THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

LIA TODAY

Volume: 23 No: 2
MAR/APR 2015

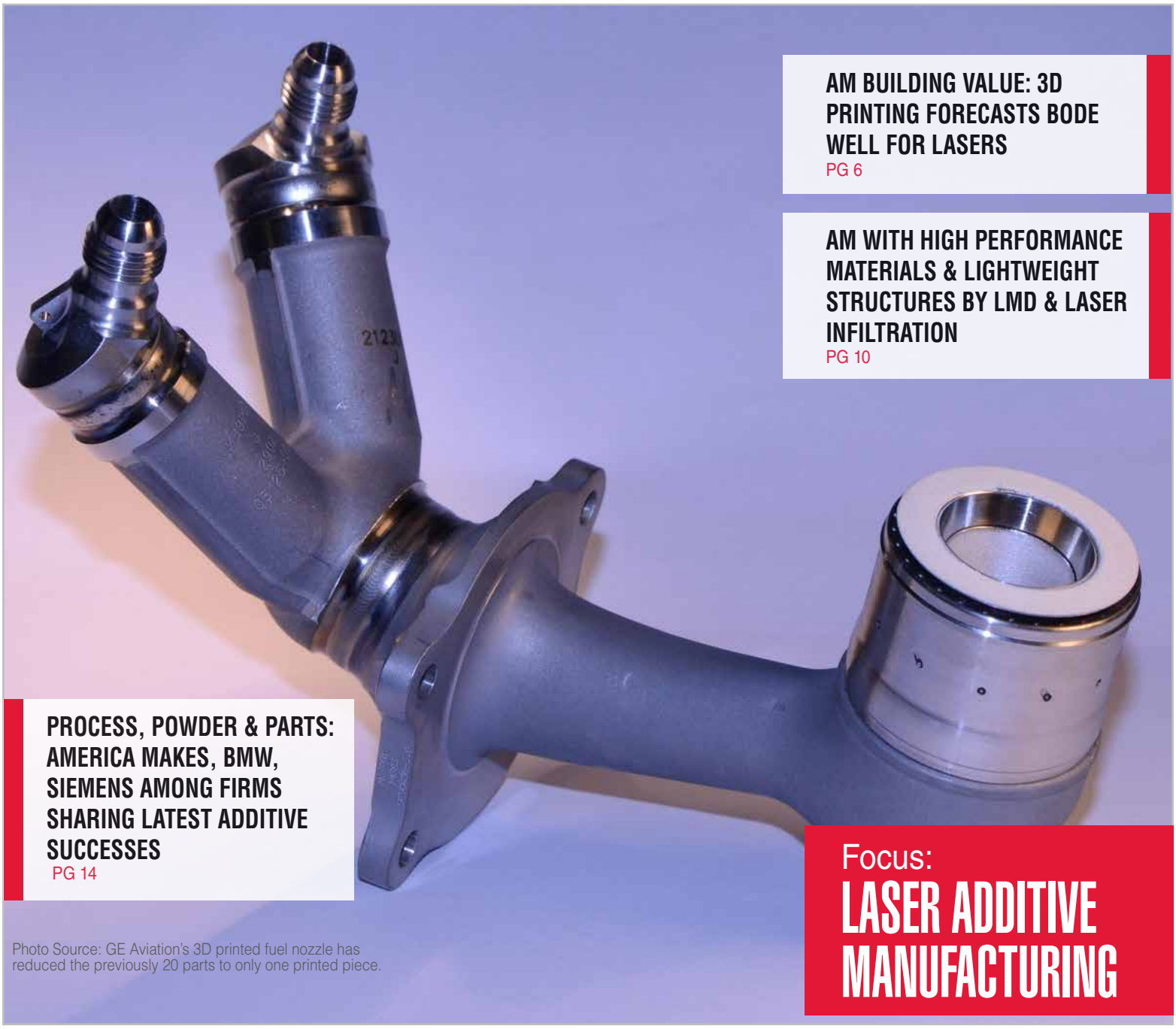

Photo Source: GE Aviation's 3D printed fuel nozzle has reduced the previously 20 parts to only one printed piece.

Focus:
LASER ADDITIVE MANUFACTURING

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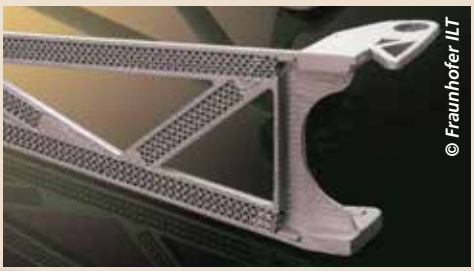

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THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

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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

Jun. 16-18, 2015	Indianapolis, IN
Dec. 1-3, 2015	Orlando, FL

Laser Safety Officer with Hazard Analysis*

Jun. 8-12, 2015	Niagara Falls, NY
Sept. 21-25, 2015	Chicago, IL
Oct. 19-23, 2015	Atlanta, GA
Nov. 2-6, 2015	Scottsdale, AZ

*Certified Laser Safety Officer exam offered after the course.

Industrial Laser Safety Officer Training

May 13-14, 2015	Novi, MI

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May 5-7, 2015	Santa Clara, CA

Medical Laser Safety Officer Training*

Jun. 6-7, 2015	Niagara Falls, NY
Aug. 15-16, 2015	New York, NY
Sept. 19-20, 2015	Chicago, IL
Oct. 17-18, 2015	Atlanta, GA
Nov. 7-8, 2015	Scottsdale, AZ

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

Oct. 18-22, 2015	Atlanta, GA

Laser Additive Manufacturing (LAM®) Workshop

Mar. 2-3, 2016	Orlando, FL

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President's Message

It is a busy time of year for LIA — especially for our membership. As spring approaches, we look forward and examine how you can participate in both the mission and the business of our society this year — the International Year of Light and Light-Based Technologies.

March brought the return of our biennial International Laser Safety Conference (ILSC®) in scenic Albuquerque, NM. This event is the world's leading conference on laser safety and includes sessions relating to technical and regulatory issues, practical applications and training in laser safety in industry, medicine and research. Two significant LIA awards are presented at this conference — the George M. Wilkening Award and the R. James Rockwell Jr. Educational Achievement Award — and I am ecstatic to serve as president in a year in which two of my longtime friends and colleagues, Mr. Jerry Dennis and Dr. Karl Schulmeister, are honored. They join only 14 others to earn these awards, some of our society's highest accolades, for their research and educational efforts to foster laser safety.

October will see us bring our flagship ICALEO® conference to Atlanta. I hope you have seen the outstanding February special issue of the *Journal of Laser Applications® (JLA)*, which includes just over 40 papers from the conference. For the first time, we have provided a forum in which conference papers can receive peer review prior to publication. What a wonderful initiative. The so-called impact factor of our journal — the measure of its popularity with our audience — continues to improve due to such next-level efforts by ICALEO organizers and JLA editorial staff. Don't miss *your* chance to present *and* publish your work. The call for ICALEO papers is circulating (**www.lia.org/conferences/icaleo/call_for_papers**). To accommodate the vigorous review process, deadlines might be earlier than you think — so don't delay.

Soon, it will be your time to nominate candidates for LIA Fellows and awards. I urge you to consider our members' outstanding contributions, which we witness at our conferences and throughout our publications. Submit your top candidates for well-deserved recognition.

Indeed, a busy year with many opportunities within the LIA! I look forward to seeing — and hearing from — many of you at these and other conferences and events.

Robert Thomas, President
Laser Institute of America

Executive Director's Message

Seven years ago Bill Shiner came to me and said that he and Jim Sears recommended that LIA hold a workshop on laser additive manufacturing. After discussion with Director of Conferences Gail Lolacono and Marketing Director Jim Naugle, we launched our first LAM® Workshop on Mar. 3, 2009, in San Antonio. Paul Denney was the first chair, and in the seven years since then, the workshop has flourished under the chairmanship of Paul, Jim Sears and Ingo Kelbassa. From the very beginning Wayne Penn and Alabama Laser have been the platinum sponsor. Thanks to them, LIA has been an effective leader in bringing the benefits of laser additive manufacturing and 3D printing to light.

In this issue of *LIA TODAY,* you can read about the latest LAM Workshop held on Mar. 4-5 in Orlando. For a more in depth look at the field, read the special open access issue of JLA, edited by Milan Brandt, which you can find at **scitation.aip.org/content/lia/journal/jla/27/S1.**

My compliments and thanks to the above-mentioned leaders and to everyone who has contributed to LIA's leadership and success in this exciting field.

Peter Baker, Executive Director
Laser Institute of America

AM Building Value:

3D Printing Forecasts Bode Well for Lasers

BY GEOFF GIORDANO

While news appears almost daily to highlight the latest novel item that might be capable of being produced with 3D printing, getting a handle on the value of opportunities in industrial additive manufacturing markets can be difficult. But a compelling picture is forming thanks to recent data.

By 2025, 3D printing could be worth $550 billion a year, according to a projection by the McKinsey Global Institute as related by John Dexheimer, president of LightWave Advisors. While the consensus is that additive manufacturing can't replace subtractive processes, the medical, automotive, aviation and power generation industries are pushing additive manufacturing to its limits to produce patient-specific implants and high-value components in aircraft, cars and gas turbines.

For the laser community, there is tremendous room to grow. For example, Dexheimer points to the 40.5 percent annual growth in the metal materials segment predicted from 2014 to 2020 by *Metalworking World Magazine*. Applying 30 percent to 40 percent growth to the 2014 sales of EOS and Concept Laser suggests they could sell between 1,930 and 3,200 systems combined in 2020. Assuming two to four lasers in the average system, that translates to somewhere between 6,000 and 12,000 lasers consumed just by those two companies. "And competitors will consume more," Dexheimer noted.

At present, lasers likely figure in much less than half of the additive manufacturing units in use, according to analyst Terry Wohlers, when considering all the fused deposition modeling machines on the market.

The robust growth of fiber lasers has helped fuel additive fervor and productivity, Dexheimer notes. In a third-quarter 2013 investor conference call by IPG, he relates, the giant laser manufacturer noted that "if before 3D printing manufacturers used 100 W lasers, during last quarter we already shipped many lasers with power up to 10 kW for manufacturing of large metal parts." Furthermore, "we have developed and started to ship in volume powder-cladding systems for turbine blade repair," IPG said. "The customer is one of the Tier One industry leaders in the world."

In terms of additive materials, metal and alloys are expected to be the fastest-growing segment. One projection suggests

> **METALS APPEAR TO BE A MUCH BIGGER STRATEGIC MARKET THAN MANY HAVE PROJECTED.**

powder metal sales for AM could reach $520 million in 2019, growing to $930 million in 2023. That would be up from $25 million in 2012. The implication, Dexheimer concludes, is $3 billion to $5 billion worth of end parts in 2019. "Metals appear to be a much bigger strategic market opportunity than many have projected," he says.

Current additive output from major players like BMW and Boeing help make the case for huge growth opportunities in powder-bed or powder-fed production of metal parts. At BMW, more than 100,000 parts a year are being made additively, according to Wolfgang Thiele, who spoke at the seventh Laser Additive Manufacturing (LAM®) Workshop (see story on page 14); more than 95 percent of those are polymer-based interior and functional parts, he said.

In the aviation world, Boeing has tens of thousands of polymer parts flying, said Wohlers at the 2014 Lasers for Manufacturing Summit, while Airbus claims it will be using hundreds of AM machines to produce parts — many of metal — within five years.

Makers of metal powders understand the cost considerations influencing adoption of additive processes — particularly as fluctuating raw material costs affect powder prices.

"We're involved in mostly the nickel and stainless materials" says Cindy Freeby, new business development manager for Ametek. "We also make titanium powder, and there's quite a bit of interest in that. We're not certified to sell into aerospace because you have to have certain certification, (but we sell into) oil and gas, agriculture (and) automotive."

Ametek is working on more gas-atomized powders as customers

add them to their repertoire. “Years ago we had made a little bit of gas-atomized powder, but we’re fully into the venture now.”

In terms of cost considerations, “most everybody knows titanium is quite expensive,” Freeby says. “It all depends on the alloy and the screen cuts. Usually, medical-grade titanium powders are more expensive because they have to meet certain specifications — and purity is of the utmost importance. It’s a bit prohibitive in some marketplaces to consider titanium — for example, in automotive. I think they would like to use titanium because of the light weight, but how do they justify the cost depending on the component?”

While experts understand additive manufacturing will not replace subtractive methods, recent heated merger and acquisition activity demonstrates increasing awareness of how transformative additive manufacturing could be in terms of saving material and tooling costs.

Exploit opportunities by having a vision and being bold, Dexheimer advises. “Can you find a pocket to create hyper-growth and sustained, long-term 20 percent to 30 percent operating income?” he asks. Go beyond being just another supplier — “that’s not the big part of the value-creation chain. Focus on contributing to transforming customer economics.” ■

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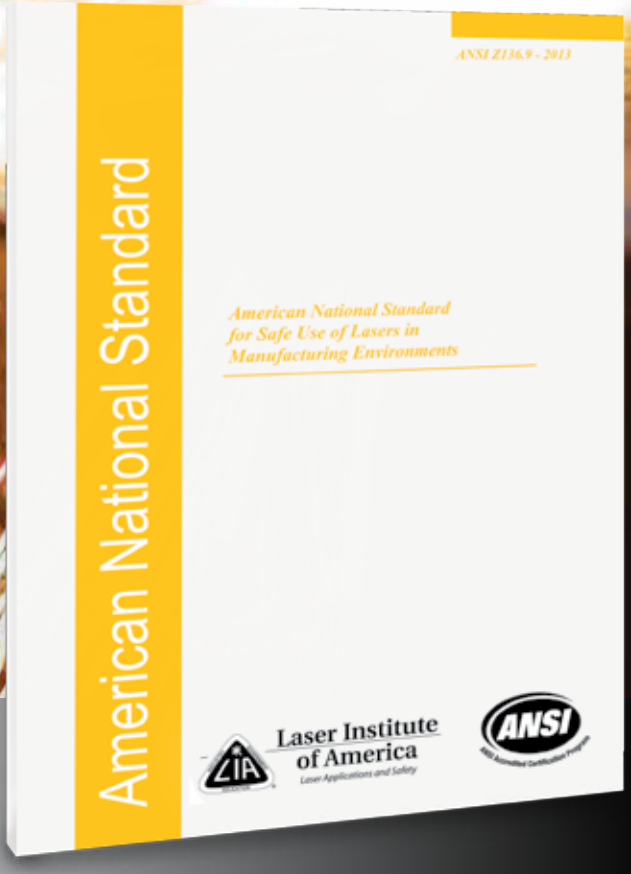

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AM with High-Performance Materials

& Lightweight Structures by Laser Metal Deposition & Laser Infiltration

BY FRANK BRUECKNER, MIRKO RIEDE, THOMAS FINASKE, ANDRÉ SEIDEL, STEFFEN NOWOTNY, CHRISTOPH LEYENS, ECKHARD BEYER

Laser Metal Deposition (LMD) is used for repair/redesign as well as for manufacturing of new parts. Thereby, wire or powder filler material is reabsorbed in the laser-induced melt pool resulting in a strong metallurgical bond with the subjacent substrate in combination with a low dilution. Among various applications, LMD is an attractive process for jet engines to improve performance and efficiency as well as to contribute to more sustainability. In addition to design methods, such an improvement can be realized by lightweight structures and high-performance materials. Figure 1 shows the specific strength as a function of the temperature of high-performance materials. Since PMC structures are very important in the first stages of a jet engine, TiAl, Ni-base superalloys as well as CMCs are more relevant in hot engine areas.

High-Performance Materials

Corrosion and high-temperature resistant superalloys are state-of-the-art in jet engines because of their ability to resist harsh conditions. Especially lightweight materials such as TiAl provide a significant improvement regarding structural strength, hardness and temperature capability due to the formation of an intermetallic compound. However, processing with these materials is a very demanding task and lamellar interface cracking easily occurs when typical cooling rates and temperature states in LMD are applied. Even the direct deposition of a single layer onto a Ti-base substrate cannot be realized without cracking, see Figure 2.

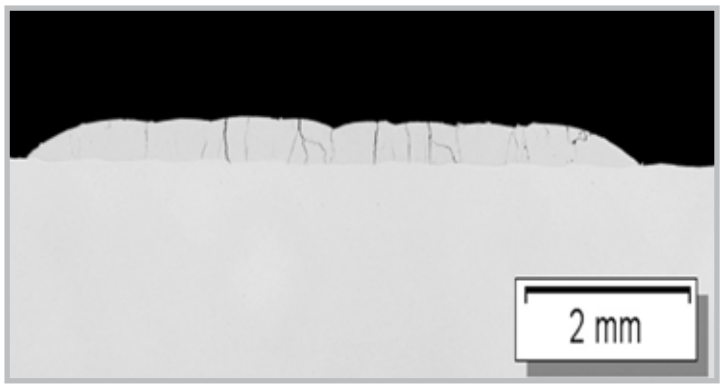

Figure 2. Cracking of a TiAl single layer (TiAl on Ti-base)

To overcome this problem, suitable temperature distribution; melt pool modifications; pre- and post-weld treatment and precise temperature regimes have to be considered while processing.

The latter was realized by an additional inductive substrate heating controlled by a closed loop camera system from IWS. A NIR temperature distribution of the substrate after the laser processing in a side view is shown in Figure 3.

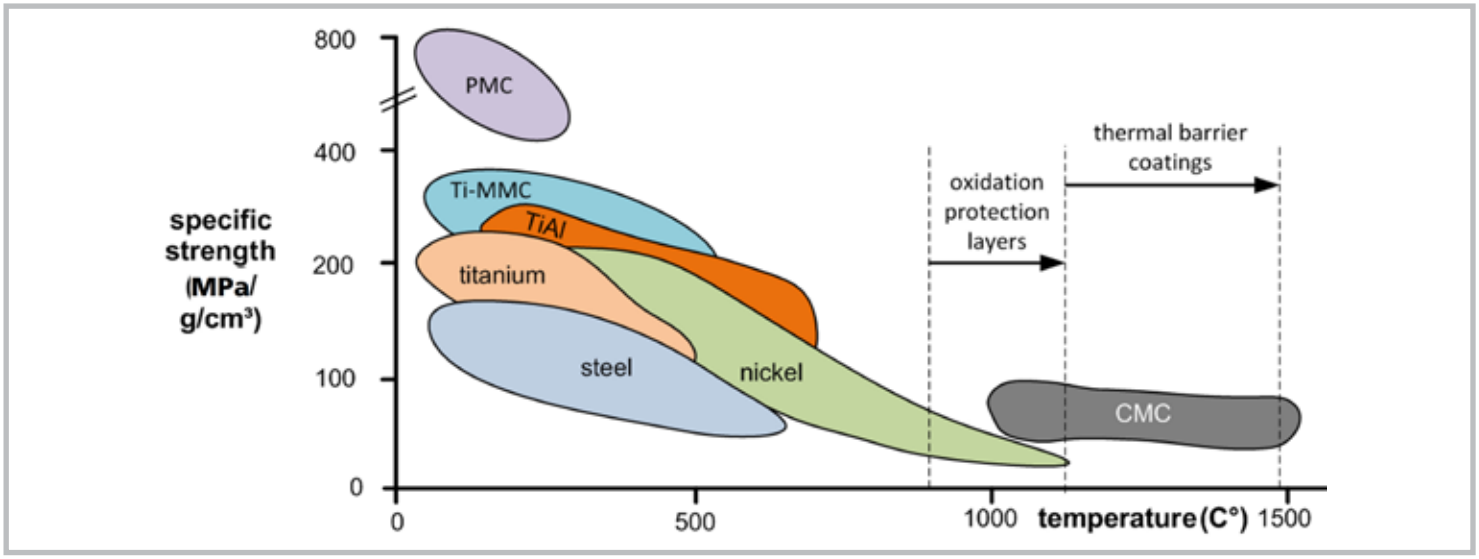

Figure 1. Specific strength of high-performance materials[1]

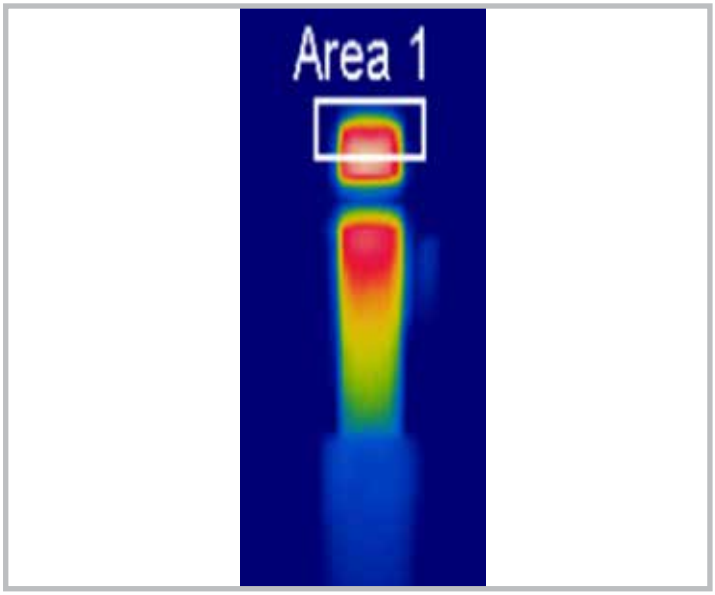

Figure 3. Side view of a NIR temperature distribution of the processed substrate

The ability to adjust temperature or even temperature profiles allows staying within the small process window of these materials. This leads to the crack-free deposition of single layers which can be accurately transferred to more complex multi-layer formations like the laser-generated TiAl blade in Figure 4.

Metallographic investigations as well as computer tomography scans ensured that the deposition of the material was carried out without cracking or significant pores (see sample and cross-section in Figure 1). A porosity contents of below 0.01 percent was measured.

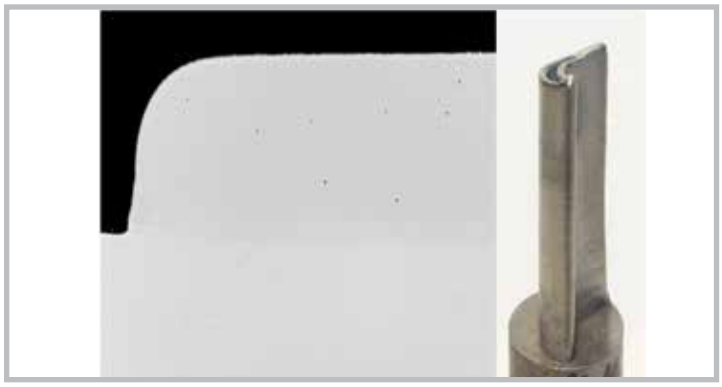

Figure 4. Crack-free inductive supported LMD build-up

Lightweight Structures

As shown in Figure 1, there is an increased need for lightweight materials like carbon fiber reinforced plastics (CFRP) e.g., in cold sections of jet engines. Obviously, such composite structures requires proper bonding to the metallic components which are in many cases rather complex and not easy to handle (intelligent composite design) [2-4]. As a result of the strong differences of thermo-physical properties, especially of the melting/evaporation temperatures between metals and CFRP, adhesive bonds are often used. In most cases, the bonding is a multistage and time-/cost-consuming process. Hence, substantial research efforts are currently focused on the bonding of fiber laminates with metallic materials.

By means of a novel approach, a single-step process can be used to assure bonding over several layers of the CFRP (see Figure 5).

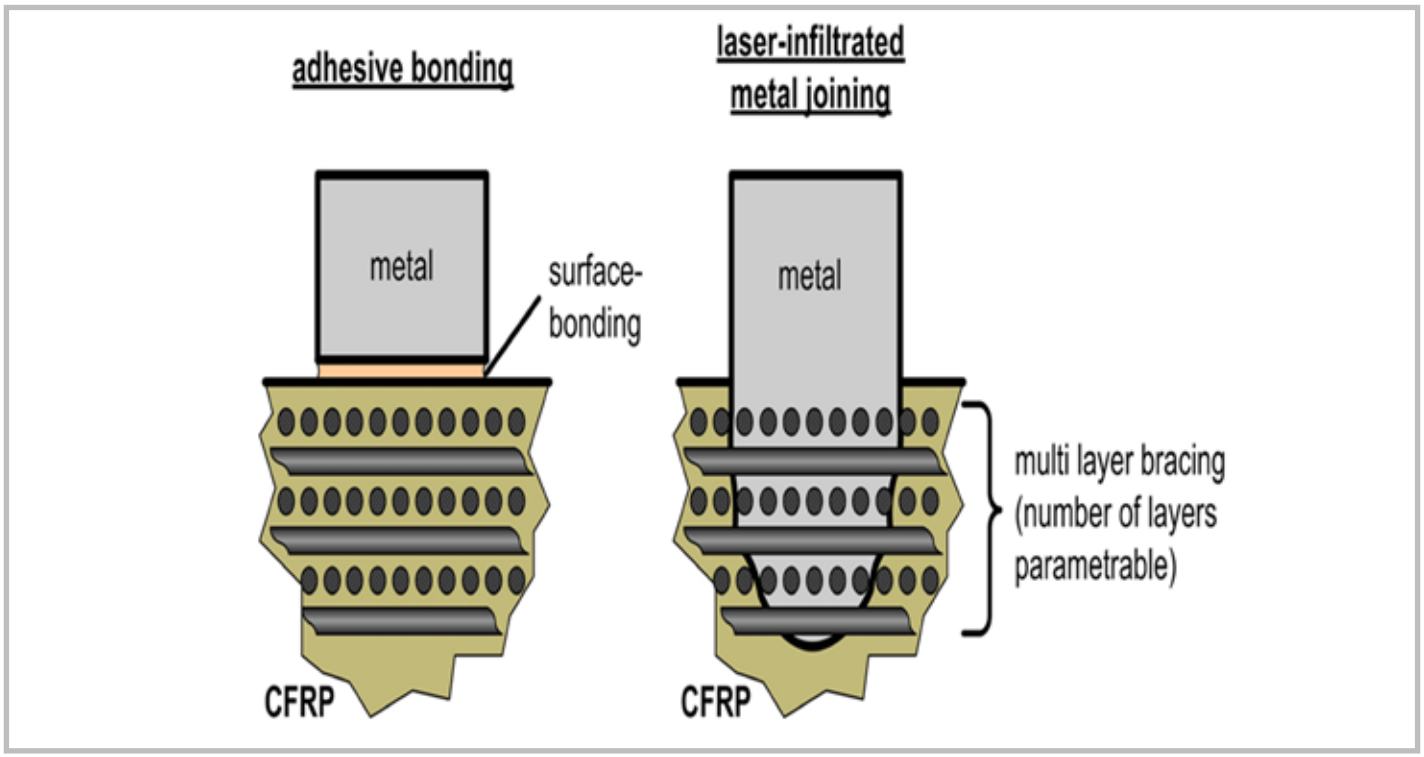

Figure 5. Mechanical clamping of laser-infiltrated metal bonds over several fiber layers in comparison to an adhesive bond (left)

(Continued on page 12)

Additionally, functional elements can be built directly on top of such bondings. Hence, the process can be divided into two phases.

Phase 1: At the beginning, the binder material is removed by the laser and subsequently infiltrated with a molten metal yielding a strong joint over several fiber layers of the CFRP.

Phase 2: Based on the laser-infiltrated bond, functional elements can be built up without a transition zone to the infiltration metal (Figure 6, left) or with a gradient to the latter (see Figure 6, right).

Experimental studies were carried out to produce high-strength metal-CFRP composite by laser-based metal-implantation

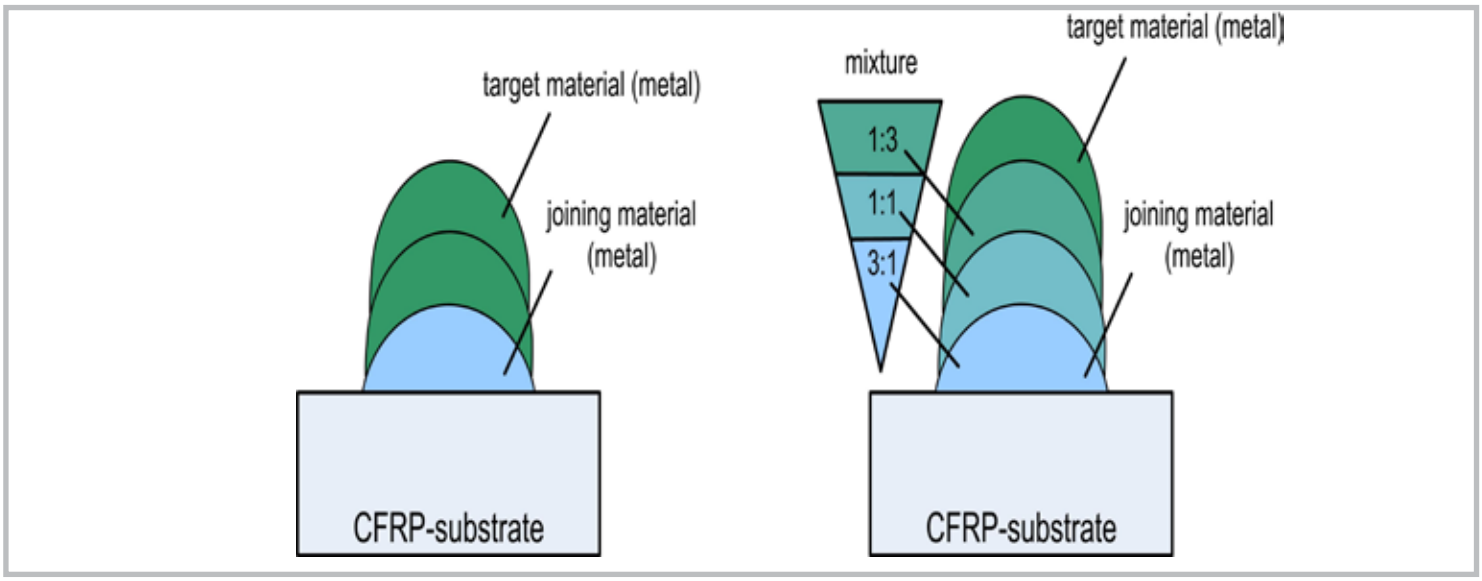

Figure 6. Transition from metallic bonding material to final metal - discrete (left); graded build-up (right)

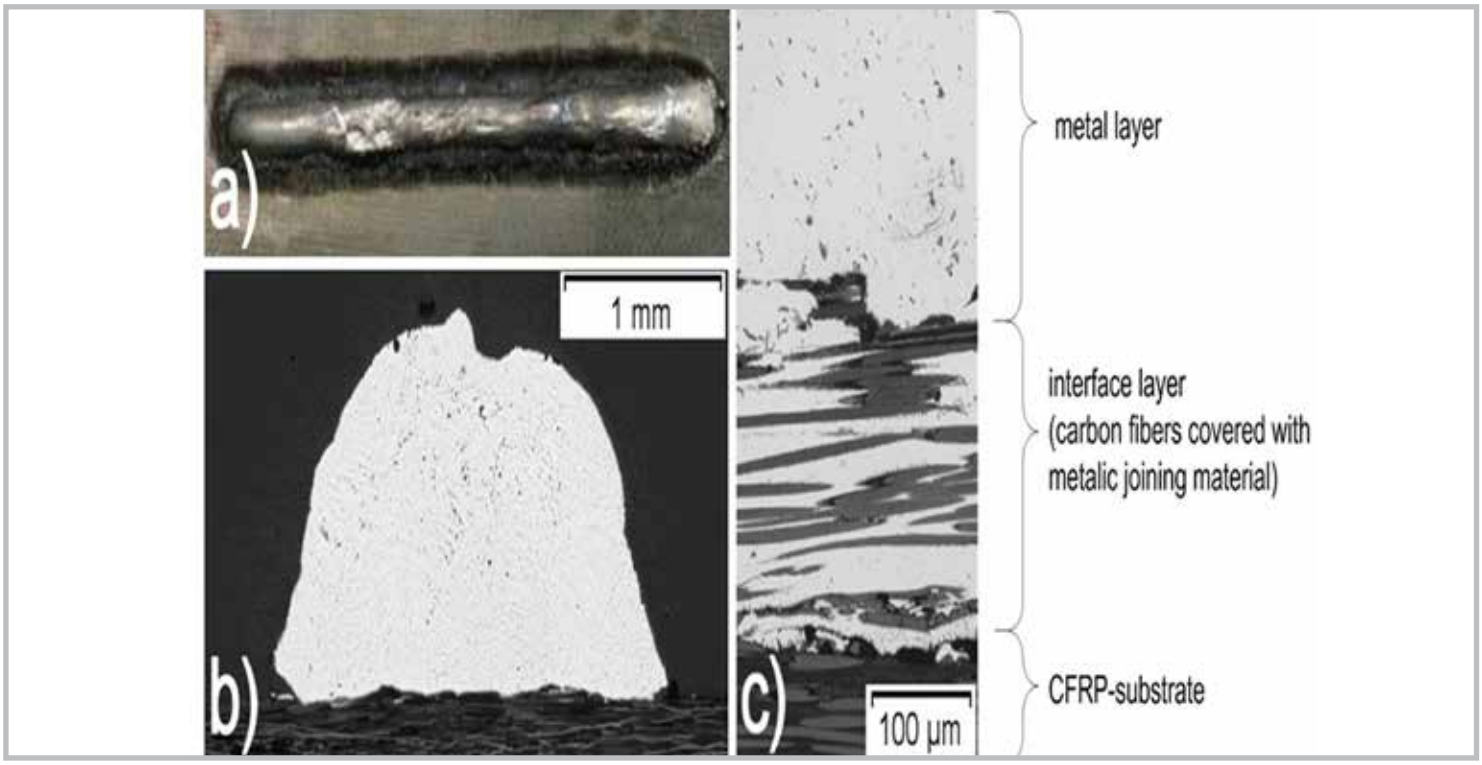

Figure 7. Laser-generated metal-CFRP bond - a) top view, b) cross section, c) details of the cross sections

(Figure 7a and 7b). As shown in Figure 7c, a high strength bond between a fiber reinforced plastic and light metal over several layers is feasible.

The described method of a precise laser-based adhesive bond and form fit could be used preferably for the following applications:

- The metal-CFRP joint may not be seen from outside as it is the case of rivet joints.
- The joint between the fiber laminate and the metal requires a strong local border, e.g., for mounting parts, edge protections or rotor blades.
- It might be especially relevant for large-area coatings on fiber laminates, e.g., lightning protection or design elements. ■

The authors of this article work for the Fraunhofer Institute for Material and Beam Technology in Dresden, Germany. Christoph Leyens and Eckhard Beyer are also associated with Technische Universität Dresden.

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Process, Powder & Parts

America Makes, BMW, Siemens Among Firms Sharing Latest Additive Successes

LAM® LASER ADDITIVE MANUFACTURING WORKSHOP

BY GEOFF GIORDANO

With roughly 50 percent of the audience attending for the first time, LIA's seventh Laser Additive Manufacturing (LAM®) Workshop fueled enthusiasm for laser-based 3D printing processes with a robust, real-world view of the state of the technology.

"We tried to address the entire process chain on the first day," said LAM General Chair Ingomar Kelbassa, "from the raw material and design through additive manufacturing (AM) processes to adaptive finishing operations like five-axis milling. On the second day, we talked about what creates more awareness and visibility" of laser-based additive manufacturing.

Kelbassa, an adjunct professor at Australia's RMIT University, hoped the success stories shared during LAM 2015, held Mar. 4-5 in Orlando, helped veterans and newcomers "get motivated for additive manufacturing in the future." Attendees learned about a broad array of accomplishments and initiatives:

- Keynote speaker Christoph Leyens of Fraunhofer IWS illustrated the potential material and cost savings of layer-by-layer, near net shape manufacturing — for example, a potential reduction of up to 5,000 euros per part when producing a strongly twisted Ti64 leading edge for an aviation fan blade with AM vs. conventional machining.

- LAM co-chair Jim Sears of GE Global Research noted that 100 desktop 3D printers have been given to 1,000 members of an in-house makers guild to help engineers in GE's aviation, corporate, health care, oil and gas, power and water, appliances and lighting divisions design parts optimized for additive production.

- BMW's Wolfgang Thiele demonstrated how the automaker uses additive processes to produce more than 100,000 parts annually for its consumer vehicles. Furthermore, BMW has made more than 600 parts for its motor sports division, using aluminum alloy and the ReaLizer 250 machine for a complex engine component requiring undercuts.

- Tim Biermann of Fraunhofer ILT shared research into the printing of blood vessels that he suggested could lead to the additive manufacture of human tissue in about 10 years.

- Forays into higher speed multibeam additive manufacturing. Henner Schöneborn of SLM Solutions discussed the company's Quad Laser Technology using four 400- to 700-watt fiber lasers. Max Schniedenharn of Fraunhofer ILT detailed a selective laser melting approach using a line of five diode lasers that can be switched on and off as part geometries dictate.

- James McGuffin-Cawley of Case Western Reserve University detailed the third and latest call for a project by America Makes, the National Additive Manufacturing Innovation Institute. The project is expected to begin in mid-July. Meanwhile, Richard Grylls of Optomec spotlighted the ASTM standard guide for directed energy deposition of metals. The roughly 55-page guide, in the works for two years and in the approval stage, advises readers to "be concerned about the powder, make sure you know what quality you're supposed to be buying, make sure you have the right mesh size range," and more, Grylls noted.

- Unique approaches to fostering AM like conformal cooling experts Linear Mold and Engineering providing long-term onsite support to customers, as well as Hayden Corp.'s creation of custom alloys.

The Mission of LAM

Consensus remains that much work still needs to be done to optimize additive manufacturing — by reducing porosity, improving crack resistance, ensuring repeatable process outcomes, developing better modeling software and AM-specific powders and training a new generation of additive-oriented engineers. But LAM once again showcased how researchers, powder suppliers, laser manufacturers, job shops and national initiatives are sharing knowledge to move applications forward in various industries.

As Kelbassa noted in his introductory remarks, LAM has evolved from a conference focused on wear and corrosion protection through laser material deposition to enlighten attendees about the 3D printing revolution. Reaffirming LAM's roots, a handful of the 24 presentations focused on the latest ways to perform bread-and-butter cladding applications.

For example, Platinum Sponsor Alabama Laser's Wayne Penn — with 42 years in the laser industry — recommended completely machining off damaged coatings from compromised hydraulic shafts. In discussing his work on a worn ceramic-coated shaft used in a seawater environment, "It's very important to always machine off the old coating." Depending on the condition of the old coating, he advised you might be tempted to "just clad over

it. Bad decision, (because) if you want to go after that precision bond, whatever is down in that base material is going to get washed up into that bond. It's always best to machine (that part) down to the base material, from our experience, and then we laser hot-wire clad that and final machine it." He was quick to note that this application can perform repairs in the field.

New Tech, New Approaches, New Contacts

In keeping with LAM's evolving focus, Leyens opened the proceedings with a broad overview of the benefits and challenges of additive part production. A key way LAM helps foster "best practices" in laser-based additive manufacturing is by straight talk by industry veterans that steers clear of hype.

"It is time for the additive manufacturing community to not only look into ways we can produce parts… but also to look into materials. We need to develop materials dedicated to additive manufacturing like we have developed materials dedicated to forging or casting. If we do this right, we will end up with the microstructures we need."

Added Sears, AM in general "is a technology that provides solutions." After 20 years of discussing the possibilities, he said, it is imperative to move additive processes out of labs and "harden" systems for manufacturing to make sure "the first part we make is the same as the thousandth." To that end he stressed the need for more additive-friendly design software, more scanners and better inspection methods to ensure internal features are sound. System makers are adapting to keep lasers building closer to 95 percent of the time.

At Siemens, AM will help produce multiple parts throughout future gas turbines to make them more efficient and durable, said Allister James.

Meanwhile, Penn detailed a cladding procedure for water wall panels, which are made up of multiple boiler tubes welded together and ranging from 10 to 40 ft long and up to 5 ft wide. Instead of moving the part to clad these undulating 3D surfaces with a fixed beam, Alabama Laser developed a flying-optic system for which a patent is pending.

After the last presentation, most people remaining in the audience indicated they had learned something at LAM 2015. At breaks between sessions, as well as during a vendor reception, attendees crowded an exhibition hall packed with key AM players.

"I came for some of the connections I wanted to make," said Todd Rockstroh of GE Aviation, who has presented at several LIA events. "You can grab (experts) and pull them to the side and find out what's really going on. We're all looking for bigger machines."

For Leyens, who estimated this was his fourth LAM, "it's always great to be here to meet old friends (and) to make new friends." For powder producer Ametek, exhibiting for the second year, New Business Development Manager Cindy Freeby noted that moving LAM from Houston to Orlando was "a good thing, because you get some different people."

LAM returns to Orlando Mar. 2-3, 2016, when past general chair Paul Denney of Lincoln Electric returns to the helm. Visit **www.lia.org/lam** for updates. ■

(Photo spread continued on page 16)

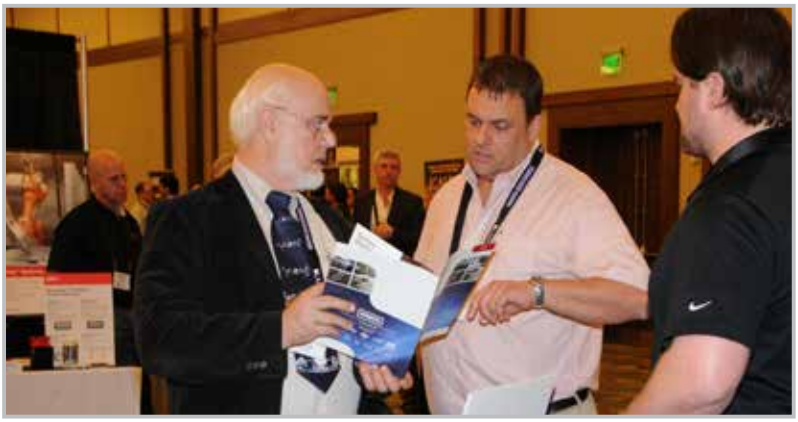
LAM 2015 GENERAL CHAIR INGOMAR KELBASSA (LEFT)

CHRISTOPH LEYENS KICKED OFF THE WORKSHOP WITH HIS KEYNOTE ADDRESS ON THE CHALLENGES AND ADVANCEMENTS OF AM

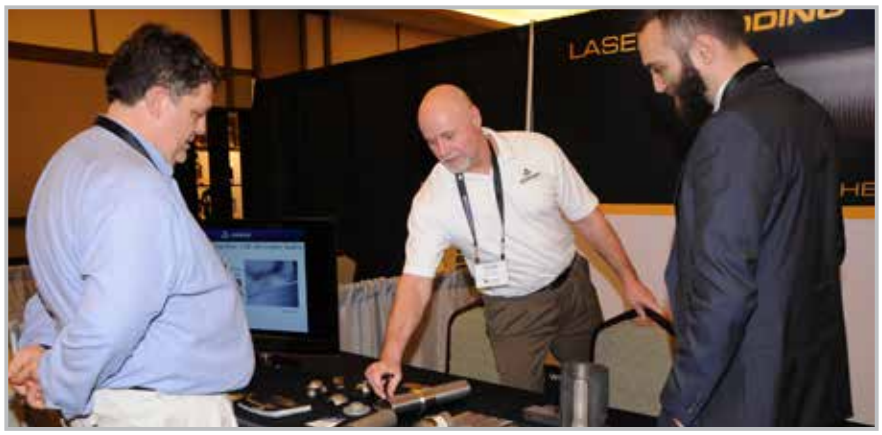
LAM CO-CHAIR PAUL DENNEY

LAM CO-CHAIR JIM SEARS

LAM PRESENTATIONS COVERED EVERYTHING FROM AM SUCCESS STORIES TO PROCESS CHAIN AND INTEGRATION

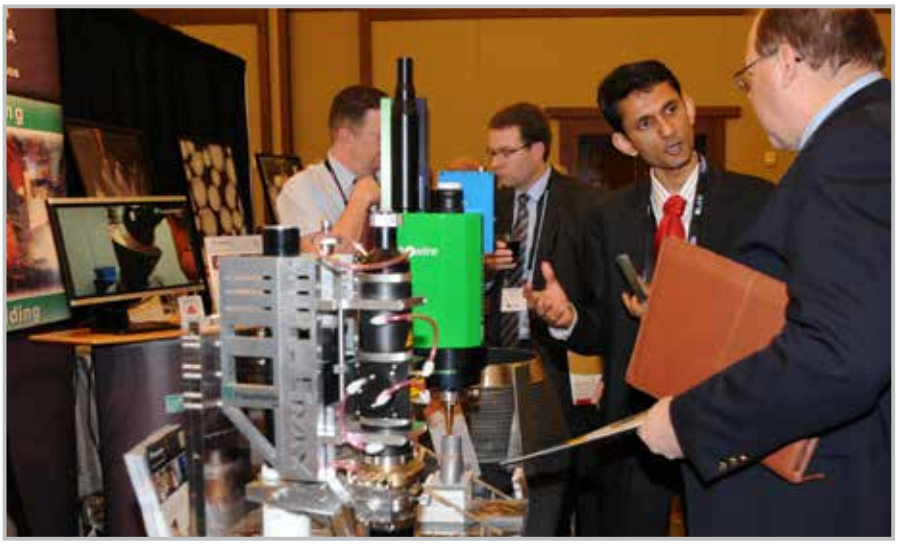


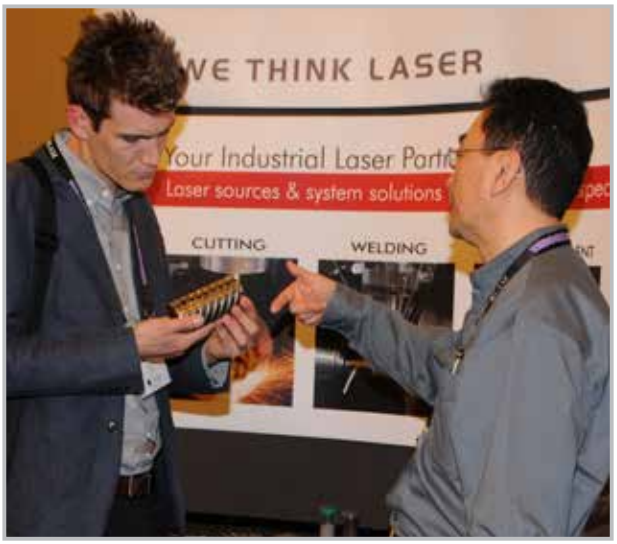
LAM OFFERED ATTENDEES MANY OPPORTUNITIES TO NETWORK WITH AM EXPERTS

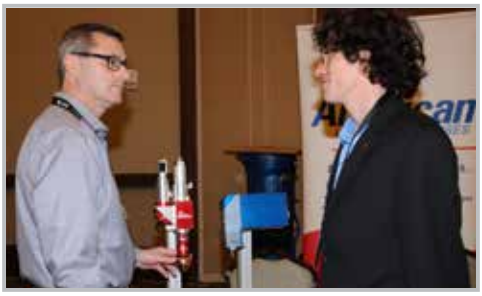


LAM 2015

Exhibitors Provided Attendees with the Latest Advancements in the Additive Manufacturing Industry







Preco, Inc.

Premier Manufacturer of Process Machinery

Preco, Inc. has been on the cutting edge of material processing and manufacturing since its inception. Originally founded in 1956 as Gramling Tool and Die Company, the company's humble beginnings in Bill Gramling's basement, supplying dies and fixtures to the gasket industry, seem like ancient history. Today, Preco is known as one of the premier manufacturers of process machinery in the world, with a reputation for high quality and superior performance in every product they make. A manufacturer for manufacturers, Preco exists on the premise of making the machines no one else makes. From cutting to scoring, cladding to perforation, Preco offers a wide range of service capabilities for many different industries.

Twenty years after its auspicious start, the company was purchased by Jack Pierson, and renamed as Preco Industries Inc. Fast forward almost 30 years to 2002, after three down years in the US manufacturing market, Pierson saw the opportunity for growth the laser industry provided, and purchased Laser Machining, Inc. rebranding it as Preco Laser Systems LLC. With the combined forces of both traditional and laser machinery, Preco expanded its product line to provide solutions for a myriad of manufacturing processes. Today, Preco, Inc. functions globally, selling machines around the world and managing facilities in the US, UK, Sweden and China, employing a team of over 200 professionals through five divisions.

Preco is known for offering its customers a "total value package" in manufacturing equipment. Able to supply machines for every step of the process, Preco listens to clients' needs, and either matches one of their standard model manufacturing machines to the customer's specifications, or custom builds one if no suitable model is available. Preco's most important asset is its diverse and experienced technical process development team that reviews and drives manufacturing applications into robust laser based manufacturing solutions. By providing both equipment manufacturing and job shop services, the key deliverable is a dependable process, fast product to market and long-term support of laser based equipment in nearly every corner of the world.

Preco looks forward to the future with expanded product lines in which multiple lasers are used over high-speed web applications, and precise laser slitting of films or nonwovens are utilized for incredibly clean edge applications. Low cost robot laser cladding and heat-treating solutions are also being explored for metals processing on the fly directly from the coil.

Customers keep coming back because of a simple promise: Preco machines work; they perform exactly how they should. And in the world of high-speed laser cutting, welding and manufacturing, a promise like this can never be overvalued. ■

For more information, please visit **www.precoinc.com**.

LPW Technology, Inc.
Pittsburgh, PA

Preco, Inc.
Somerset, WI

Riegl USA
Orlando, FL

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

International Year of Light

INTERNATIONAL YEAR OF LIGHT 2015

With the International Year of Light and Light-based Technologies in full swing, a discussion of its importance was a fitting note upon which to end the International Laser Safety Conference (ILSC®) in March.

"We're taking this very seriously," said Public Health England's John O'Hagan, general chair of ILSC 2015, in his closing presentation Mar. 26 in Albuquerque, NM. "It's a real opportunity." (A complete report on ILSC 2015 will appear in the May/June issue of *LIA TODAY*.)

LIA is representing the laser industry's contributions to photonics advancement as a silver-level sponsor. Of course, harnessing the power of light safely is critical. Leading in to O'Hagan's address, Bruce Stuck urged ILSC attendees to celebrate IYL 2015 by promoting clarity in optical radiation dose expression in their incident reports and manuscript reviews. (Stuck is chairman of the Technical Subcommittee on Laser Bioeffects and Medical Surveillance of the ASC Z136.)

But the International Year of Light is not only about science, technology and engineering, O'Hagan noted. IYL 2015 also stresses the arts, particularly the visual arts, as well as charitable efforts tied to the importance of light in everyday life. In a presentation touching on everything from the earliest research in optics to the Mar. 20 solar eclipse over northern Europe, O'Hagan noted that "when the sun went down, it wasn't that long ago that people didn't actually know whether it would come back up again; they didn't know where it was going."

At the end of an impressive year of events (view the full list at **www.light2015.org**), IYL 2015 is scheduled to wrap up with a ceremony in Mexico City next March. If you are attending or participating in any IYL 2015 events, we'd like to hear your impressions for future articles. Contact Geoff Giordano, **ggiordano@lia.org** to share your experiences with lasers, suggest stories or offer your commentary on issues regarding any facet of laser technology.

Member Innovations

ABB Expands Symphony Plus Range to Enhance Flexibility and Energy Efficiency
ABB, the leading power and automation technology group, launched its Symphony® Plus SD Series of flexible control and input/output (I/O) products, which offer total plant automation across application types, irrespective of size or physical location. They were showcased at ABB's Automation and Power World event in Houston, TX, Mar. 2-5.

The SD Series is designed to improve energy efficiency and productivity in diverse operating environments within the power and water industries. The new range is especially suited for applications where control is distributed over a wide area often in harsh conditions, such as wind and solar power plants as well as water facilities.

The new portfolio is the latest addition to the Symphony Plus product family, ABB's flagship automation platform for the power generation and water sectors and the most widely used distributed control system in these industries.

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

Emissions under Control: Comprehensive Exhaust Air Analysis during Laser Processing of Plastics
In order to provide optimal protection for machine operators and the environment, it is utterly necessary to know exactly which emissions are being released during laser processing of plastics. Scientists at the Laser Zentrum Hannover e.V. (LZH) and at the Kunststoff Zentrum SKZ in Würzburg have compiled a comprehensive analysis of the main emissions released during laser processing of plastics. This information is now available in the form of emission data sheets.

What is the influence of the laser output or process speed on the hazardous materials released? How are the materials, process conditions and emissions related? Based on these and similar questions, equipment for material removal, cutting and welding of plastics was investigated at the place of use, using a mobile measurement unit developed by the LZH. It can be integrated in any exhaust system, and makes direct and guideline-conform measurement of the exhaust possible, with subsequent evaluation according to the Technical Instructions on Air Quality Control (TA Luft). Parallel to this, measurements of the workplace ambient air were taken, and the hazardous material concentrations were compared to the workplace threshold levels (AGW) according to the Technical Guidelines for the Handling of Hazardous Substances (TRGS) 900/910.

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

Members In Motion

BMBF's Digital Photonic Production Research Campus Opens with a Key Moment
With the United Nations having declared 2015 the "International Year of Light and Light-Based Technologies," the opening of the BMBF's new "Digital Photonic Production (DPP)" research campus at the end of January was perfectly timed. Located on the RWTH Aachen Campus, the DPP research campus is destined to become well known as the home to a new kind of collaboration between science and industry. The aim of the DPP research campus is to research and further develop light as a tool in the production of tomorrow.

BMBF-funded work at Aachen falls into two categories. While the Flexible Electrical Networks Consortium (FEN) is developing new ways of transporting energy using direct current, the DPP research campus will focus on the basic physical effects of light as well as on new methods of using it as a tool in the industrial production of tomorrow. Of course this refers to lasers, which have already become a truly universal manufacturing tool – whether for dental implants, automotive parts or aircraft components.

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

Phil Kilburn joins LPW Technology as Commercial Director
LPW Technology Ltd, UK: A market leader in the development and supply of metal powders for Additive Manufacturing (AM), has appointed Phil Kilburn as Commercial Director for its comprehensive range of products and services within its global group.

Working with many of the leading companies within the aerospace, biomedical and automotive industries, LPW has long been unrivaled in its provision of optimized metal powders to the Additive Manufacturing (AM) industry, and are now applying their insight and expertise to revolutionary online software.

Bringing a wealth of knowledge to the LPW team, Phil has worked in the metal AM industry for seven years having been involved in the general AM industry for the last 22 years, and will be drawing on his skills and expertise to drive the company's software provision strategy forward, as well as developing business opportunities to build on LPW's expertise in alloy development and powder analysis.

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

Each year prior to its annual meeting, a ballot is distributed to ASC Z136 members to approve officers and chairs, and consider membership applications. This year there was a record number of membership requests, including six representational changes and two new organizations to the committee.

Organizational Representatives that moved to Individual Membership Status

Bruce Stuck
Karl Umstadter

Organizational Appointments to the Committee

Federal Aviation Administration (FAA):
Lee Abbott replacing Ricky Chitwood

Los Alamos National Laboratory (LANL):
Joanna Casson replacing Connon Odom

Underwriters Laboratories (UL):
Winn Henderson replacing Peter Boden

US Army Institute of Surgical Research (USAISR):
Brian Lund replacing Bruce Stuck

New Members

ASC Z136 welcomes the **Federal Bureau of Investigation/ Criminal Investigative Division (CID)**/ Violent Crimes Unit/ Transportation Crimes Program and its representative Louis Sager to the committee. The FBI CID's Transportation Crimes Program is responsible for the Laser Strike Working Group National Initiative, which has been actively engaged in a national laser awareness campaign with the FAA, TSA and Air Line Pilots Association since Feb. 2014. Mr. Sager is a Senior Federal Air Marshall with 24 years of Federal law enforcement experience.

Peter Boden, longtime member representing UL will now be representing new organizational member **Laser Product Safety, LLC (LPS)**. LPS is a leading laser and photobiological product safety test house located in Cary, NC that specializes in laser safety testing and classifying laser, LED, UV and IR products and components to global laser/LED safety regulations.

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

Credibility Key to Safety

With multiple lasers running on a manufacturing floor or in a health care facility or lab, wouldn't it be nice to know that the person in charge of keeping employees or patients safe has invested significant extra time in his or her education about laser hazards?

To support those who are deeply invested in the highest standards for the safe use of lasers, LIA created the Board of Laser Safety (BLS®) in 2002. Since then, hundreds of discerning laser safety officers have completed the path to certification. In 2004, a certificate program for their peers in medicine was created.

What distinguishes the CLSO® program? For starters, it was developed by a select panel of premier US laser safety experts drawn from the ranks of ANSI Accredited Standards Committee Z136 members. Involvement of these foremost laser safety authorities provided tremendous expertise and credibility.

Of course, medical laser use presents challenges distinctly different from industrial applications. For example, fifth- and sixth-generation designs are used for a very narrow range of clinical applications and do not allow unattended operation. Then there are infection-control imperatives to weigh. As unique as medical laser conditions are, so too is the CMLSO® program.

The bottom line? BLS-certified LSOs and MLSOs warrant acknowledgement of their supreme dedication to laser safety. Achieving CLSO or CMLSO status conveys indisputable next-level technical skill and bolsters credibility with colleagues. Institutions with certified professionals demonstrate due diligence and expertise on staff, helping to ensure the legitimacy and superiority of their laser safety programs.

WE ARE PROUD TO RECOGNIZE THE CLSOs AND CMLSOs WHO HAVE BEEN CERTIFIED 10 OR MORE YEARS:

CERTIFIED LSOs (since 2002)			CERTIFIED MLSOs (since 2004)
Douglas Ashby	Bill Janssen	Jonathan Schluter	Jose Antony
Ken Barat	Myung Chul Jo	Cathi Scogin	Ray Beauregard
Nadia Capolla	Martin Johnson	Randall Scott	James Case
Luz Cheng	Tom Johnson	Geoffrey Sirr	Kwok Kwan Chan
Ahsan Chowdary	Johnny Jones	David Sliney	Pat Clark
Eddie Ciprazo	Kimberly Kantner	Mordechai Snir	Terri Clarkson
Surenda Dua	Karen Kelley	Candace Soles	Vangie Dennis
Ben Edwards	Mark Krauss	Sandu Sonoc	Erin DeVita
Bill Ertle	Michael Lefebvre	Paul Sorensen	Susan Hayes
Danny Fok	Wes Marshall	Dewey Sprague	John Hoopman
Mark Frankfurth	Wally Mitchell	Tekla Staley	Patti Owens
Penelope Galoff	Robert Mueller	Nikolay Stoev	Penny Smalley
Joseph Greco	Ross Muenchausen	Tracy Tipping	Susan Taylor
Jamie Gurney	Bruce Murdoch	Karl Umstadter	Margaret Wojcik
Douglas Gwin	Rod Nickell	Susan Winfree	
Stephen Hemperly	Jay Parkinson	Allen Wood	
Tim Hitchcock	Jodi Ploquin	Sheldon Zimmerman	
Richard Hughes	Tod Richards		
Pak Ching Ip	Bob Sarason		

OSHA | Update

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

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

OSHA publishes Notice of Proposed Rulemaking updating a National Consensus Standard in its Eye and Face Protection Standards

The Occupational Safety and Health Administration published a proposed revision to its Eye and Face Protection Standards that updates personal protective equipment requirements in the agency's general industry, shipyard employment, longshoring, marine terminals and construction standards. The proposed revisions will reflect current national consensus standards and ensure that employers use up-to-date eye and face protection during hazardous workplace operations.

This Notice of Proposed Rulemaking (NPRM) incorporates the latest American National Standards Institute eye and face protection standard, which was adopted after OSHA issued the final rule on personal protective equipment in 2009. The 2009 final rule did not modify the construction standard. This NPRM also updates language in the construction eye and face protection standard to make it more consistent with general industry and maritime standards.

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

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

JLA | Editor's Pick

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.

Design, Processing and Characterization of Nickel Titanium Micro-Actuators for Medical Implants

BY RONNY HAGEMANN, CHRISTIAN NOELKE, THOMAS RAU, STEFAN KAIERLE, LUDGER OVERMEYER, VOLKER WESLING AND WIM WOLKERS

Cochlear implants (CI) are complex medical implants used as a common therapeutic measure for deaf people who suffer from damage to the inner ear. The success of CI insertion, a manual surgery procedure, is highly dependent on the surgeon's experience. Additionally, more precise positioning of the electrode close to the membrane structures could increase the effectiveness of frequency selectivity and stimulus conduction. To overcome these limitations, the degree of deformation of the electrode during its insertion has to be controllable. This ability can be achieved by integrating micro-actuator elements of a nickel titanium (NiTi) shape memory alloy (SMA) inside the electrode. These elements are manufactured using selective laser micromelting (SLμM). Initially, different concepts of activation mechanisms for SMA actuators for CI electrodes are discussed. Following the rules of additive manufacturing on a microscale, the corresponding actuator design and manufacturing strategies are presented.

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

ICALEO 2015 Sponsorships Available

There is still time to sign up to exhibit at or sponsor ICALEO 2015. LIA's 34th annual International Congress on Applications of Lasers & Electro-Optics (ICALEO®) Oct. 18-22, 2015, will be held in Atlanta, GA. ICALEO has a 33 year history as the conference where researchers and end-users meet to review the state-of-the-art in laser materials processing and predict where the future will lead.

ICALEO offers various levels of sponsorship opportunities to help create a lasting impression with attendees. As an ICALEO sponsor, your company will have the opportunity to increase conference-wide visibility, maximize awareness and generate sales leads. Unique to the industry, ICALEO attracts more decision makers to one place than any other laser processing event. Please contact Andrew Morrison, **amorrison@lia.org** for more information, or visit **www.icaleo.org** and download the Sponsor/Exhibitor brochure.

LASER World of PHOTONICS

LASER World of PHOTONICS 2015 is Industry and Research Flagship

From June 22-25, 2015, the international laser and photonics industry will be meeting in Munich, Germany for the industry's most important flagship show: LASER World of PHOTONICS. More than 27,000 visitors and 1,100 exhibitors from all over the world are expected to attend. What is more, LASER World of PHOTONICS will expand by one hall to over 592,000 square feet at the fairground of Messe München International, presenting the biggest event ever in the show history of photonics.

As the leading international trade show for this sector, LASER World of PHOTONICS presents the global market for photonics more comprehensively and in greater detail than any other event. To maintain an overview of photonics, the show will revolve around innovation in all five halls. Focus areas for all aspects of photonics will be "Imaging," "Laser Systems for Manufacturing" and "Biophotonics & Medical Technology." World of Photonics Congress, the international scientific elite's get-together, will take place parallel to LASER World of PHOTONICS 2015 at the Messe München fairground.

For more information, visit **www.world-of-photonics.com** or contact the US office directly at **fnovak@munich-tradefairs.com**.

Register for Online Training Now & Save $100!

Gain more knowledge in less time with Laser Safety Officer Training – Online! LIA's Laser Safety Officer course is the most comprehensive and convenient program available. With a focus on safety program development and administration, it covers lasers and optics, bioeffects, beam and non-beam hazards, control measures and training requirements. A Medical Laser Safety Officer course is also offered and specifically designed to meet the special needs of RNs, OR supervisors, training coordinators and other medical professionals who have been appointed the critical responsibility of LSO.

With access to the training online, you can enhance your laser safety knowledge at your own convenience, from home or the office. Save time and money by cutting out the many costs of travel. Learn at your own pace and set your own schedule. And now is the time to sign up for LIA's online training to save even more! Visit **www.lia.org/education** and use discount code **TRAIN100** to receive $100 off LIA's Laser Safety Officer Online Training or Medical Laser Safety Officer Online Training courses for a limited time only.

LAM®
LASER ADDITIVE MANUFACTURING
WORKSHOP

Save the Date & Sign Up Today for LAM 2016

LIA's Laser Additive Manufacturing (LAM®) Workshop returns to Orlando on March 2-3, 2016, with past general chair Paul Denney of Lincoln Electric at the helm. LAM 2016 will bring together representatives from industries including power generation, aerospace, agriculture and automotive. Attendees will hear case studies from large and small firms describing successes in depositing wire or powder with lasers to prevent and repair corrosion on vital componenets. Now is the time to mark your calendar to attend this revolutionary event! Visit **www.lia.org/lam** for more details.

If you are looking for a valuable way to reach a highly-qualified target audience, then sign up as a LAM 2016 Sponsor or Vendor. LAM Sponsors will have the opportunity to communicate directly with influential decision makers, provide solutions to technology challenges, promote brand recognition through high visibility and source new products to your target market. For more information, please contact Andrew Morrison at **amorrison@lia.org**.

TRUMPF

Simply brilliant laser technology

For more than forty years, TRUMPF has led the way in industrial laser technology. With the broadest product portfolio, including disk, fiber, direct diode, Nd:YAG, ultrafast and CO_2 lasers, combined with well established expertise in every application, TRUMPF is a knowledgeable and reliable partner. From advanced OEM lasers to complete turnkey laser systems, you can trust TRUMPF to help develop and fully support your production solution: from installation, applications support, service, spare parts and everything in between.

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