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THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

LIA TODAY

Image courtesy of Fraunhofer USA CLA / IWS

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Focus:
AUTOMATION PROCESS & PRODUCTS

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

Laser Institute of America
Laser Applications and Safety

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LIA TODAY

THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

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ABOUT LIA

Laser Institute of America (LIA) is the professional society for laser applications and safety. Our mission is to foster lasers, laser applications and laser safety worldwide.

We believe in the importance of sharing new ideas about lasers. In fact, laser pioneers such as Dr. Arthur Schawlow and Dr. Theodore H. Maiman were among LIA's original founders who set the stage for our enduring mission to promote laser applications and their safe use through education, training and symposia. LIA was formed in 1968 by people who represented the heart of the profession —a group of academic scientists, developers and engineers who were truly passionate about taking an emerging new laser technology and turning it into a viable industry.

Whether you are new to the world of lasers or an experienced laser professional, LIA is for you. We offer a wide array of products, services, education and events to enhance your laser knowledge and expertise. As an individual or corporate member, you will qualify for significant discounts on LIA materials, training courses and the industry's most popular LIA conferences and workshops. We invite you to become part of the LIA experience —cultivating innovation, ingenuity and inspiration.

CALENDAR OF EVENTS

Laser Safety Officer Training

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

Laser Safety Officer with Hazard Analysis*

Sept. 18–22, 2017	Chicago, IL
Oct. 16–20, 2017	Phoenix, AZ
Nov. 6–10, 2017	Miami, FL
Jan. 29–Feb. 2, 2018	Orlando, FL
Mar. 5–9, 2018	Marina del Rey, CA

*Certified Laser Safety Officer exam offered after the course.

Industrial Laser Safety Officer Training

Nov. 15–16, 2017	Novi, MI

Medical Laser Safety Officer Training*

Sept. 16–17, 2017	Chicago, IL
Oct. 14–15, 2017	Phoenix, AZ
Nov. 4–5, 2017	Miami, FL
Jan. 27–28, 2018	Orlando, FL
Mar. 3–4, 2018	Marina del Rey, CA

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

Oct. 22–26, 2017	Atlanta, GA

Laser Additive Manufacturing Conference (LAM®)

Mar. 27–28, 2018	Schaumburg, IL

Lasers for Manufacturing Event (LME®)

Mar. 28–29, 2018	Schaumburg, IL

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President's Message

We have passed the mid-point of the year. Summer is upon us and we are beginning to get a better feel for how good 2017 will be for business. GDP and productivity are on many people's minds. Whether you are a company in Detroit, Monterrey, Shenzhen, or Stuttgart, you are trying to make more for less. By decreasing the labor portion in the production of a part, you are uncoupling the production from the chase for lower labor rates. So, processes, like laser-based ones, that are automated and high-speed are prime candidates for implementation that can improve productivity.

Due to the nature of laser processing, it is almost always an automated process. In many cases, the automation of laser processing is synonymous with a workcell that is dedicated to a single part, if not a single application on a single part. But most customers want flexibility for customization or for families of parts and/or processes. In one of this month's articles, Michael Sharpe with FANUC Robotics will discuss how flexibility in automation is possible with laser processing.

As you automate and increase the rate of processing, it becomes more difficult for the operator to "sense" when you may be producing defective parts. In some laser applications, such as processing of medical devices, the processing occurs when a lot of "value" has already been added to the part so any mistakes can be costly. For this reason, it may be worthwhile to find ways to monitor and control the laser process. Rahul Patwa and Craig Bratt writes about recent innovations related to monitoring and control this month.

Finally, the ability to integrate a laser into an industrial piece of equipment is a special talent. An LIA corporate member company that has been doing this for over 20 years is Wayne Trail. Over the years, they have worked on everything from tailor-welded blanks for the automotive industry to mold cleaning for aerospace. They have watched and adapted as laser technology has changed from CO_2 and Nd:YAG to disk, fiber, and direct diode. During most of this they have been corporate members of LIA.

Enjoy the rest of the summer and the year. Hopefully it will be *productive* for you and yours.

Paul Denney, President
Laser Institute of America

Automated Lasers
& the Role of Flexibility

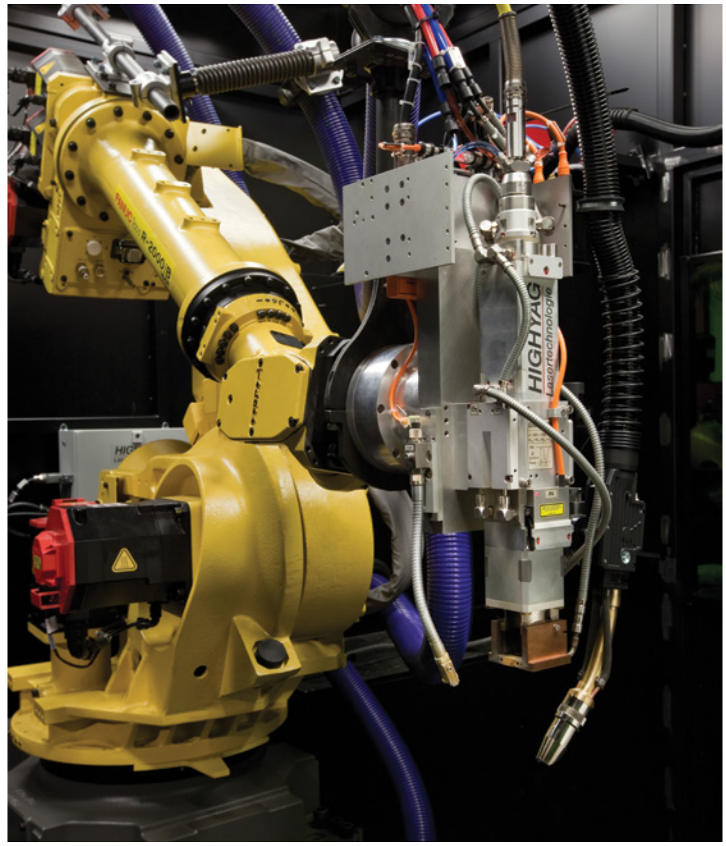
BY MICHAEL SHARPE

The role of flexibility in supporting the pace of advanced manufacturing through laser innovations is critical for success. Flexibility is essential when designing and building systems to address current and future manufacturing needs. Versatility of core motion control performance, whether in machine or robotic applications, is key to driving the confidence in users and the success of the application. Motion control features for cutting and welding of tomorrow's products need to build on capabilities which compliments the advances of the past while anticipating unique solutions to meet future functionality. Laser technology demands and deserves progressive and intelligent developments with a strong focus on flexibility and versatility.

Computer Numerical Controls most commonly used on laser processing equipment are mature and readily accepted throughout the industry. Customers have been quite successful at utilizing the full capabilities of laser oscillators when coupled to advanced motion control. At the dawn of NC control and high capacity industrial lasers, manufacturers were mostly using CNC controls in a rectilinear machine. These machines were a simple moving bridge to carry the processing optics in an X, Y plane with Z height control. Rudimentary but they were effective for the application demands of the day.

Robots have witnessed recent advancements that have improved motion path performance and I/O trigger accuracy, refining process quality. The downward cost trend of industrial $1\mu m$ fiber lasers and increased robotic processing performance has given the industry new vigor, providing a best cost point for high production applications. CNC applications continue to prosper with improved accuracy and speed but are limited in overall flexibility. Customers have more choices than ever based on their manufacturing requirements for laser applications, benefiting all manufacturers of CNC, lasers, and robots.

While it appears straightforward to compare a robot to CNC, they have physical attributes and control nuances that make them each suited for different markets. A laser in motion can produce incredible results but only with the precision of motion control and synchronized input and output control. To effectively use either motion device, it must have the ability to adjust the laser output based on position and velocity. As the motion device accelerates it must have a proportional controlled output to allow the laser power to follow, thereby providing uniform energy distribution along the cut or weld path. Despite their differences, they have similar control functions with different markets. CNC lasers may appear to be more easily deployed as they are mostly configured



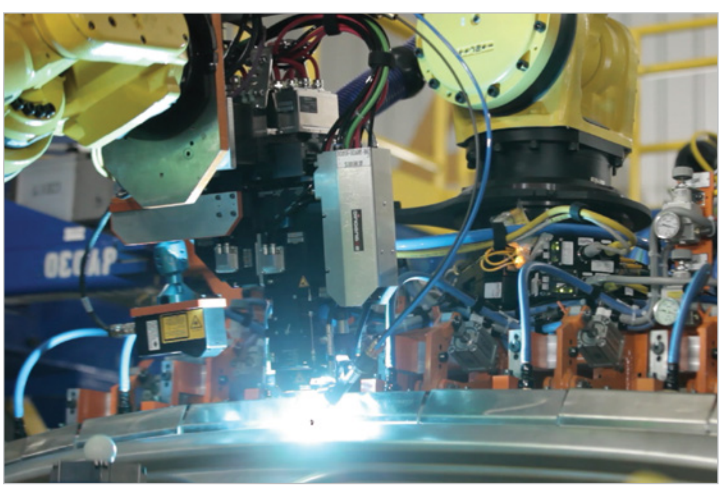
FANUC Laser Welding Robot. Image courtesy of FANUC America Corp.

by machine tool builder in series production, preconfigured for the application purpose. The machines typically offer limited motion range from three degrees of axis motion and up to five degrees in machines with multi-axis heads for orientation control. Most CNCs are rectilinear so they can only do work with one laser processing head at a time, and within their motion envelope. This design cannot support motion overlap of more than one bridge and gantry structure since it will interfere within its own structure. Despite the mechanical design limits, CNCs have enjoyed a large market share in CO_2 laser applications as the beam delivery is well suited for the rectilinear structure and its Cartesian motion envelope.

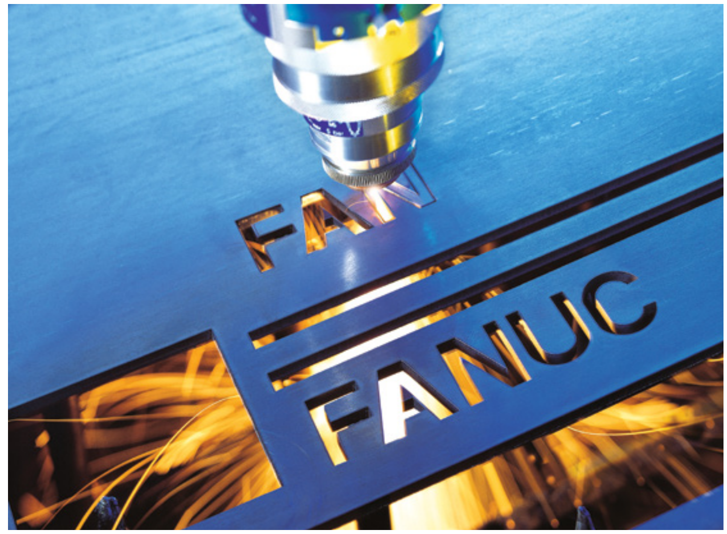
The use of CO_2 on robots has been limited to specialized applications and was tried early on with some success. The largest problem is beam delivery can become quite complex if not designed properly, though some good solutions exist. Today the robotic CO_2 market is primarily plastics trimming where the 10-micron wavelength is more suitable. While fiber delivery is nearly as simple as routing the optical fiber cable along the arm and to the processing head. The cost per watt of a fiber laser has come down significantly while robot motion performance has increased steadily over the last decade and this is where the market has gone in the way of laser processing.

Robot manufacturers continually improve the mechanical structure and motion control to achieve higher path accuracies with improved laser output response. Many features that enhanced the CO_2 market are readily available to robot users, including laser height control to adjust the focus, automatic power control to adjust the output to be constant to the travel speed, and laser monitoring. Robotic applications are more flexible because they are not dependent on the rectilinear motion envelope described above. A six-axis robot has the ability to work with other robots and on the same part, improving laser on time. By coordinating or sharing the laser output you can improve efficiency with a smaller investment and with a more compact footprint since the robot takes up only a 'slice' of vertical space in the work cell.

Opportunities abound for robotic laser applications and are being largely driven from new materials and construction techniques in the automotive market to the latest in 3D printing technology. The requirements for the latest Café fuel consumption standards and the overweighting of cars with safety equipment has forced manufacturers to seek improvements in materials strength to weight ratio, or light-weighting. Components that are made with hot-pressed steel are more difficult to trim to shape and weld. Fiber lasers offer the flexibility to work in these areas by using the robot to cut and trim hot-stamped components with ease. Robotic fiber laser cutting is a natural extension of the robot's work envelope or range to process a variety of formed parts that have a 3D profile. Offline programming provides maximum uptime of the laser system, allowing quick changeover since the cutting path can be programmed offline, maximizing valuable laser on time. Path control features allow the robot to self-tune the motion performance to get the most accurate feature. Laser power is controlled through output level, duty, and pulse rate, providing the best cut quality. These functions are automatically adapted to the robot speed, easing the programming.



Aluminum laser welding at a General Motors plant. Image courtesy of General Motors.



FANUC high speed motion control. Image courtesy of FANUC America Corp.

A popular welding application is remote scanner welding where the beam delivery is controlled by a galvanometer system to steer the beam while coordinating the motion of the robot through its path. This technology is well suited to high throughput applications in automotive body welding and specialty applications for marking and surface treatment. Control techniques to coordinate the robot, scanner, and laser offer precise positioning and are easy to use through a single point of control. Higher throughput is achieved when the robot and scanner's movements are coordinated with simultaneous control. More nameplate manufacturers are using aluminum for automotive body structures and with class 'a' finishes. Complex body shapes have become popular as well as further integration of sensors for safety. The challenge is to form the body shapes and hide the sensors so they do not disrupt the cars' aesthetics. Wire-fed laser welding solutions help support these initiatives by providing a well-controlled feed rate of filler wire into a body seam while precise laser power control causes the weld to form. All of the welding functions are controlled through the robot and are automatically adapted to the robot tool center point velocity along the weld joint. A high quality weld is formed without the operator programming special ramping techniques with program outputs, the new adaptive welding systems can handle the welding filler wire and laser power repeatedly.

Robotic laser control has matured from the cumulative learning experience of CNC applications while offering the utmost in flexibility. The future looks very bright as more and more laser processes and markets mature such as material conditioning, 3D printing, and future flexible robotic laser applications. ■

Michael Sharpe is a Staff Engineer in the Materials Joining Group at FANUC America Corp.

High Growth Areas in Industrial Laser
Processing & Monitoring

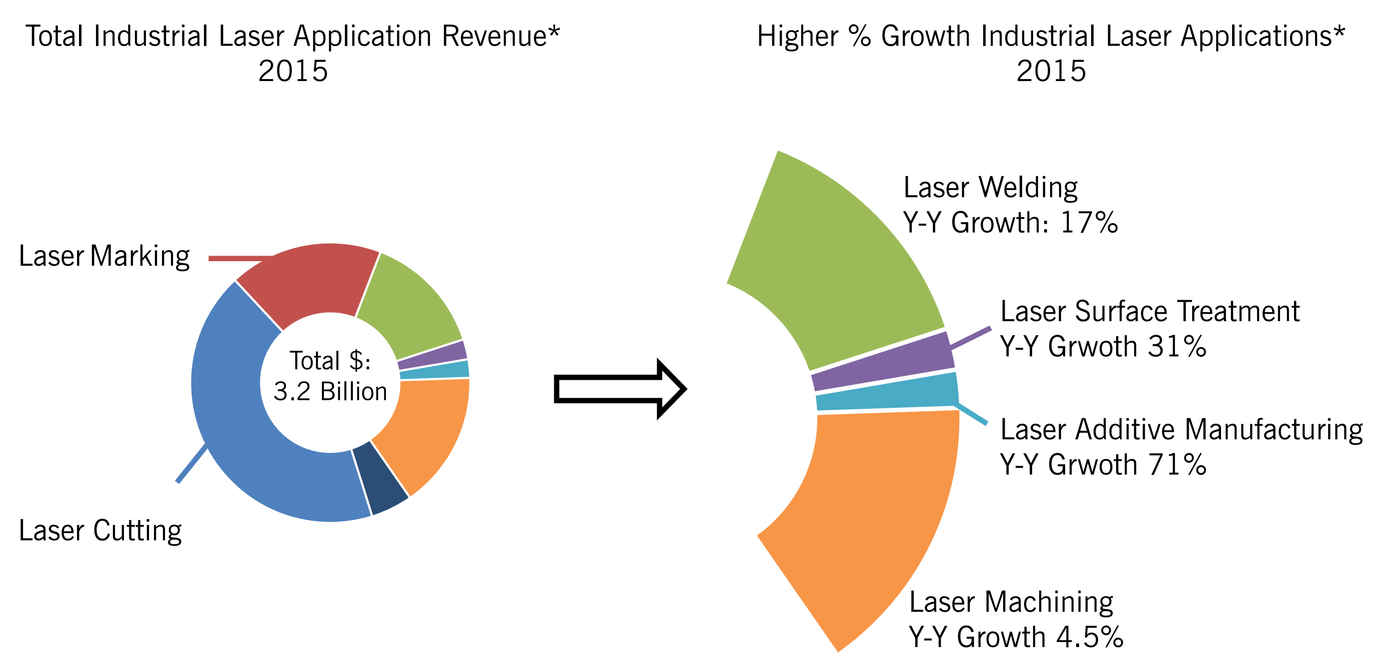
CRAIG BRATT, RAHUL PATWA

The brilliant light of the laser promises unlimited possibilities for materials processing. Its use in manufacturing dates back to the late 1960s where laser drilling was developed for jet engine components. As laser technology has progressed, fast-paced advances in computers and sensor technologies have enabled the development of improved process monitoring devices which has further enhanced the performance, reliability and ease of use of industrial laser systems.

In 2014, the total global market for laser systems for material processing which include both the source and the components was $9.2 Billion (Source: Optech Consulting, VDMA). From this, the total global laser source revenue was $2.9 Billion, according to the data presented by Industrial Laser Solutions (Feb 2016). In 2015, this revenue (only the global laser source revenue) increased by 6.9% to $3.2 Billion. Although, the largest market share has been and continues to be (61% in 2015) in the laser cutting and laser marking/engraving, their % year-over-year growth has been limited to <5%. More interestingly, the higher % Y-O-Y growth areas are laser welding (17%), laser surface treatment (31%) and laser additive manufacturing (71%).

In this article, we present a clear view of how advances in laser power and beam quality along with a significant drop in laser cost per watt and improved laser wall plug efficiency has contributed to major innovations in laser material processing. We have identified four broad laser processing segments and analyzed what is driving innovation.

Manufacturers in many industries have long used laser welding to tackle traditional welding challenges, but laser welding technologies are evolving for even greater utility. Hybrid welding where laser welding is combined with other conventional arc welding methods such as GMAW (MIG) and GTAW (TIG), laser welding with filler wire, and part pre-heating have been successfully implemented in Industry. This has been possible now due to the availability of higher power lasers at lower cost. In turn, materials that were considered difficult to weld until now such as higher carbon steels and cast iron can now be successfully laser welded. The additional filler material changes the composition of the weld, preventing the formation of hard and brittle microstructures. Likewise, induction preheating can be used to help prevent cracking due to martensite formation by slowing down the cooling rate after welding. For instance, in an automotive transmission part, a bolting process was replaced with laser welding, cost savings were achieved through



*Source: Industrial Laser Solutions, Feb 2016

Laser welded transmission part versus traditionally bolted assembly

Laser remote welding

reduced material and processing costs (drilling operations / bolting operations and the bolts themselves), and an overall part weight reduction was accomplished with a more efficient production method using laser technology.

Remote laser welding is another laser welding process which dramatically reduces welding process cycle times compared to conventional welding and is now possible due to availability of higher beam quality lasers and high speed scanners. It involves the use of moving optics in order to rapidly scan the laser beam across the workpiece over large distances both for high speed and for high precision point to point movement.

To capture the higher potential of laser welding, there has been substantial yet continuous development in laser welding head technology which includes the welding optics themselves and also the sensor optics. Some of these process monitoring technologies have been in development for some time. Some are not yet ready for application at scale. But camera based laser monitoring is now at a point where its greater reliability and lower cost is starting to make sense for high power welding applications.

Fraunhofer CLA has developed a high speed camera vision system which can record the welding process in high clarity in real-time and provide both image and video data from the process. This information is processed and calibrated with reference data based on pre-determined actual 'good' weld measurements using reinforcement learning. Using customized image processing software algorithms, it is possible to detect many of the most common weld defects.

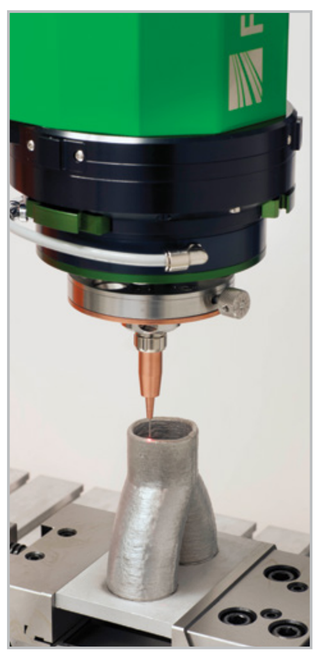
One laser processing technology which has recently been moving up to forefront of innovative, or even disruptive technologies is laser additive manufacturing (LAM). This process uses laser beam as heat source and is primarily divided in two processes: Selective laser melting (SLM) and Laser metal deposition (LMD).

In the SLM process, a layer of powder is deposited on a build platform and then a rapidly scanned laser beam fuses powder together in the right shape and multiple thin powder layers are deposited to create complex 3D parts.

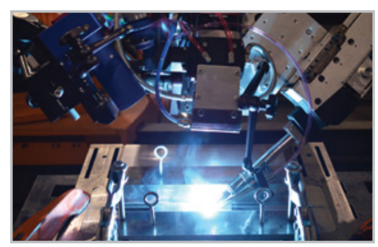
In the LMD process (also known as direct energy deposition or laser cladding), the laser is used to melt metal powder fed through the nozzle which is then deposited in layers onto a substrate, which results in a full metallurgical bond with a small heat affected zone and minimal dilution. It has been developed for surface wear and corrosion coatings, component repairs / remanufacturing, and generation of complete components from scratch.

Two other variations of LMD—hot/cold wire cladding and internal diameter cladding—have now evolved into successful industrial processes and are now widely used in the oil industry, agriculture, power generation and remanufacturing sectors. A recent key development by Fraunhofer IWS is a new coax laser deposition head COAXwire™ which provides omni-directional welding performance for the use of metallic wires as filler material which is of particular use for 3D build up additive manufacturing of metallic components.

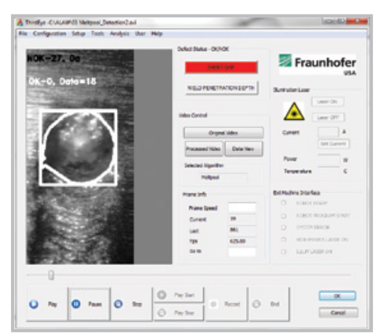
One area of laser material processing that has benefitted the most from technology improvements in both spatial and temporal properties of the laser is laser machining. In addition, the advent of lower cost and smaller footprint laser power sources has lead to much wider industrial adoption of laser technology. The latest generation of pulsed lasers with pulse lengths—from millisecond all the way to femtosecond—has led to a rich pipeline of innovations impacting virtually every manufacturing industry. For example, laser cutting of battery electrodes can produce excellent cut quality and achieve high cutting speeds for application in lithium-ion battery cell production. Similarly lasers can be used for coating removal



Fraunhofer Coax wire deposition head allows multi directional build up using wire



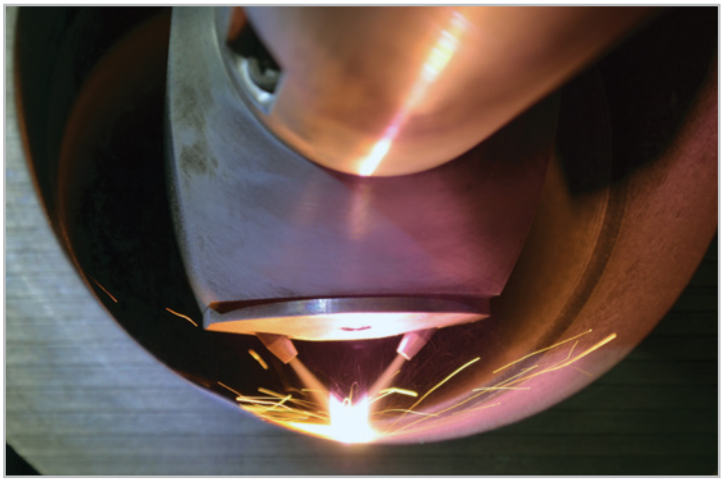
Fraunhofer process monitoring system hardware



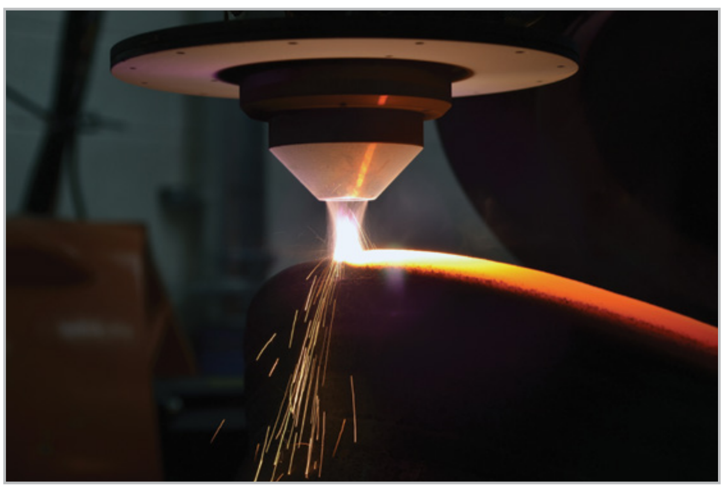
Fraunhofer high speed camera system software

(Continued on page 10)

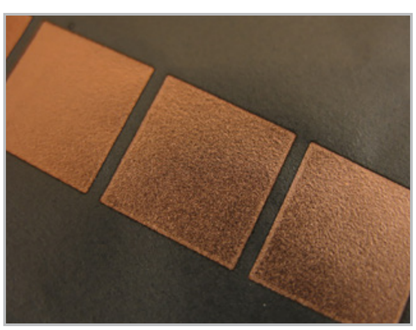
for electrical contacts on battery foils. Large area coating removal for paint stripping, deoxidization, mold and die cleaning or removal of special coatings is conducted by applying high power lasers. Lasers are also used for high rate drilling process for up to 15,000 holes/second.



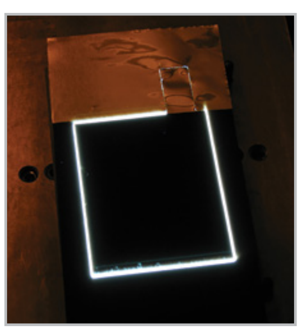
Laser inner diameter cladding developed by Fraunhofer using COAX™ 8 nozzle



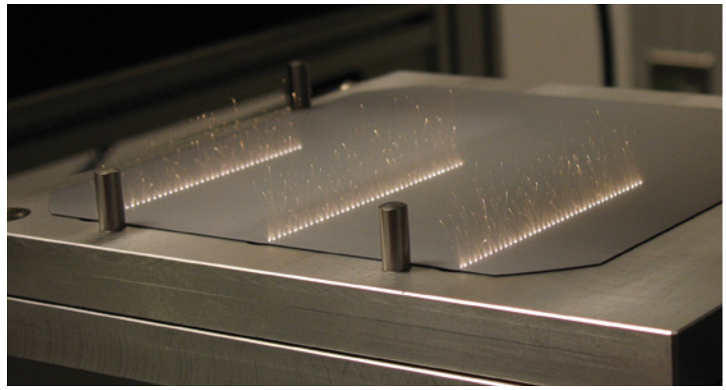
Laser Metal Deposition developed by Fraunhofer using COAX™ 8 nozzle



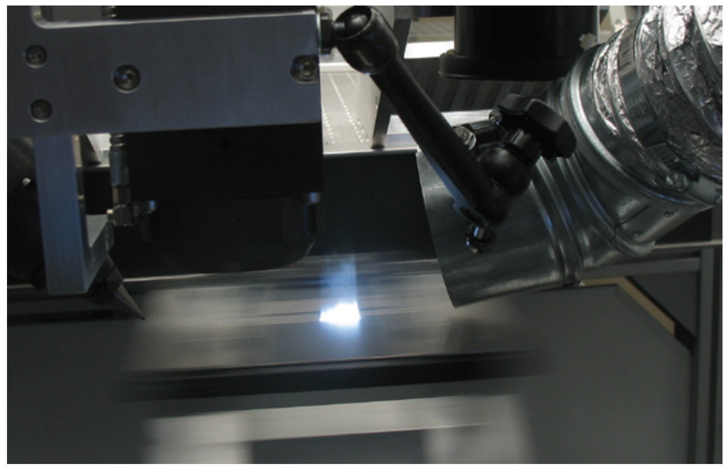
Laser electrode coating removal developed by Fraunhofer



Laser electrode cutting developed by Fraunhofer



Laser drilling of 15,000 holes/sec developed by Fraunhofer



Laser coating removal developed by Fraunhofer

In summary, the current pace of innovations leading to new laser technologies and products is constantly increasing with a wide array of new applications being developed for every industry imaginable. ■

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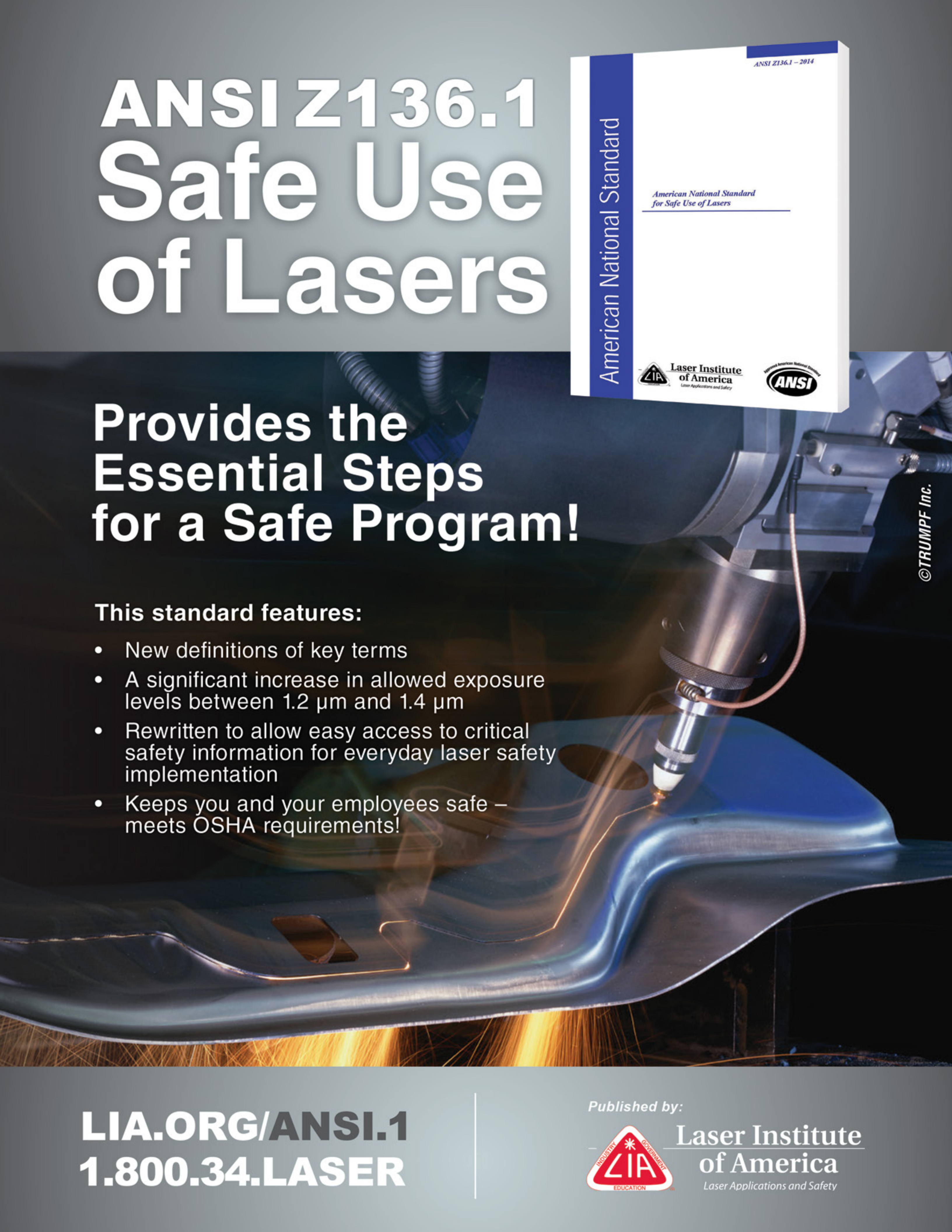
Craig Bratt, Executive Director, Fraunhofer USA, Center for Laser Applications, cbratt@fraunhofer.org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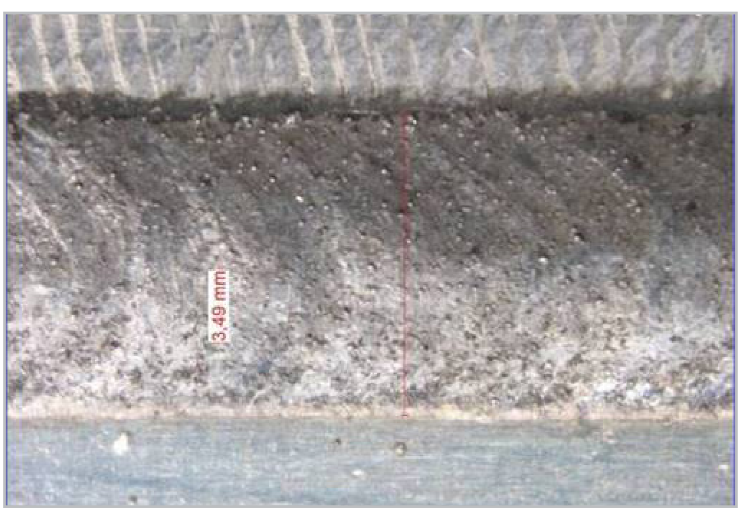
Metal Powder Based Additive Manufacturing
& New Applications

BY FRANK GEYER

The phrase "3D printing" has been the figurative buzzword in the manufacturing industry for a while now. Customers are familiar with plastic 3D printers and their capabilities and many have already seen metal applications at this point. The GE LEAP engine fuel nozzle is a prime example for this technology, and one that has received much attention. However, the field of metal powder based additive manufacturing offers a wide variety of processes and abilities that goes beyond the most popular understandings of 3D printing.

Joining with Laser Metal Deposition

One such process has been around for over two decades and is commonly known as laser cladding. The deposition of a higher performing material onto a cheaper base part is nothing new; it is simply the application most customers have in mind. Laser metal deposition (LMD) can also be used for other applications, for example, as a joining or an additive process. Laser welding is a very effective and accurate means of joining parts together. One of the drawbacks that comes as a result of the accuracy is the critical part fit up requirement. This makes part preparation and fixturing a necessity for a successful result. When joining with laser metal deposition it is possible to bridge gaps while welding. LMD can also be used to weld dissimilar materials by providing the required additional materials through the powder. While a slower process, welding with LMD, for example, provides a smoother and hermetic seal when joining a stamped aluminum part to a cast aluminum part. There are no blowouts and a very smooth weld surface can be achieved while the fabricator is able to close small gaps between the parts.



Joining/seam weld with LMD

Structure Buildup with Laser Metal Deposition

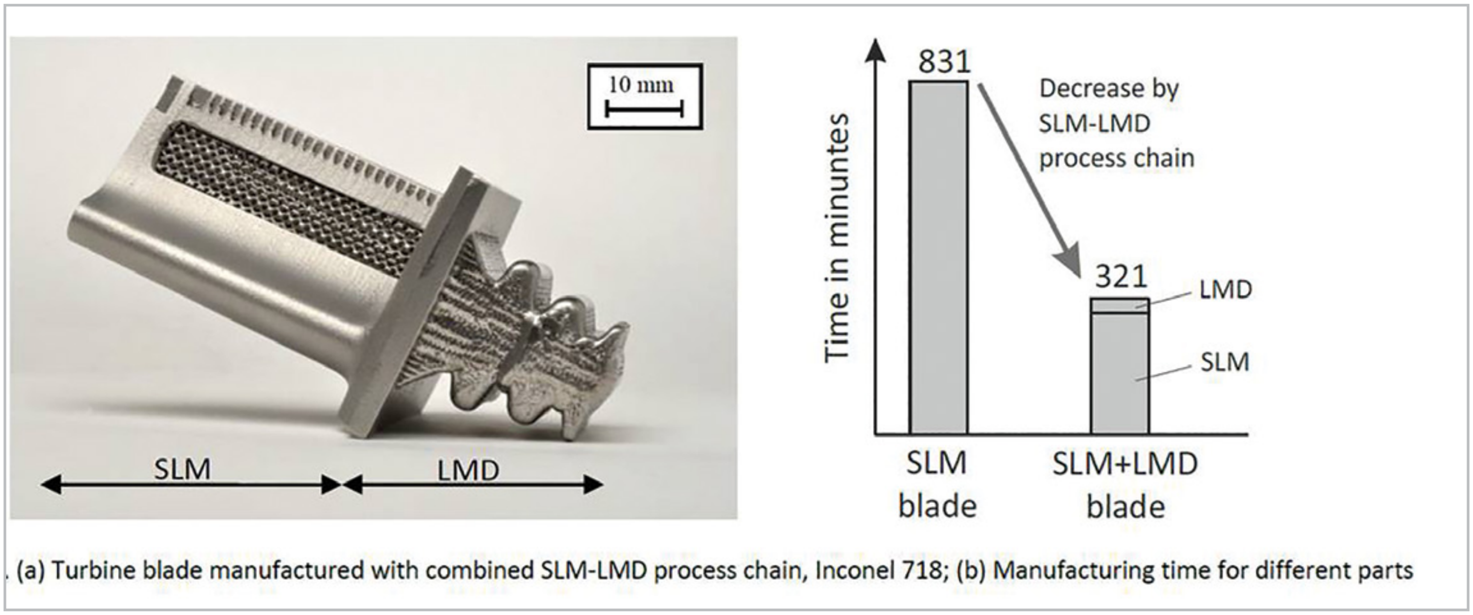
The most commonly used processes for structure buildup are manual welding with wire, electron beam welding with either wire or in the powder bed, and direct metal deposition using a laser with wire or a metallic powder. Laser Metal Deposition, the powder based process, is also an additive means of manufacturing. It allows users to build up structures and features either from scratch or onto existing structures, making it a very versatile process. By adding a feature onto a base geometry, the amount of material that has to be machined can be reduced and subsequently, the size of the block the part is machined from is also smaller. As a result, the forging die can be reduced to a smaller size and of a simpler geometry as the LMD process adds the complexity required. Modification of forming dies are also more efficient and achieved with less rework when compared to manual weld ups. Furthermore, the LMD process introduces a much smaller amount of heat into the die drastically reducing the distortion. The process can also used for repairs, both to fill in voids as well as to add structure, for example to repair the tips of compressor blades.

Increasing Efficiency of AM by Combining Processes

Since 3D printing is a high precision process, it is not always needed throughout the entire part geometry as some features do not benefit from being generated in that way. In this case, the approach for manufacturing the part should be adjusted and the most effective processes selected. An example is a turbine blade that is comprised of both the complicated blade with internal structures and the solid, simpler root with mounting features (Christmas tree). The blade complexity requires the accuracy and capability of the powder bed process while the root does not. There the root can be made using the LMD method. This ensures the flexibility of using additive processes for making a part while optimizing it for the part requirements and process capabilities. A 3D printed part can be produced in a much shorter time when the solid portion is build by LMD, the build time reduction for this example is close to 40%.

Combining AM with Conventional Manufacturing Methods

The thought of combining processes based on their requirements and abilities goes beyond AM. Simpler geometries might not require any type of AM process. Sometimes a base structure can be made by cutting or forming, to greatly reduce process complexity and cycle time. The following example highlights the optimization of the process by comparing a fully printed part to a combination part. A customer, Urban Alps, has developed a new safety key and lock design that differentiates itself through internal key features that are read by the lock. The internal features cannot be scanned and with that, not copied. The lock also can no longer



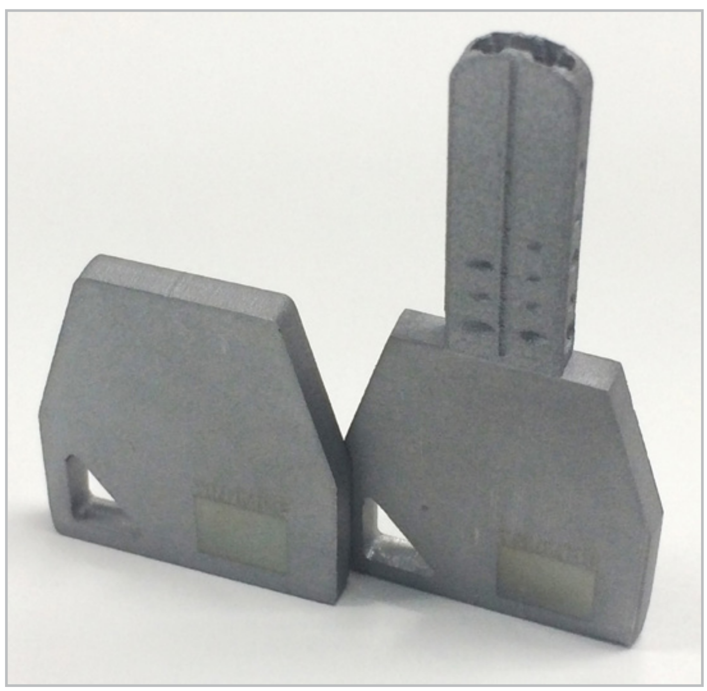
Manufacturing of turbine blade by LMD and LMF (Fraunhofer IPK, Germany)

be picked as it reads a combination of external and internal features. The challenge was in producing a key structure that has complex inner geometries. Laser Metal Fusion (3D printing) is the enabling technology as it allows the customer to print hollow structures in fine detail.

The key structure orientation was determined to be most accurate when built standing upright on the key handle. This also allows for the highest number of parts to be packed on the build plate, maximizing the build efficiency and chamber utilization. The first version of the safety keys was completely printed. Support structures were used for an easy removal from the build plate and to allow the design features of the handle part to be printed. This design required the removal of the support structures, both inside the handle and connecting the part to the build plate, which is expensive and time consuming. The structures also resulted in a lower surface quality after their removal.

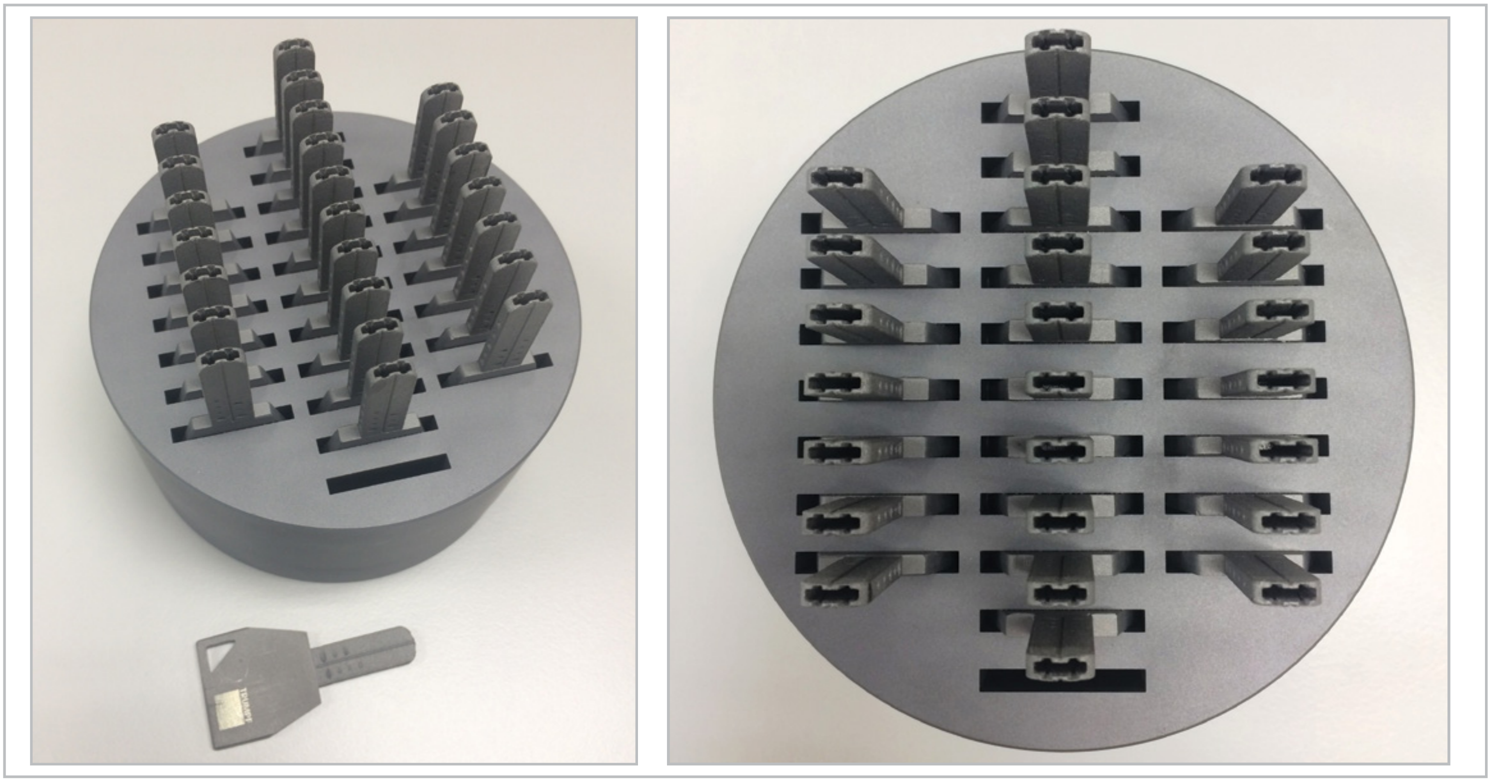
While it is possible to print the entire part, some features of this safety key example do not offer any benefits in functionality when printed. The handle is a simple shape that, except for intricate artwork, can be manufactured by other methods such as cutting. Company logos or other information can be laser marked instead of being printed. In this case, the handle parts were laser cut to provide a high quality surface to print onto instead of building the key in its entirety.

If preformed parts are to be used, several boundary conditions have to be met. Printing on top of an existing structure requires that surface to be flat. Unlike the LMD process, where powder is blown onto a surface which allows for structure build up on 3D surfaces, the LMF process applies the powder only in a plane. The surface quality produced with a laser cut is sufficient to be processed onto with a secondary LMD process, but a fixture that holds the preformed part in place is needed. In this example of combined technologies, the number of layers was significantly reduced, resulting in a 60% decrease in build time and 30% cost reduction. The combination of 3D printing with conventional manufacturing methods allows for optimized designs that maximize the advantages from all processes involved.



Laser cut and marked key handle and finished key

(Continued on page 14)



Parts in pre-form with separate finished key

Metal powder based AM offers a large variety of manufacturing options that, when combined with conventional methods, can make those processes viable for larger volumes where cost optimization becomes a driving factor. While there are rumors that AM will replace conventional manufacturing the opposite is actually the case. With the increase of AM and the ability to combine it with machining and forming processes, the manufacturing world now has a greater flexibility in using the right process and with this, making certain AM project economically viable. ■

Frank Geyer is the Product Manager-Additive Manufacturing at TRUMPF Inc.


Image courtesy of TRUMPF Inc.
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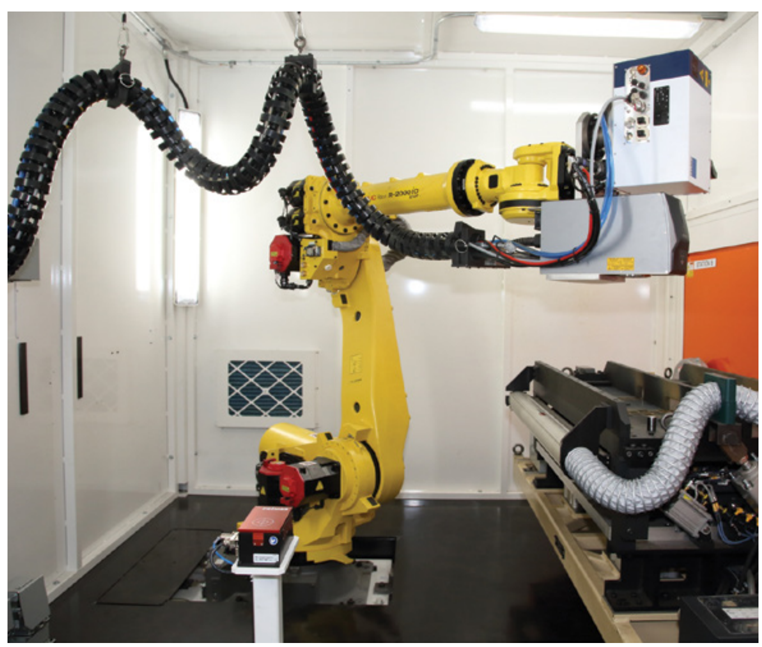
Wayne Trail, a subsidiary of Lincoln Electric, has been recognized as a leader for over 55-years in the design of flexible, automated systems used within a wide range of metal forming, fabricating, and joining industries such as automotive, aerospace, energy and in consumer products. Current capabilities and application expertise includes robotics, welding, and fixturing; press automation; tube bending and fabricating systems; tubular hydro-form and structural-frame automation; build-to-print manufacturing services; and extensive laser processing systems.

Lincoln Electric employs 11,000 people across its 63 manufacturing operations, joint ventures, and alliances in 23 countries. The Company has developed an extensive portfolio of automation capabilities and solutions and has a team of over 1,400 employees focused on serving customers and driving innovation in this area. Research and development of next-generation laser processes and applications in brazing, ablation, laser die cleaning, and laser/hot wire for cladding and welding applications is a core focus and aided by state-of-the-art laser labs which are equipped with multiple laser power supplies, beam delivery optics, and work stations to develop a wide variety of laser applications and processes. With the availability of new materials and the affordability of laser technology for customers, Lincoln Electric continues to weld, clean, cut, and drill complex components for customers.

As a member of Laser Institute of America (LIA) since 1995, Wayne Trail has maintained access to information and opportunities that span all laser-related industries. Through its presence at LIA conferences and expos, the membership has also allowed Lincoln Electric and its automation team to further collaborate and contribute to the industries it supports. ■

For more information, visit ***www.waynetrail.com*** *and* ***www.lincolnelectric.com***.



Tier 1 Automotive Supplier Uses Laser Capabilities to Increase Productivity
A Tier 1 automotive supplier that manufacturers seating components was in need of automating its welding process to meet production requirements. Currently using MIG and resistance welding processes, the client was looking to achieve higher production volumes in less time. As a solution, Lincoln Electric designed a laser processing cell with tooling. Using the laser processing cell, the Tier 1 supplier is now able to weld a seat frame 3.5x's faster and reduce part distortion. With a 60% decrease in the welding cycle time, the supplier was able to meet the volume requirements, delivery a quality product, and reduce overall costs.

Member
Innovations

New Coherent 10 kW HighLight Fiber Laser Combines Innovation and Reliability to Enable Higher Throughput in Materials Processing

A new 10 kW fiber laser from Coherent was showcased at Laser World of Photonics in Munich (June 26–29, 2017) as a part of the HighLight™ product family. HighLight products are high-power fiber, direct diode and fiber-coupled diode lasers that combine innovation and reliability into solutions for industrial materials processing applications. HighLight lasers benefit from Coherent's vertically integrated manufacturing. From diode epitaxy to gain fiber and delivery fiber, in-house sourcing ensures product quality and performance. The modular designs of the HighLight product family combine the best attributes from Coherent's technology centers of excellence. The new HighLight FL10000 combines the output of four individual 2.5 kW laser modules into a single output fiber, reaching 10 kW total output.

HighLight FL-Series modularity enables OEMs to tailor a laser for their specific needs. At the full system level, the FL-Series features the option of up to four separate fiber outputs, thus enabling time or energy sharing, and simplifying integration into machining workstations and robotic systems. The control interface is compatible with industrial standards.

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

SCANLAB GmbH Introduces Its High-Dynamics excelli*SHIFT* Z-Scanner to the Marketplace

As the leading provider of high quality "made-in-Germany" scan systems, SCANLAB GmbH introduces its high-dynamics excelli*SHIFT* z-scanner to the marketplace. Unlike conventional z-axes, the underlying patented concept fully eliminates use of transmissive elements. The resulting enormous rise in dynamic performance opens up completely new laser-processing possibilities. Moreover, this functionality is fully independent of mounting orientation, thus significantly increasing the number of degrees of freedom for machine builders and integrators. The new z-scanner is particularly compelling when used in conjunction with a 2D scanner for micro-structuring, laser engraving and processing of complex free-form surfaces.

Compared to conventional z-axes, the new z-scanner attains previously unachievable accelerations during focal shifting in the z-direction. The tried-and-proven galvanometer principle —a SCANLAB core competency and key technology —facilitates this enormous rise in dynamic performance. Thus, focal motions in the z direction are no longer a limitation for laser processing in three dimensions. The new z-scanner performs just as dynamically as a 2D scan head. The system design eliminates transmissive optics, thereby not only boosting dynamics, but also maximizing integration flexibility.

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

Members
In Motion

IPG Photonics Announces Acquisition of OptiGrate Corporation

IPG Photonics announces that it has acquired OptiGrate Corporation, a pioneer and leading manufacturer of the highest-quality chirped volume Bragg grating (VBG) technologies. OptiGrate VBG-based components enable performance improvement, miniaturization and cost reduction of ultrafast pulsed lasers for micro materials processing, medical and other applications. OptiGrate is a supplier to IPG, and as this relationship has deepened, the companies determined that there was a strong mutual benefit to joining together.

"As the technology leader in volume Bragg gratings and thermo-refractive glass, OptiGrate will help IPG develop new leading-edge solutions and improve our current products and components," said Felix Stukalin, IPG's Senior Vice President of North American Operations. "IPG is intensely focused on advancing the use of lasers around the world and the technology used in them. As such, the acquisition completes IPG's internal set of core components for our revolutionary new ultrafast pulsed laser product lines that we are introducing to the market."

OptiGrate was founded in 1999 by Dr. Leonid Glebov, Research Professor of Optics and Photonics at University of Central Florida, which licenses certain technology to OptiGrate. OptiGrate's President and General Manager, Dr. Alexei Glebov, and CTO, Mr. Vadim Smirnov will continue to run the business. IPG anticipates that OptiGrate's operational location will remain in Oviedo, FL, and that current employees will continue with the company, enabling further growth and innovation. IPG intends to support and honor all existing customer commitments while further expanding the market for OptiGrate's products. Terms of the acquisition were not disclosed.

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

LaserStar Technologies Celebrates 60 Year Anniversary

LaserStar Technologies celebrated 60 years in business on June 1, 2017. The leading manufacturer of laser systems is doubling the size of its facility in Orlando, FL, putting its Southern operations on par with its flagship facility in Providence, RI. "One of the things we're most excited about is breaking ground in Orlando to build the new production facility next to our existing facility," says James Gervais, President and COO. "Our corporate goal is to establish the capacity to produce 1,000 lasers a year. We're excited that we should be breaking ground in the next 75 days."

For more information, please visit **www.laserstar.net**.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Vertical and Horizontal Standards —What?!

Standards terminology tells us that standards can be characterized as either horizontal standards (sometimes called general or basic standards) or vertical standards (sometimes called application standards).

Ideally, a horizontal standard would only contain fundamental principles, concepts, definitions, terminology and similar general information applicable over a broad subject area.

Application-specific areas should be addressed by vertical standards, or "stand-alone documents", which only address the necessary information specific to that application or product. Development of appropriate vertical standards would allow removal of the application-specific information found in a horizontal standard.

In 2005, Accredited Standards Committee (ASC) Z136 formed an ad-hoc working group to review the vertical versus horizontal aspects of the ANSI Z136.1 *American National Standard for Safe Use of Lasers*. The issue? When the first edition of the ANSI Z136.1 was completed, almost all lasers were found in research laboratories; thirty years later the document had become too complex in an attempt to cover all laser related applications. The recommended solution? A smaller ANSI Z136.1, aka "the parent document" and the addition of vertical standards to provide specific guidance based on industries and applications.

With the publication of the ANSI Z136.8-2012 *American National Standard for Safe Use of Lasers in Research, Development, or Testing* and the ANSI Z136.9-2013 *American National Standard for Safe Use of Lasers in Manufacturing Environments*, the revision of the current ANSI Z136.1-2014 has begun the slimming down process. The critical components to remain in the ANSI Z136.1 under consideration:

- Introduction and Definitions
- Classification
- MPEs
- LSO responsibilities and basic controls for any future, limited applications not yet covered. Note that emphasis on control measures will be application-specific.

While the revision currently in development will be pared down, the expectation is that the subsequent edition will be the truer, smaller version of the ANSI Z136.1 standard first envisioned in 2005.

For questions regarding the work of the committee, or to participate on ASC Z136 or any of its subcommittees, please contact Barbara Sams at **+1.407.380.1553** or email **bsams@lia.org**.

BLS Board of Laser Safety

An exciting next-step in one's career development as a Laser Safety Officer (LSO) or Medical Laser Safety Officer (MLSO) can be achieving certification, and it need not be an overwhelming process. Exam candidates often have questions when applying to sit for the CLSO and CMLSO Exams. The following are three common questions from exam applicants, plus a tip!

Q: I work for a company that manufactures medical equipment. Which of the two certifications is right for me?
A: The BLS offers two types of certification. The first type is called Certified Laser Safety Officer (CLSO) and is intended for professionals who are working with lasers in a scientific, manufacturing, or industrial environment. The second type is called Certified Medical Laser Safety Officer (CMLSO) and is intended for professionals who are working with lasers in a medical environment; when beam energy is intentionally directed at a living creature—human or animal —for a health care application. For those working in a manufacturing setting, the CLSO exam is recommended.

Q: I took a laser safety course and received a certificate at the end, doesn't this mean I'm certified?
A: The certificate received at the end of a laser safety course is a certificate of course completion. Certification, on the other hand, demonstrates ones qualifications and proficiencies, and can only be earned by eligible individuals who pass either the CLSO or CMLSO exam. One of the pre-requisites that must be met in order to be eligible to sit for an exam is the completion of a laser safety officer training course. LIA offers two BLS-approved courses which meet this requirement. For a list of pre-approved courses, visit www.lasersafety.org, certification, requirements.

Q: How difficult are the exams?
A: Each exam is a true certification examination. The exams are comprised of 100 questions, written and vetted by laser safety Subject Matter Experts (SME). Candidates have a maximum of three hours in which to respond to the questions, although not all candidates need the full three hours to complete the exam.

Although the pre-approved courses provide a good overview of laser safety information, they are not exam prep courses. The CLSO exam has been updated to be compliant with the 2014 edition of the ANSI Z136.1 *Safe Use of Lasers* standard, and the current CMLSO exam is compliant with the 2011 edition of the ANSI Z136.3 *Safe Use of Lasers in Health Care* standard. It is highly recommended that candidates study the standard applicable to the exam for which they are taking. In addition, exam reference guides are available on the BLS website as a free PDF download.

Tip! Approval to sit for an exam starts a two-year window in which to take the exam. Apply early and allow adequate time to study. Have questions? Email **bls@lasersafety.org** or call us at **+1.407.985.3810**.

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

Announcing the OSHA-NIOSH Heat Safety Tool & OSHA Heat Safety Campaign

As part of our effort to keep you informed of new OSHA resources, we wanted to let you know about the release of the OSHA-NIOSH Heat Safety Tool. The new app, available for both Android & iPhone, is a collaborative effort between OSHA and NIOSH to update the OSHA Heat Safety Tool. Since its launch in 2011, more than 450,000 users have downloaded the OSHA Heat Safety Tool. With the release of the co-branded version, which provides a new and refreshed interface, both agencies expect to reach even more users. Anyone using the current version of the OSHA Heat Safety Tool is encouraged to download the new OSHA-NIOSH Heat Safety Tool. The OSHA Heat Safety Tool will no longer be available for download after September 30, 2017. In addition, OSHA recently kicked off its annual heat illness prevention campaign with an updated web page that features stories about what some employers are doing to protect their workers from the heat. Employers are encouraged to continue submitting their stories to HeatSafetyTips@dol.gov or by clicking on the “Submit your ideas” link on the web page. In addition, OSHA continues to share information and updates via Twitter at #WaterRestShade and through OSHA’s e-Newsletter QuickTakes.

Proposed Rule May Modify OSHA Beryllium Standard

OSHA recently announced a proposed rule that would modify its standard on occupational exposure to beryllium that was published on January 9, 2017. That rule consisted of three separate standards: one for general industry, one for construction, and one for shipyards. Representatives of the shipyards and construction industries raised concerns that they had not had a meaningful opportunity to comment on the application of the rule to their industries when the rule was developed in 2015–16. This proposal provides a new opportunity to comment on the rule for those industries and the public. The new proposal would make changes to the rule only for the shipyard and construction sectors. The general industry standard is unaffected by the proposal. OSHA will not enforce the construction and shipyard standards without further notice while determining whether to amend those standards. A public inspection of the proposed rule is now available and the proposed rule was published in the Federal Register on June 27, 2017. OSHA encourages the public to participate in this rulemaking by submitting comments during the 60-day period.

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

JLA Journal of Laser Applications

Process Characteristics in High-precision Laser Metal Deposition asing Wire and Powder

BY FRANK BRUECKNER, MIRKO RIEDE, AND FRANZ MARQUARDT

Laser-based additive manufacturing (AM) technologies such as laser metal deposition have been introduced in various fields of applications. Laser metal deposition is not only used for the fabrication of complete new parts but also for the purpose of repair and redesign. Therefore, weld beads with dimensions above 1 mm were mostly used in the past. In some cases, bead widths can even exceed 10 mm or more. However, the build-up of filigree parts by means of submillimeter structures has gained interest during the last several years.

Fabrication of structures with small dimensions requires different process modifications along the process chain. This includes not only general process strategies but also adjusted system components. The changed process yields material deposition of varying geometries possibly used in aerospace, space, medical technology, and microtooling. Additionally, it can also be used in the repair of worn or damaged microparts. In this paper, the aforementioned process modifications are shown and demonstrated. In addition, high-speed process observations are discussed and, finally, the fabricated parts are analyzed. The latter includes nondestructive and also destructive methods. Based on the combination of changed process elements, a stable laser-based AM procedure is presented, which is already in production.

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Registration Now Open for Laser Institute of America's 2017 ICALEO® Conference

Registration is now open for the 2017 International Congress on Applications of Lasers & Electro-Optics (ICALEO®) Conference. Held this year from October 22–26 at the Sheraton Atlanta Hotel in Atlanta, Georgia, the 36th edition of the conference continues its legacy as the leading source of technical information in the laser industry dedicated to the field of laser materials processing. The conference allows researchers and end-users to meet and review the best in the business, while presenters at the conference will be given the opportunity to have their technical papers peer-reviewed.

Each year, ICALEO attracts more than 200 companies and organizations from more than 30 different countries. With more than 30 vendors currently scheduled for this year's conference, LIA's unique Laser Industry Vendor Program allows vendors and attendees the opportunity to discuss the latest equipment and applications in a low-key setting after the technical sessions.

ICALEO also offers sponsorship opportunities, acknowledging sponsors through onsite signage, visibility on the website, and inclusion in the distributed program. Attendees will have the opportunity to experience the most-current products and services from the leading industry exhibitors and sponsors. In keeping with tradition, the 2017 edition of ICALEO brings together academics and laser industry professionals and allows them a space to discuss the advancement of laser technology and encourage its successful reach into the future.

To learn more about attending the premier lasers and electro-optics conference, visit **www.icaleo.org**.

Lasers In Manufacturing

AM: Trends in North America

Laser Institute of America Presented Inaugural Lasers in Manufacturing AM: Trends in North America Session at World of Photonics Congress 2017

LIA presented its inaugural 90 minute session, Lasers in Manufacturing AM: Trends in North America, on Wednesday, June 28, 2017 from 2:00–3:00 PM local time at the International Congress Center in Munich, Germany. The session was part of the Additive Manufacturing subconference of Lasers in Manufacturing (LiM) 2017 at the World of Photonics Congress Lasers in Manufacturing event, held from June 26–29, 2017 and organized by the German Scientific Laser Society (WLT).

Attendees enjoyed the unique perspective on the success of North American AM regarding cost and increased efficiency. Keynote speaker David Ott of the Global Humanitarian Lab (GHL) discussed 3D printing's impact on humanitarian efforts in the private, academic, and scientific sectors, while addressing communities affected by disasters globally. Author Rob Martinsen, CTO of nLight, presented breaking solutions in AM. Additional featured speakers included author William Herbert, Director of Corporate Development for Carpenter Technologies, and Yannick Lafue, Business Developer for Aeronautics Defense and Oil & Gas at IREPA LASER.

For more information about Lasers in Manufacturing and the German Scientific Laser Society, visit **http://www.photonics-congress.com**. To explore the latest LIA events, visit **www.lia.org**.

LASER World of PHOTONICS

Photonics: The Key to Technological Progress

The trade show LASER World of PHOTONICS 2017 took place in Munich, Germany, from June 26 to 29 and ended with a record-breaking number of visitors. A total of 1,293 exhibitors presented their products to more than 32,000 trade visitors from 90 countries and they were very satisfied with what LASER World of PHOTONICS had to offer. The Gelszus Messe-Marktforschung survey revealed that 99 percent of visitors rated the trade show as excellent or good, with the bulk of them assuming the trade show will continue to grow in importance. In addition to Germany, the top five visitor countries were France, UK, Japan, Switzerland and the USA; 60 percent of the visitors and Congress participants traveled from outside Germany, while 800 of the 1,293 exhibitors were from abroad. The exhibitors' assessment of their market is between very good and good. Exhibitor participation increased by 5.4 percent on the previous event and exhibitor growth was generated both domestically and from abroad. The next LASER World of PHOTONICS will take place from June 24 to 27, 2019. The next World of Photonics Congress will run from June 23 to 27, 2019.

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