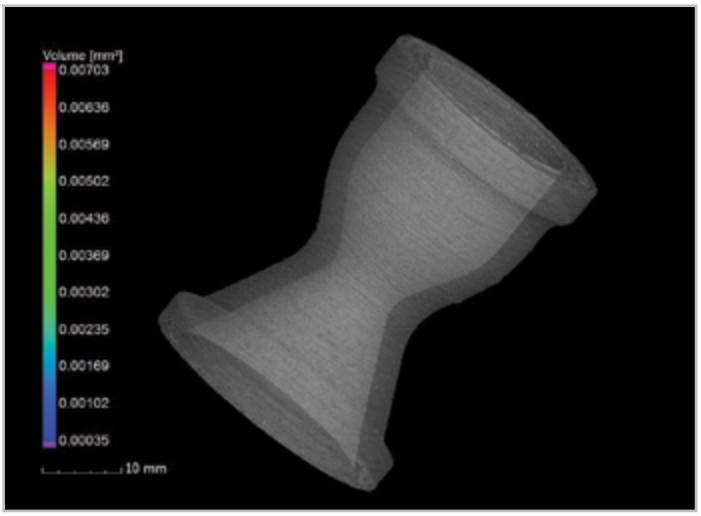


Figure 3: X-ray CT measurement of a via electron beam melting manufactured Ti-43.3Al-4.3Nb-1.2Mo-0.1B (at. %) alloy nozzle without cracks and macrospores and very limited microspores in regions close to the outer surface

Modification of a Gamma Titanium Aluminide (γTiAl) Nozzle via Hybrid Laser Metal Deposition

With hybrid LMD, the material is applied layerwise analogous to the EBM process. Nonetheless, there is a fundamental difference since the deposition can be applied entirely or local. Moreover, this can be done in a radial and/or axial orientation with single or multi materials (see Fig. 4).

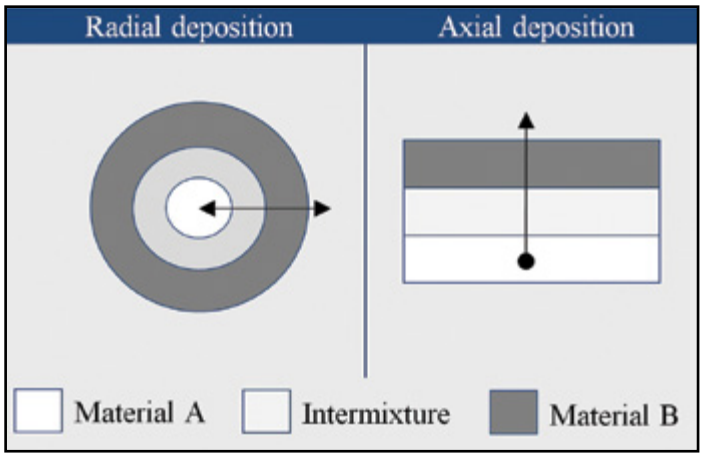


Figure 4: Schematic illustration of the partitioning of the layerwise additive manufacturing of rotation-symmetric parts into the essential elements of three-dimensional additive material deposition

Since there are also inner diameter deposition systems available, the radial deposition can be performed on the inside as well. Moreover, there is the unrivaled multiscale resolution of LMD with powder. Starting from a lateral single track resolution of 30 μm, it can be scaled up to 45 mm. Furthermore, LMD can be easily combined with additional energy sources. In the present case, inductive heating is used to overcome the BDTT analogous to the EBM processing (see Fig. 5).

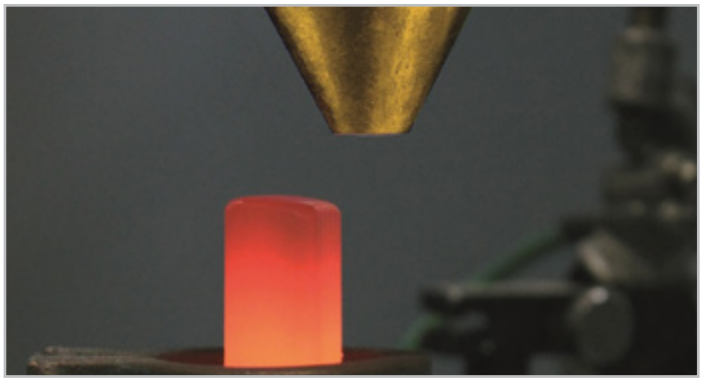


Figure 5: Hybrid additive manufacturing of a gamma titanium aluminide solid part with a coaxial laser powder nozzle and combined inductive heating [12]

The deposition welding was carried out via electron beam melting manufactured TNM-B1 alloy nozzles in the as-built surface condition. The experimental result is a fully dense coating with a continuous metallurgical bonding between the nozzles and the build-up (Fig. 7). Beyond a material deposition without defects, the surface was significantly smoothed (see Fig. 6).

Figure 6: Exemplary presentation of the radial (left) and axial adaption (right) and modification of the via electron beam melting manufactured Ti-43.3Al-4.3Nb-1.2Mo-0.1B (at. %) alloy nozzle by layerwise additive manufacturing via hybrid LMD with the same type of powder

(Continued on page 8)

Considering the low ductility of intermetallics, this can be a distinct advantage with regard to mechanical intermediate or post-processing. The technological challenge is to remove material by plastic deformation rather than the characteristic brittle fracture. Hence, laser metal deposition can also enable the reduction of topographically induced stress peaks.

Post machining of the via hybrid LMD manufactured gamma titanium aluminide (γ-TiAl)

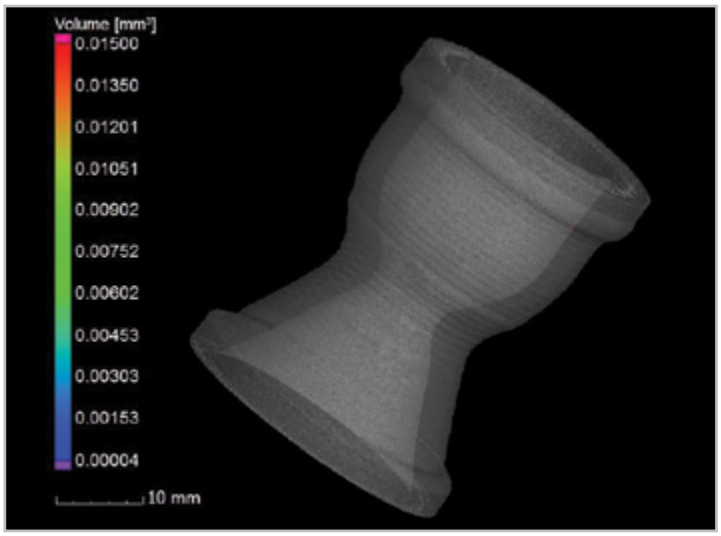


Figure 7: X-ray CT measurement of an via electron beam melting manufactured Ti-43.3Al-4.3Nb-1.2Mo-0.1B (at. %) alloy nozzle after radial laser metal deposition with the same type of powder material

Looking at high-quality components, subtractive and additive manufacturing are not competitors. Instead, it is the case that intermediate or post machining is often essential for successfully applying additive manufacturing to the production of end-use metal parts. In this sense, it is evident that additive manufacturing process chains need to include appropriate subtractive manufacturing processes. In this context, it can be determined that latter processes are also closely related since they are an inversion of the near net concept, but instead of adding material it is subtracted away.

The subsequent figure shows the radial and axial adapted TNM-B1 nozzle in the post machined condition (see Fig 8). In summary, it shall be indicated that the investigations looked at the entire process chain with particular regard to the production of individual parts and/or products. ■

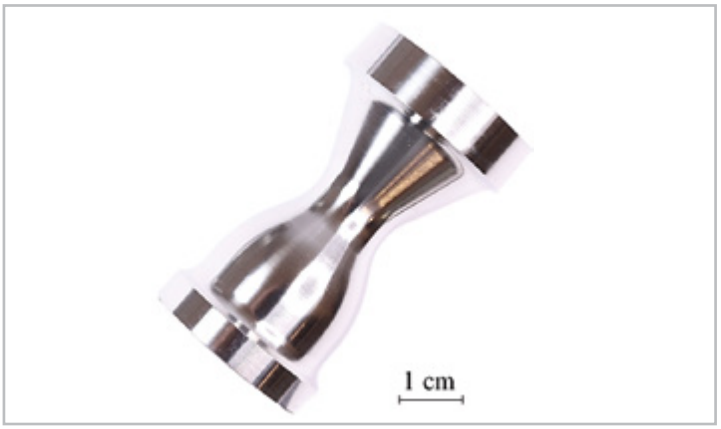


Figure 8: Radial and axial adapted TNM-B1 nozzle in the post machined condition

Literature

[1] Gubta et al.; Hybrid Machining Processes Perspectives on Machining and Finishing, Springer International Publishing AG, 2016

[2] Grzesik; Advanced Machining Processes of Metallic Materials: Theory, Modelling, and Applications, Edition 2, Nov. 2016

[3] Brückner, Frank; Seidel, André; Straubel, Ariane; Willner, Robin; Leyens, Christoph; Beyer, Eckhard.; Laser-based manufacturing of components using materials with high cracking susceptibility, Laser Institute of America -LIA-: pp.586-592, Paper 1001 (peer reviewed)

[4] Leyens, Christoph; Brueckner, Frank; Seidel, André; Straubel, Ariane; Marquardt, Axel; Willner, Robin; Laser Additive Manufacturing of Titanium Alloys and Titanium Aluminides, Ti-2015: The 13th World Conference on Titanium, Symposium 5. Intermetallics and MMCs

[5] Yu Wang, Dongliang Lin, et al. (1999). "Brittle-to-ductile transition temperature and its strain rate sensitivity in a two-phase titanium aluminide with near lamellar microstructure." Journal of Materials Science 34: 3155-3159.

[6] Straubel, A., et al., Gamma Titanium Aluminide Alloys 2014, John Wiley & Sons, Inc., 2014, pp. 105-109.

[7] Lipsitt, H. A., D. Shechtman, et al. (1975). The deformation and fracture of TiAl at elevated temperatures. Metallurgical Transactions A 6 (11): 1991-1996.

[8] Appel, F., J. D. H. Paul, et al. (2011). Gamma titanium aluminide alloys / science and technology. Weinheim, WileyVCH.

[9] Brookes, S. P. (2009). Thermo-mechanical Fatigue Behaviour of the Near-[gamma]-titanium Aluminide Alloy TNB-V5 Under Uniaxial and Multiaxial Loading, Bundesanstalt für Materialforschung und-prüfung BAM.

[10] F. Brückner, Modellrechnungen zum Einfluss der Prozessführung beim induktiv unterstützten Laser-PulverAuftragschweißen auf die Entstehung von thermischen Spannungen, Rissen und Verzug, Dresden: Fraunhofer Verlag (Diss.), 2011.

[11] Riede, M.; Mikro-Generierte Verklammerungsstrukturen, Fraunhofer Annual Report 2016, S. 34-35

[12] Brückner, F.; Finaske, T.; Willner, R.; Seidel, A.; Nowotny, S.; Leyens, C.; Beyer, E.; Laser additive manufacturing with crack-sensitive materials - Temperature monitoring system for defect-free material build-up, Laser-Technik-Journal 12 (2015), Nr. 2, S 28-30

Affiliations

André Seidel, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Ariane Straubel, Technische Universität Dresden

Thomas Finaske, Fraunhofer Institute for Material and Beam Technology

Tim Maiwald, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Stefan Polenz, Fraunhofer Institute for Material and Beam Technology

Maximilian Albert, Fraunhofer Institute for Material and Beam Technology

Jonas Näsström, Luleå University of Technology

Axel Marquardt, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Mirko Riede, Fraunhofer Institute for Material and Beam Technology

Elena Lopez, Fraunhofer Institute for Material and Beam Technology

Frank Brueckner, Fraunhofer Institute for Material and Beam Technology, Luleå University of Technology

Eckhard Beyer, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Christoph Leyens, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Enhanced Manufacturing Possibilities Using Multi-Materials

in Laser Metal Deposition

BY FRANK BRUECKNER, MIRKO RIEDE, MICHAEL MÜLLER, FRANZ MARQUARDT, ROBIN WILLNER, ANDRÉ SEIDEL, ELENA LOPÉZ, CHRISTOPH LEYENS, AND ECKHARD BEYER

Laser Metal Deposition (LMD) is used for the coating, part refurbishment, and also the manufacturing of functional components in several branches. The process is suitable to a broad spectrum of materials as Fe-, Ni-, Co- or Ti-based alloys.

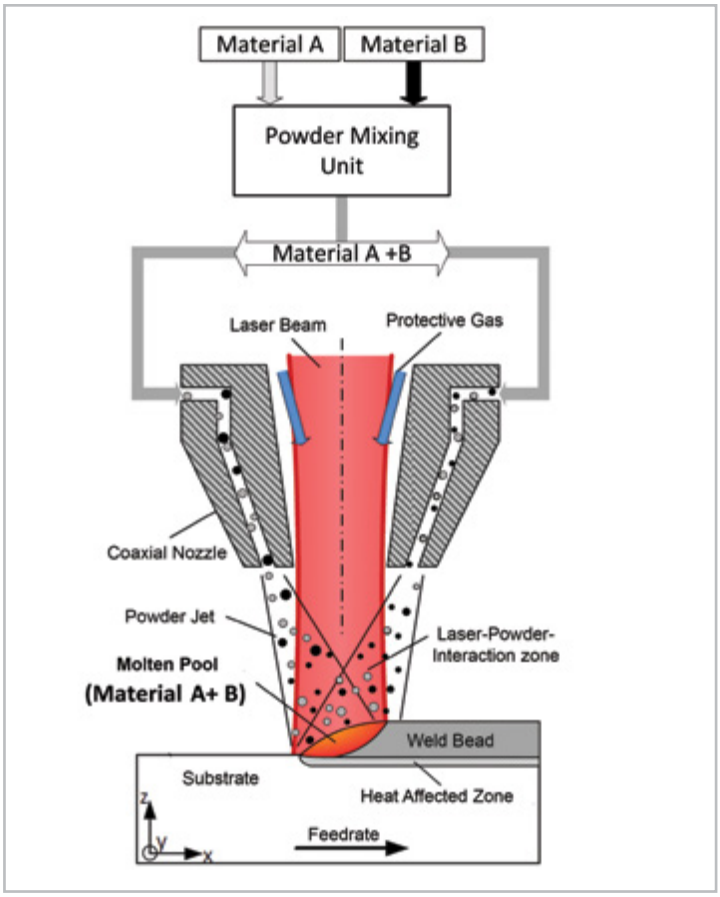


Figure 1: Powder-based multi-material LMD processing

To deposit material on a substrate, the powder is blown into the process zone by a nozzle, preheated in the laser beam, and finally reabsorbed in the laser-induced melt pool. Several different powder materials can be mixed in-situ by an integrated powder-mixing chamber in the nozzle tip (Fig. 1). Due to a continuous as well as localized controlled powder mixing, LMD enables new possibilities in AM (e.g., in-situ alloying without any additional joining process [1-2]).

Possibilities of Multi-Material LMD

By means of the simultaneous use of several powder materials, LMD is capable of forming the following multi-material configurations:

I. Locally tailored material properties
II. Integrated transition joints
III. Composite materials
IV. In-situ alloying

I. Locally Tailored Material Properties: The filler material can be chosen according to the local requirements of the part by creating a sharp material intersection or by creating a graded material transition over several layers. This offers a "material follows function" approach in order to achieve a lighter and more-efficient component.

II. Integrated Transition Joints: Buffer layers can be applied to overcome the metallurgical incompatibility. The buffer layer isolates the substrate material from the final build-up material and helps to evade brittle intermetallic phases or unfavorable differences in the thermo-physical properties.

III. Composite Materials: The integration of hard materials (e.g. carbides, ceramics) into a ductile metal matrix can significantly increase the wear resistance of the produced parts (e.g. for components as tools or turbine blade tips [1].)

IV. In-situ Alloying: The LMD process can also be used for an in-situ alloying approach. By controlling the mixture between different powders, the alloy composition of the deposited material can be customized simultaneously.

Material-Related Challenges

Several material combinations, such as Cu-Fe, are highly interesting for industrial applications but cause several issues stated below:

I. Differing thermo-physical properties
II. Poor miscibility
III. Differing absorptivity
IV. Inhomogeneous material distribution [3]

I. Differing Thermo-Physical Properties: Primarily the material properties thermal conductivity, melting range and CTE cause problems concerning the multi-material processing by means of LMD. Differences in these properties may lead to unwanted formation of cracks, delamination or an instable welding process.

II. Poor Miscibility: Several material combinations cause issues due to a decreasing miscibility during the cooling process and the formation of brittle phases. The metallurgical incompatibility can be overcome by previously described buffer layers with beneficial miscibility related to the substrate as well as the final build-up material.

III. Differing Absorptivity: By modifying the material composition during processing and, hence, the absorptivity, a changed energy input combined with locally differing temperature states might occur. In order to improve the absorption of highly reflective materials like copper, green lasers with a favorable wavelength of λ=515 nm can be applied.

IV. Inhomogeneous Material Distribution: To overcome material segregation of premixed powders, the material mixing has to be done closely to the process zone, which could be realized by using powder nozzles with a built-in mixing chamber. Vaporization of single alloying elements can be avoided by well-chosen thermal boundary conditions or by well-adjusted filler materials.

Multi-Material Combinations with Beneficial Miscibility

A steady transition in material properties is desirable in order to decrease unwanted effects like high residual stress. The following example shows experimental investigations of a graded LMD transition based on the materials stainless steel AISI 316L and the nickel-based superalloy Inconel 718 (see Fig. 2).

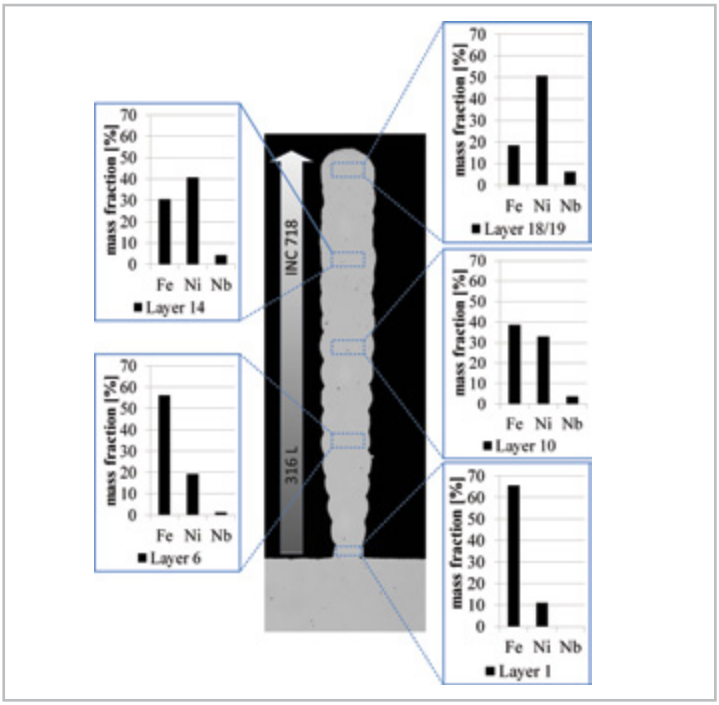


Figure 2: EDX analysis (Fe, Ni, Nb) of the generated AISI 316L-INC718 graded material transition

With increasing wall height, the amount of AISI 316L powder being fed was decreased and replaced with Inconel 718 powder in order to gradually achieve a complete material transition. For analyzing the changing chemical composition, an EDX analysis was conducted (Fig. 2). Since Nb is only part of the alloy Inconel 718, it can be used as a marker element for detecting the gradual transition. The EDX analysis indicates a gradual replacement of AISI 316L and Inconel 317 in the same ratio. It can be seen that AISI 316L has been fully replaced by Inconel 718.

Multi-Material Combinations with Limited Miscibility

Copper on stainless steel is a potential material combination of high relevance. This joint is particularly interesting for heat exchangers, electrical components and coatings on thermal-loaded parts to improve heat dissipation.

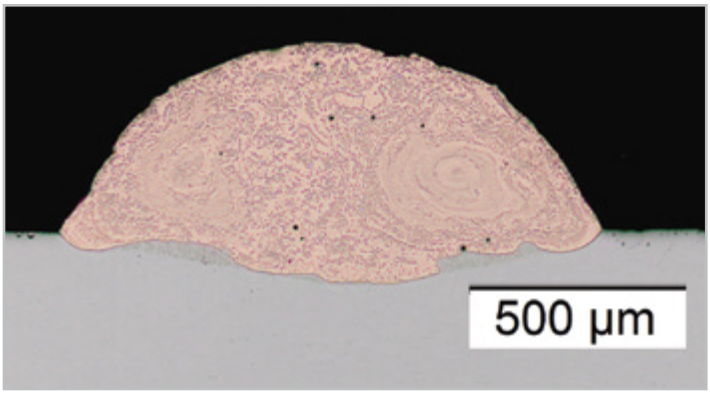


Figure 3: Cross section of a single LMD track of Cu on AISI 304L

In this study, 44.4% pure copper was deposited on an AISI 304L stainless steel substrate (Fig. 3). The alloys were processed by Laser Metal Deposition using a green laser with a wavelength of 515 nm. The microstructure of the single track is characterized by inhomogeneous distributed steel globules and star-shaped dendrites in a copper-rich matrix (Fig. 4).

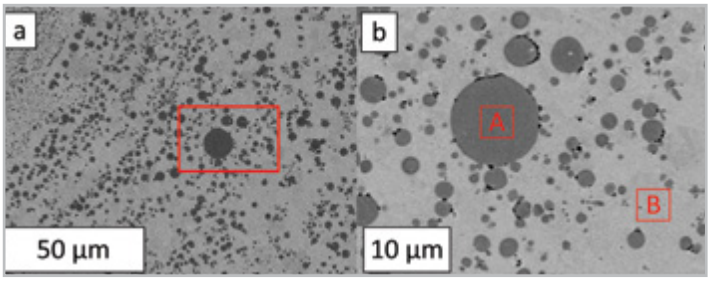


Figure 4: SEM of the copper track

The composition of the dark spherical areas (marked with A) measured by EDX (Fig. 4b) is similar to 304L stainless steel with some traces of copper and a minor nickel content.

(Continued on page 12)

The analysis of the bright zones (marked with B) indicates a higher concentration of copper containing less iron and residual elements.

Immiscible Material Combinations

Complete immiscibility is often caused by missing melting range overlap or missing liquid phase. Nevertheless, such combinations are applied for particle or fiber-reinforced metal matrix composites (MMC), which provide highly beneficial mechanical properties.

Using LMD, the matrix component is completely molten while the solid component is preheated and reabsorbed in the melt. Due to the melt pool convection (Marangoni effect) the particles are distributed and embedded homogenously. Using the benefits of LMD, even a graded distribution is possible. Using this approach, a TiC-Ni MMC was manufactured by LMD.

Conclusion

Relevant multi-material combinations (sharp transitions, graded structures, composites, buffer layers as well as in-situ alloying) are already feasible for a certain amount of materials.

The broad range of material combinations shows the enormous potential of LMD. Investigations of further material combinations, such as Fe- and Ti- based alloys, are expected to be highly beneficial for the improvement of industrial applications. ■

Literature

[1] Cuppoletti, J. (Ed.): Metal, Ceramic & Polymeric Composites for Various Uses. InTech 2011

[2] Kotoban, D., Aramov, A. and Tarasova, T.: Possibility of Multi-material Laser Cladding Fabrication of Nickel Alloy and Stainless Steel. Physics Procedia 83 (2016), p. 634–646

[3] Li, W., Yan, L., Karnati, S., Liou, F., Newkirk, J., Taminger, K. M. B. and Seufzer, W. J.: Ti-Fe intermetallics analysis and control in joining titanium alloy and stainless steel by Laser Metal Deposition. Journal of Materials Processing Technology 242 (2017), p. 39–48

Affiliations

Frank Brueckner, Fraunhofer Institute for Material and Beam Technology, Luleå University of Technology

Mirko Riede, Fraunhofer Institute for Material and Beam Technology

Michael Müller, Fraunhofer Institute for Material and Beam Technology

Franz Marquardt, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Robin Willner, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

André Seidel, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Elena Lopéz, Fraunhofer Institute for Material and Beam Technology

Christoph Leyens, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Eckhard Beyer, Fraunhofer Institute for Material and Beam Technology, Technische Universität Dresden

Laser Safety Solutions for 40 Years

Industrial / Medical / R&D

Upcoming Laser Safety Training Courses

Raleigh-Durham, NC: June 25-29, 2018

Hosted by:

Measurements for Laser Safety:

- *This two and one half day hands-on course (6/25-6/27) will teach you how to perform laser safety measurements according to applicable laser safety standards.*

Principles of Lasers & Laser Safety Officer Course:

- *This five-day course (6/25-6/29) is designed for those persons designated as the Laser Safety Officer (LSO) for their facility who also need a solid introduction to lasers.*

Please visit www.rli.com for additional dates and details.

Laser Sentry™ Entryway Control System With LED Warning Sign

- Manages entry, egress and laser emissions within a controlled area
- 50,000 + Hr LED Lifetime / Low Voltage
- Complies with "Entryway Controls" as specified by ANSI Z136.1-2014, Section 4.4.2.10.3

Rockwell Laser Industries is a global provider of laser safety training, audits, consulting, and products.

Rockwell Laser Industries, Inc.
Tel: (800) 94-LASER
Int'l: +1 (513) 272-9900

www.rli.com

LAM 2018 Highlights

10 YEARS LAM® LASER ADDITIVE MANUFACTURING CONFERENCE

BY RON D. SCHAEFFER, PH.D.

The Laser Additive Manufacturing Conference (LAM®) was held in Schaumburg, IL from March 27-28, co-locating with the Lasers for Manufacturing Event® (LME®). The attendance at LAM was over 100 people, of which 63% were first time attendees. This is a very interesting statistic, as new blood fuels growth for future years. Coupling this fact with the feedback I received, returning attendees also had highly positive comments about the event and will continue to return year after year.
This year's program was led by Conference General Chair Milan Brandt of RMIT University. John Hunter of LPW Technology, Inc. and Minlin Zhong of Tsinghua University served as Conference Co-chairs. Here are a few highlights:

- One of the keynote speakers, Rob Gorham, the executive director of America Makes, National Center for Defense Manufacturing and Machining, received very positive feedback for his talk on a public-private approach to advancing the AM industry. He drew from his experience with America Makes, which is a public-private partnership focused on research and innovation in additive manufacturing and 3D printing.
- John Lehman's (leader of the Sources and Detectors research group at NIST) talk on novel developments in process monitoring at NIST was very well received. Since the 1970s, the National Institute of Standards and Technology has used thermal detectors to provide high-power laser measurements. The Institute has also been exploring novel methods for detecting alloying elements and melt-pool evolution in laser-based manufacturing processes. Lehman's presentation explored these developments as well as applications for laser-based manufacturing.
- Finally, Jana Kelbassa, a research associate in the Laser Material Deposition group at the Fraunhofer Institute for Laser Technology, received the most kudos for her talk on Wire vs. Powder in laser metal deposition. The Fraunhofer Institute for Laser Technology has developed a way to improve the process by introducing a prototype for a 3D-capable coaxial wire processing head to replace the traditional powder additives. Wire additives pose less health and safety risks, leave the deposited material and machinery cleaner than powders, and are more efficient. Kelbassa has participated in a collaborative research and development project focused on using the new wire processing head in repair and additive manufacturing applications.

Overall, presentations were rated as highly relevant. Attendees found the presentations provided valuable insight into the additive manufacturing industry. When asked what topics were found to be most interesting, we had a large range of responses including metallurgy, process monitoring, quality assurance, policy and technology, advances in wire fed/coaxial systems and looking at future applications. Most responders felt that the opportunity to interface with world-wide experts on a personal basis was the best part of the conference. Our overseas friends in particular thought it was a great opportunity to meet with potential customers and collaborators in the US.

Rob Gorham from America Makes delivers LAM's keynote address

After the final LAM session, attendees took advantage of the free access to the LME exhibit. There were about 60 exhibitors, including LAM Sponsors such as Alabama Laser, TRUMPF, LPW and Laserline.

As the LIA staff evaluates the conference and plans for the future, they welcome any and all feedback on ideas to attract more people and grow this conference as this segment of the industry grows. In the future, we will try to attract more people from industries other than defense, aerospace and oil/gas and try to address mainstream consumer markets, which will greatly expand the interest in this conference.

Finally, all of the attendees gave high kudos to new LIA Executive Director Dr. Nathaniel Quick and his team for their dedication and hard work, and also for their availability and approachability. ■

Ron D. Schaeffer is a contributing writer for LIA.

LME 2018 Highlights

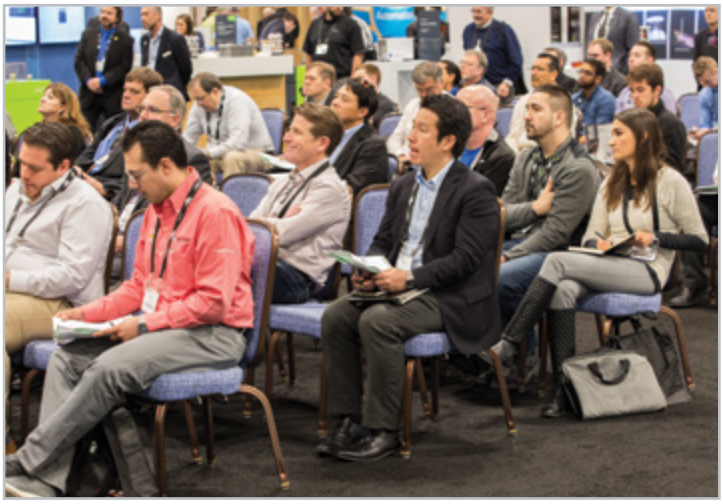
LME® LASERS FOR MANUFACTURING EVENT®

BY RON D. SCHAEFFER, PH.D.

The Lasers for Manufacturing Event® (LME®) was held in Schaumburg, IL, March 28–29. For the participants, the event was very successful, as they were able to interface with laser and optics exhibitors at leisure. Unlike larger events like Photonics West, individuals could receive as much "face time" with exhibitors as needed, and many took advantage of this opportunity. As far as the exhibitors, LME provided high-quality leads.

The education portion of LME, expertly organized by Education Program Chair Dr. Robert Mueller, started with the Wednesday morning Tutorial that I gave on high precision USP (Ultra Short Pulse Laser) material processing. There were about 30 people in attendance—pretty good for an 8:30 am presentation. More than two-thirds of the attendees were new to LME. The next day, Tracey Ryba of TRUMPF gave a Tutorial on Laser Welding that had about the same attendance. These Tutorials were held during the show's off-hours in a dedicated room off of the show floor.

There were four Keynote addresses held in the theater on the show floor—one in the morning and one in the afternoon of each day. Once again, I had the privilege of giving the first Keynote on Wednesday morning. The attendance at this particular talk could not have been better, as there was "standing room only." The talk focused on reviewing 2017 industry numbers and giving some predictions based on metrics and gut feelings about how the 2018 year would look. There are a lot of factors —such as politics—that cannot be factored into any logical forecast. But just looking at the laser industry and assuming no real political or market upheavals, 2018 looks to be a solid year. In any case, there are two things that are sure. The first is that, no matter how the economy in general does, the laser industry is once again outperforming it, so we are really in a great industry! The second is that, according to all of the people I talked to, Q1 numbers look good to great so far!

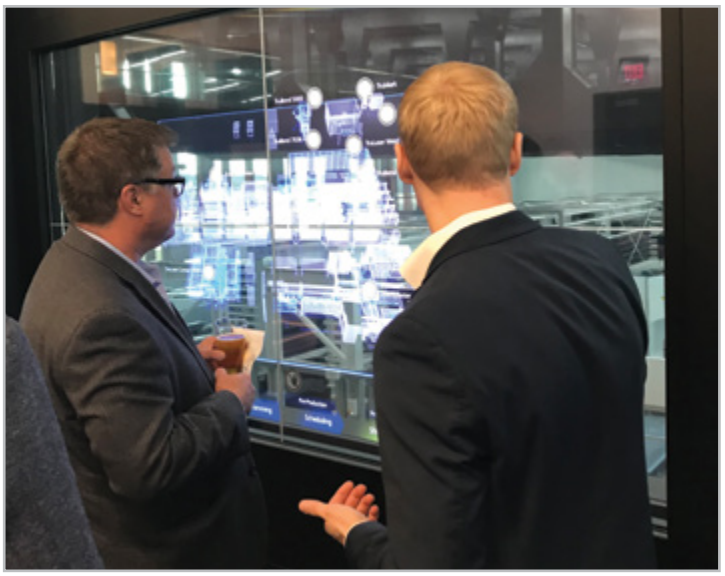


LME attendees take a break and listen to presentations at the laser technology showcase

LME attendees browse the latest laser products and solutions the industry has to offer

My fellow Beer's Law band member, Dr. Henrikki Pantsar (LIA Secretary), rounded out the Keynotes in the afternoon with his talk on "Laser Processing in Heavy Fabrication." Dr. Pantsar is very well-qualified to discuss this subject, as he is Director of Applications and Services at TRUMPF Inc. and interfaces with applications laboratories across the country. On Thursday, the Keynote talks were given by Carl Bryant from Prima Power and Dr. Ken Dzurko from SPI Lasers. Carl's talk followed the Prima Power open house on Wednesday night and was a great opportunity to tie up any loose ends that may have been left after the plant tour (more about this later) and also to inform attendees who could not make the tour about Prima Power. Ken, a well-known speaker and great presenter in the laser industry, presented advances in laser welding using high brightness fiber lasers. The audiences for these talks varied according to subject and time slot, but there were at least a couple dozen interested listeners for each talk with topics covering the range of activities in the laser community. Between these talks, exhibitors and

(Continued on page 16)



LME atttendees at TRUMPF's Smart Factory Tour

other industry people were given the opportunity to make their pitches on the show floor.

The Ask the Expert booth, arranged by Neil Ball of Directed Light, was a valuable resource for attendees and other exhibitors alike. The primary role of the scheduled experts was to direct anyone with questions to the appropriate person on the show floor where any and all detailed questions could be answered.

Two offsite tours were held on Wednesday evening, one to the local TRUMPF Smart Factory and one to Prima Power—both within a 15-minute drive. My only complaint is that I could not attend both, so I chose the TRUMPF Smart Factory tour (primarily because I heard of it first!) I was quite impressed —and not just with the great food and freely flowing drinks! It was not clear to me beforehand, but this facility showcases both TRUMPF's laser and non-laser manufacturing equipment. I also learned onsite that this is a fully functional 'job shop' making parts for both TRUMPF and for some external customers who are either waiting to purchase equipment or have volumes too small to justify buying a big piece of machinery. It is a self-funding showroom! The first thing that impressed me was that there were about 80 people given complete access to the whole area, walking around with food and drinks while machines did their thing and robots whisked about the factory. Of course some of us (no names!) tried to get in front of the moving robot to see if we could get run over, but those darn things are smart enough that not only was nobody run over, but nobody even spilled a drink! The second thing that impressed me was the "smart glasses" used in the control room and by service personnel. These glasses are Internet-connected. Images are sent by the service center to the service technician and are displayed on the field technician's data glasses with instructions, thus allowing hands-free service.

Prima Power also hosted an Open House at its showroom in nearby Arlington Heights, IL. Another large group of visitors, composed of laser industry experts, suppliers, and prospective customers, were able to get a close-up view of the Prima Power Laser Next 3D Laser. Thanks to a deep and unique experience of more 35 years in this field and to a continuous dialogue with customers and partners operating in the car industry, Prima Power has designed the new 3D laser machine for automotive production: Laser Next. In developing Laser Next, Prima Power has focused on the achievement of the following main benefits for the user:

- Maximized throughput with a dramatic reduction of cycle times (25% increased efficiency over previous models)
- Space-efficient layout both for standalone and multi-machine configuration (Space is money, and a well-conceived layout helps save square meters and optimizes plant logistics.)
- Improved overall equipment efficiency (capitalizing on its experience of hundreds of installations for the 24/7 manufacturing) Laser Next has a working range of 3,050 x 1,530 x 612 mm and is equipped with 3 kW or 4 kW high-brilliance fiber lasers.

One thing everybody agreed on is that the LME hotel/conference venue was really good in that it had everything available onsite with reasonably priced rooms, plenty of parking and a friendly and helpful staff. The hotel staff set up my cohort Henrikki and me with a PA and a great location in the bar/restaurant for a Beer's Law gig on Tuesday evening (which went very well, and they even asked us to play again the next night, but we had other offsite visits as mentioned above). Another positive recurring theme was that there was a wide range of products and services offered by exhibitors representing just about everything one could hope to find related to lasers, systems, components and in particular a large range of laser processing expertise available on the show floor.

Finally, we all owe a great debt to the LIA staff who work tirelessly before, during and after the conferences to make the experience pleasant and profitable—so hats off to the LIA staff and new Executive Director Dr. Nathaniel Quick as they navigate the stormy seas of the laser industry and prepare for the big flagship event in the Fall, ICALEO®. This year's ICALEO will be held in Orlando. Insiders have heard of some surprises and very high-profile speakers who might attend as a part of LIA's 50th anniversary celebration at ICALEO. Plan to come to this very important conference in the fall! ■

Ron D. Schaeffer is a contributing writer for LIA.

LIA's 50th Anniversary – Part 2

Laying the Groundwork for ICALEO

BY DAVID BELFORTE

It was a bright November day in 1979 and I was on my way to a meeting at the Tokyo Hilton Hotel that would lead to a defining moment in the history of LIA.

First, a little framework is in order. Back in the day, Japan was arguably the world leader in industrial laser material processing, mainly as a result of government funding for research and development programs at leading technical universities. Metal fabricating shops in Japan had advanced laser sheet metal cutting to industry acceptability, positioning Japan as the preeminent market for this technology.

With a background in laser metal cutting, I was intrigued by this success in Japan, so in 1976, I arranged a fact-finding trip to the country to look into business opportunities for the Avco Everett Metalworking Lasers company where I was employed. This trip, arranged by the two trading companies representing my employer—Marubeni and Japan Lasers—took me on a two-week journey to most of the laser material processing hot spots in the country.

In the course of this and subsequent trips, I gained a unique view of the laser processing technology advances being made in Japan. In doing so, I met with and established relationships with most of the leading developers of laser cutting and welding technology in the country. They opened my eyes to a wealth of laser process technology that had advanced metal processing but was relatively unknown outside Japan.

With this knowledge, it occurred to me, as the 1978 LIA president, that the advances made in Japan deserved wider dissemination outside the country. I broached an idea on how to do this with Sid Charschan (Western Electric), Chairman of LIA's Material Processing committee, and the Executive Committee of the LIA Board of Directors. Out of this came LIA approval to open discussions with leading Japanese laser processing organizations with a goal of presenting an international conference on the subject.

I outlined plans for a joint conference to my company's representatives in Japan and briefed them on actions they should initiate. Shortly thereafter I received a wake-up call—the leaders of the organizations I proposed as conference partners were cautious about teaming up with LIA, and they were not receptive to partnering with each other.

I won't go into the details behind this, except to say many organizations in Japan were competing for laser processing development funding from the same government agencies, creating tense relationships. To a degree, this engendered personality clashes that closed down communications channels.

For several months, using contacts I had established in my travels, I was able to direct the LIA's conference proposition to leaders of the Japan Laser Processing Society and the Japan Society for Laser Technology, who agreed to meet in Tokyo to discuss the LIA's proposal. And that takes us to where I started this story.

My local representatives had arranged for the meeting in a corner of the Hilton's lobby, which had several couches set in a circle. The invited guests from each organization staked out seats as far from each other as possible, so I took my seat between them, where I could be a referee if necessary.

Acting as a moderator and backed by an interpreter, I attempted to assuage any strong feelings by suggesting a conciliatory idea—the conference would be a joint U.S./Japan event to be known as the first International Laser Processing Conference (ILPC). Each organization would be responsible for providing technical papers and speakers from a list of well-known authors on various aspects of the technology.

The International Laser Processing Conference (ILPC) early 80's

David Whitehouse, President of LIA presents the Honored Speaker Award to Herbert M Dwight, Jr. at the ILPC in 1981

Dave Belforte, chairman of the ILPC conference presents an award to Professor Dr. Y. Arata, President of the Japan Laser Processing Society

An extensive dialogue exchange followed, and after an hour we arrived at a consensus. The ILPC was born, and it was to be held in 1981 at a convenient date and location in the U.S., with me as the General Chairman.

As the meeting drew to a close, I shook hands with each leader, setting an example that they reluctantly followed. Departing the hotel, I noticed the leaders of each group communicating with each other in an amiable fashion, even deep bowing, a sign of great respect. My local representative gave me a thumbs up and a large smile and said, "We didn't believe you could pull this off."

The conference was set for November 16-17, 1981, in Anaheim, California, with a program with 33 juried papers from Japan and the U.S.

The event, held at the Marriott Hotel in Anaheim, was a great success, drawing more than 150 attendees. Included was a large contingent of post-grads from Germany, who later became leaders of laser technology in that country, surpassing the technical prowess in Japan.

Later, David Whitehouse, then LIA President, disclosed that the LIA Education Committee had decided to take the ILPC model to the next level as part of the newly created International Congress on Applications of Lasers & Electro-Optics (ICALEO), a conglomeration of 5 symposia on laser applications. The first such event would be held in Boston on September 20-23, 1982. As part of the first ICALEO, an LIA Material Processing Symposium was scheduled. Organized under Chairperson Michael Bass, in cooperation with 14 organizations (two of which were the Japanese Societies that had first made their international appearance at the ILPC event the previous year), a modest 23 papers drew a small but enthusiastic audience.

Over the years, ICALEO has become an internationally recognized laser material processing event, drawing a larger audience each year as the LIA has moved the event around the U.S. to attract an increased foreign audience. This year, the 37th ICALEO, now focused exclusively on laser material processing, will move back home to Orlando on October 14-18.

On the 50th Anniversary of the LIA, it is appropriate to look back at the beginnings of this immensely important and highly regarded ICALEO series and recall its more humble origins when a group of technically autogenous yet socially disparate Japanese laser process developers cast aside differences to join with an ambitious young society from the U.S. to plant the seeds for one of the world's most respected international advanced laser material processing conferences. ■

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

Dave Whitehouse (right) receiving the President's Award for outstanding service to the LIA, from Myron Wolbarsht (left). 1983 LIA President

Exhibitors' displays provide conference attendees glimpses of state-of-the-art equipment available in the laser industry (1983)

ALIO Industries, Inc.

Meeting and Exceeding Current Application Needs

A pacesetter in the industry, ALIO Industries, Inc. is known for its innovative designs and successful production of precision motion systems. More than 300 standard products and numerous custom OEM designs, ALIO Industries repeatedly meets and exceeds the current application needs for precision, high performance and reliable motion.

Founded in 2001 by current owner Bill Hennessey, ALIO Industries is dedicated to building the most precise motion systems with unparalleled performance and reliability. The expert team at the Colorado-based company has created numerous products and product lines that prove integral to the industry.

Since its inception, ALIO Industries has designed and built a patented Hexapod product line that focuses on precision needs with the fiber and memes assembly industry. Today, the company has grown to offer more than 300 standard products for True Nano® Precision motion systems with 6-D Point Precision® for the global precision industrial markets. ALIO Industries' product range covers linear and rotary motion using both high-precision-mechanical and air bearings. The company also offers single-axis motion, integrated monolithic XY stages with closed and open centers, rotary axes and complex integrated multi-axis solutions—such as its patent-pending Hybrid Hexapod®, which is unparalleled in its 5- or 6-axis precision.

ALIO Industries developed this revolutionary product, which is among the company's most important, to meet the demand for systems with better precision and performance than legacy motion systems. As a result, the Hybrid Hexapod® is more precise than traditional Hexapods or stacked stages, with forward and inverse kinematics that can be integrated with lasers and programmed with G-code as a CNC machine. This allows for precision laser machining, especially when kerf, chamfer or drilling precision holes are required.

With an unwavering focus on Point Precision®, ALIO Industries continually provides the highest-precision motion systems available across the globe by starting with rigid novel designs. The company utilizes unique machining techniques and careful and exacting assembly methodology, all while testing to standards that exceed the current ISO/ASME procedure requirements. ALIO Industries' nanometer level bi-directional repeatability, flatness and straightness provide the basis of its novel 6-D Nano Precision® standard of motion systems.

Over the years, ALIO Industries has remained dedicated to meeting customer needs in a variety of industries. Most recently, the company has seen the largest growth from the electronics manufacturing industry, which has kept ALIO Industries doubling in size for several years. The company's products are used for applications that range from metrology, basic inspection and display tests to laser machining glass and sapphire. To meet the latter demand, ALIO Industries will soon introduce its laser-integrated gimbal motion system. This system for machining sapphire and glass, which allows for very large angular motion to machine edges more than 90 degrees from the plane, can also be used for 3-D metal printing for turbine blades and complex geometric forms.

A member of Laser Institute of America (LIA) since 2013, ALIO Industries appreciates the organization's focus and contacts, which aid in the company's efforts to further its networking and maintain its product relevancy. ■

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

WELCOME NEW CORPORATE MEMBERS

Eastern Maine Medical Center
Bangor, ME

Nuburu Inc.
Centennial, CO

CourierTronics / SILL Optics
Troy, NY

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

Member Innovations

Laser Zentrum Hannover (Lzh) and Scientific and Efficient Technologies Limited (SET) Have Developed a More Flexible Mobile Laser Processing System

On-site welding, cutting, and material removal of large and heavy components is now much easier with a newly developed, lighter, more-flexible laser processing system. The system was created by LZH and SET through the MOBILLAS project, as a part of the EU LASHARE project.

The new system was created with 3D-printed components, an increased processing length, a second axis to extend the machining area and a smaller laser optic. The output power is 6 kW, as opposed to the former system's 2kW. This system can be utilized in several modules and has been tested in the lab and in a shipyard. It can cut 6mm thick metal sheets at a high speed and reach practical welding depths when used in joining.

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

Lasercoil Adds End-Of-Line Robotic Stackers to Its Coil-Fed Laser Blanking System

LaserCoil has added automated stacking capability to its coil-fed laser blanking that can handle rectangular, patterned, trapezoidal, contoured and irregular shapes made of both steel and aluminum. The robotic stackers can be used side-by-side as either single or dual stations and reach speeds of up to 120-spm.

Automated stacking eliminates the risks of damage to and contamination of the blanks that come with manual stacking. Automated stacking is highly accurate and can nest components closely together to reduce excess materials.

The LaserCoil systems are a quick blanking technology that can use various materials in aluminum, mild steel, the new high-strength steels, and other materials for surface-sensitive panels as well as structural components. The systems can be integrated into any coil processing line or fixed onto an existing mechanical press blanking line.

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

Members In Motion

LIMO is the Winner of the 2018 Prism Award for Material Processing & Additive Manufacturing

At the Photonics West trade fair in San Francisco, CA, German-based LIMO was presented with the Prism Award, also known as the "optics Oscar," for photonics innovation. LIMO received the award for its beam-shaping system, Activation Line UV-L750, used for treatment of surfaces and coatings, particularly mobile phone displays.

For the past 10 years, the award has been bestowed upon companies that introduce impactful products that solve problems and improve lives.

LIMO is one of the leading companies specializing in laser beam shaping. The company's award-winning product helps improve materials and expands the applications for the technology. LIMO also offers technology for autonomous cars, energy, and environmental applications.

Of winning the award, CEO Dr. Guido Bonati said, "It shows us that we're doing business the right way—with our constant focus on the needs of our customers and partners, whom we supply with key technologies in the form of pioneering laser systems and optics for market-relevant, innovative leaps."

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

NSSMC Acquires Katakura Steel Tube Company

After announcing plans to acquire the Japan-based Katakura Steel Tube in December, Nippon Steel & Sumitomo Metal Corporation (NSSMC) officially made the company a consolidated subsidiary on February 1. Before the acquisition, Katakura Steel Tube was an affiliate of NSSMC with a 24.9% shareholding. Now, the company shares 80% of common stock with NSSMC. Katakura Steel Tube has appointed Koichi Tatsuta as the new Representative Director and president. The company will be known as Nippon Steel & Sumikin Katakura Tube Co., Limited as of April 1, 2018.

This acquisition is part of NSSMC's strategy to meet the stricter requirements for high-performance components that are expected to follow the recently strengthened environmental regulations for steel tubes for automobiles and construction machinery. NSSMC specializes in manufacturing steel tubes, and Katakura Steel Tube is known for cold-drawing processing for extensible tubes. NSSMC believes the combination of the companies' efforts will be effective in helping the company meet the new standards.

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

Annual Meeting Overview

Harkening back to the days of the Great Depression, the Drury Plaza Hotel Riverwalk in San Antonio provided an eclectic Art Deco backdrop for the annual meeting of Accredited Standards Committee (ASC) Z136. Formerly the Alamo National Bank Building, careful renovations preserved many of the unique period features in the lobby, like stained glass windows, ornate bronze framework, and marble floors. When not in meetings, ASC Z136 members were able to explore the Riverwalk or tour the Alamo.

Traditionally, ancillary subcommittee meetings are held immediately before and after the annual meeting; this year was no exception. Technical Subcommittee 1 (bioeffects), as well as a subcommittee officers update, meetings took place Saturday afternoon. Standards Subcommittees 4, 6, and 9 (measurements, outdoors, and manufacturing, respectively) took time Monday to work on their document revisions.

This year's annual meeting opened with a welcome to LIA's Executive Director, Dr. Nat Quick, who revealed to the group LIA's new vision and initiatives to increase valuation. Following his presentation, appointments by the secretariat were announced—Ted Early as committee secretary, Robert Thomas as chair, and Sheldon Zimmerman as vice-chair. The Administrative Committee (ADCOM) reporting included the ballot results for subcommittee chairpersonships, review of the year's interpretations, and membership requests and recommendations. Administrative secretary, Barbara Sams, briefed the committee on the findings of the ANSI audit held in July 2017, and actions taken to resolve procedural findings, which led to the revision of ASC Z136 Procedures and reaccreditation of the committee under these revised procedures.

Subsequent to the ADCOM portion of the meeting, an overview of each subcommittee's activities was presented by its chair. The afternoon agenda deviated a bit from previous years, with analysis of sales and cost of goods data leading to deliberation of a future roadmap for vertical standards.

The afternoon closed with the formation of three ad-hoc groups, tasked to (1) discuss and evaluate whether to add to the current document in development for entertainment, or create a new standard, guidelines for laser illuminated projectors; (2) examine antitrust policies of similar standards groups (benchmark) and propose possible changes for inclusion into ASC Z136 Procedures; and (3) investigate the status of current actual and near-miss laser accident reporting and advise the committee of their findings.

The next ASC Z136 annual meeting will be held in conjunction with the International Laser Safety Conference (ILSC) on March 17, 2019 in Kissimmee, FL.

The Board of Laser Safety is pleased to announce the 12th Department of Energy Laser Safety Officer Workshop, which will be held May 8-10, 2018, at the University of Rochester, NY.

The Laboratory for Laser Energetics (LLE) is a unique national resource for research and education in science and technology. LLE was established in the fall of 1970 as a center for the investigation of the interaction of intense radiation with matter.

The DOE LSO Workshop is intended for individuals with responsibility for, or interest in, laser safety in a research or academic setting. This 2-1/2 day workshop will include both invited and contributed talks on current laser applications, and associated laser safety issues and solutions.

As in previous years, the BLS will offer its Certified Laser Safety Officer (CLSO) examination the day prior to the start of the workshop. The CLSO examination is optional for workshop attendees and is not included in the workshop registration. Separate application to the BLS is required; please contact the BLS for more information at **bls@lasersafety.org**.

BLS Certification Maintenance (CM) points will be awarded for attendee participation as well as speaker presentations. A copy of the workshop agenda is available at *http://meetings.lle.rochester.edu/LSOW/agenda.php*.

Highlights include the opportunity to tour and learn about the OMEGA Laser Facility, its laser technology development, scientific mission, and achievements. A Vendor Exhibit will be held on Wednesday afternoon; participants will be able to meet with vendor representatives, examine product displays and literature, and discuss product needs.

Call for Nominations for BLS Illumination Award

CLSOs and CMLSOs—nominate your employer today for the BLS Illumination Award. This award recognizes an institution, company, or organization that directly employs a certified Laser Safety Officer and makes outstanding contributions to the laser safety community.

Any CLSO/CMLSO employer is eligible, including private businesses, nonprofit organizations, health care facilities, government or academic entities that meet the criteria. Award criteria, nomination and supporter forms are available on the BLS website at *https://www.lasersafety.org/forms/bls-illumination-award*.

Save the Date

Start planning now to participate in the 2019 International Laser Safety Conference. ILSC® 2019 is scheduled for March 18-21, 2019, and will be held at the Embassy Suites® Lake Buena Vista South in Kissimmee, FL.

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 & Performing Arts Organizations Renew Their Alliance to Protect Entertainment Industry Workers

The Occupational Safety and Health Administration (OSHA) has renewed its five-year alliance with the United States Institute for Theatre Technology (USITT) and International Alliance of Theatrical Stage Employees, Moving Picture Technicians, Artists and Allied Crafts of the United States, its Territories and Canada, AFL-CIO, CLC (IATSE).

USITT is a professional organization for those in the theatre technology industry that provides career development and networking opportunities to its members. IATSE is a labor union representing technicians, artisans, and craftspersons working in live theater, motion picture production, television broadcasting, and related equipment and construction shops.

Through the Alliance Program, OSHA works with organizations dedicated to promoting the health and safety of workers to provide them with better workplace safety and health resources. USITT and IATSE will be informed about fall, electrical, ergonomic, and other entertainment industry hazards. In return, the performing arts organizations will also educate OSHA about industry-specific safety procedures, including fall prevention and safe use of portable power systems. USITT and IATSE will also promote OSHA announcements and campaigns such as the Safe + Sound Campaign for Safety and Health Programs.

OSHA and the Board of Certified Safety Professionals Form Alliance to Provide Safety and Health Information to Certification Holders

The Board of Certified Safety Professionals (BCSP) has joined the OSHA Alliance Program. Through this two-year collaborative program, OSHA provides mentoring and resources to help safety and health-focused organizations prevent workplace fatalities, injuries and illnesses. BCSP members will take part in developing educational safety resources for employers, and they will participate in OSHA's Safe + Sound Campaign, as well as the National Safety Stand-Down to Prevent Falls in Construction.

BCSP sets the standards for safety practices and has certified more than 38,000 safety, health, and environmental professionals.

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

JLA Journal of Laser Applications

Investigations of Surface Processing of Functional Ceramics Applying Ultrashort Laser Pulses

BY MARIA FRIEDRICH, SEBASTIAN WAECHTER, AND JAN GIESECKE

Traditional laser surface processing for ceramics presents challenges due to the vast range in parameters that comes with the wide variety of ceramic types. These parameters affect the ablation rate and surface quality. Conventional processing methods have caused microcracks, induced stresses, material deposits and brittle edges on the surface of ceramics. However, research has indicated that using lasers with shorter pulse durations may result in better surface qualities.

A study was conducted using low-temperature, co-fired ceramics and both a picosecond and femtosecond laser to evaluate the effects of ultrashort pulse lasers on the shaping and ablation of bondable glass ceramics (BGC).

The experiment found that using picosecond pulses can create cavities with sharp edges and well-defined depths without cracks or heat-affected zones. Although prior research found that shorter pulse durations often lead to better surface quality, the femtosecond lasers in this study refuted this claim. The use of these lasers caused surface deterioration and roughness due to the formation of melting structures on the surface.

More research needs to be done in this area to prove whether a change in process conditions can lead to the development of melting structures that smooth the material surface rather than cause roughness.

LIA | Announces

***Lasers: The Perioperative Challenge* is Now Available in the LIA Store!**

The fourth edition of Dr. Kay Ball's comprehensive guide to laser technology for medical professionals is now in stock on the LIA website. The book offers simplified information on the latest research, foundational laser physics, and safety practices for lasers used in the operating room and other medical applications. The manual also features more than 300 helpful illustrations/graphics and templates for writing laser safety procedures for clinical environments.

Lasers: The Perioperative Challenge is available for purchase on the LIA website for $80 for members and $90 for non-members. For a limited time only, receive a FREE hard copy version of the ANSI Z136.3 (2011) *Safe Use of Lasers in Health Care* with your purchase.

Visit **www.lia.org/store** for more information.

Revision Coming Soon!

Revised Z136.3 - Safe Use of Lasers in Health Care Coming Soon

The latest version of the Z136.3 *Safe Use of Lasers in Health Care* standard is expected to be released in May 2018. This definitive document on laser safety in all health care environments was last revised in 2011. It provides guidance for the safe use of lasers for diagnostic, cosmetic, preventative and therapeutic applications. This standard is intended for use by all personnel associated with the installation, operation, calibration, and maintenance and service of the laser delivery system.

If you need the standard right away, the 2011 version is still for sale on the LIA website at a reduced price. Visit **www.lia.org/store** for more information.

ILSC®
INTERNATIONAL LASER SAFETY CONFERENCE

ILSC Call for Papers & Posters is Now Open

The biennial International Laser Safety Conference (ILSC®) will take place March 18-21, 2019 in Kissimmee, Florida. This four-day event covers all aspects of laser safety practice and hazard control. The conference features scientific sessions that address developments in safety standards for laser products and laser use, as well as Practical Applications Seminars (PAS) that explore everyday scenarios that the Laser Safety Officer and Medical Laser Safety Officer may encounter. ILSC is an invaluable experience for anyone looking to further their laser safety education.

The abstract submission deadline for papers and posters is October 4, 2018. For more information and a list of topics, visit **www.lia.org/ilsc**.

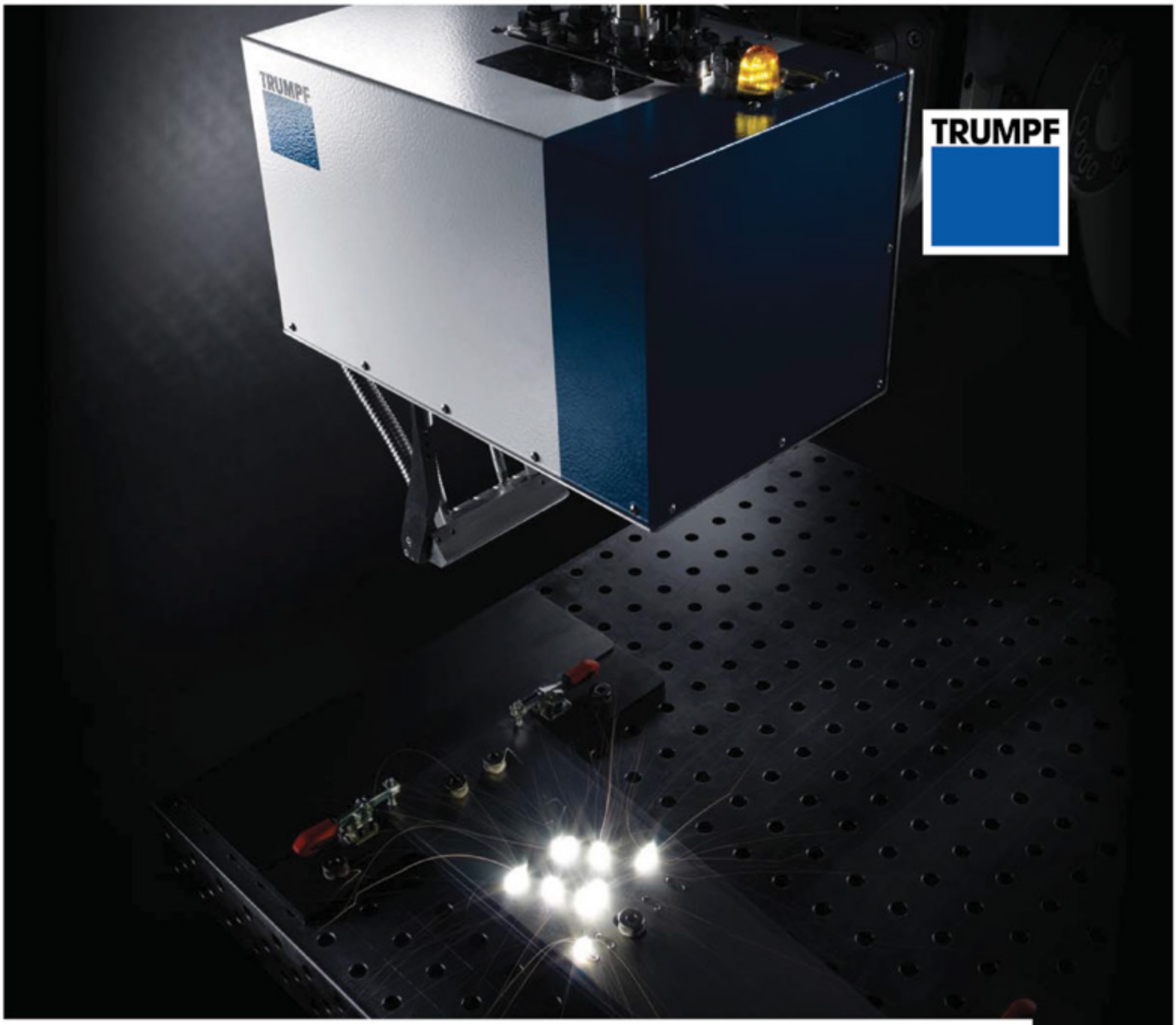
INDUSTRIAL LASER CONFERENCE 2018

Sponsorships available for the Industrial Laser Conference

The Industrial Laser Conference will be held September 12, 2018 at McCormick Place with the International Manufacturing Technology Show (IMTS) in Chicago, IL. Chaired by Paul Denney of IPG Photonics, this conference teaches attendees how to incorporate lasers into their company manufacturing processes to increase profits and efficiency.

The Industrial Laser Conference is now accepting sponsors. Sponsoring the Industrial Laser Conference is an excellent opportunity to showcase your brand and be exposed to companies that are actively seeking laser technology solutions.

Interested companies can find more information at **www.lia.org/laserconference**.



For Innovation in Production

Put Your Confidence in TRUMPF

Laser Joining

It's easy to see why thousands of manufacturers have made the switch to laser joining. Benefits include minimal heat input and distortion, improved stiffness and strength, high productivity, elimination of secondary processes, and reduction of cost per part. And when parts are designed specifically for laser welding, manufacturers get the best of these benefits. In the pursuit of making products lighter, stronger, safer, or more affordable, TRUMPF's broad laser portfolio and applications expertise provide the perfect solution. Put your confidence in TRUMPF - Together we can build your success.

www.trumpf.com

LASER INSTITUTE OF AMERICA
13501 Ingenuity Dr., Suite 128
Orlando, FL 32826 USA