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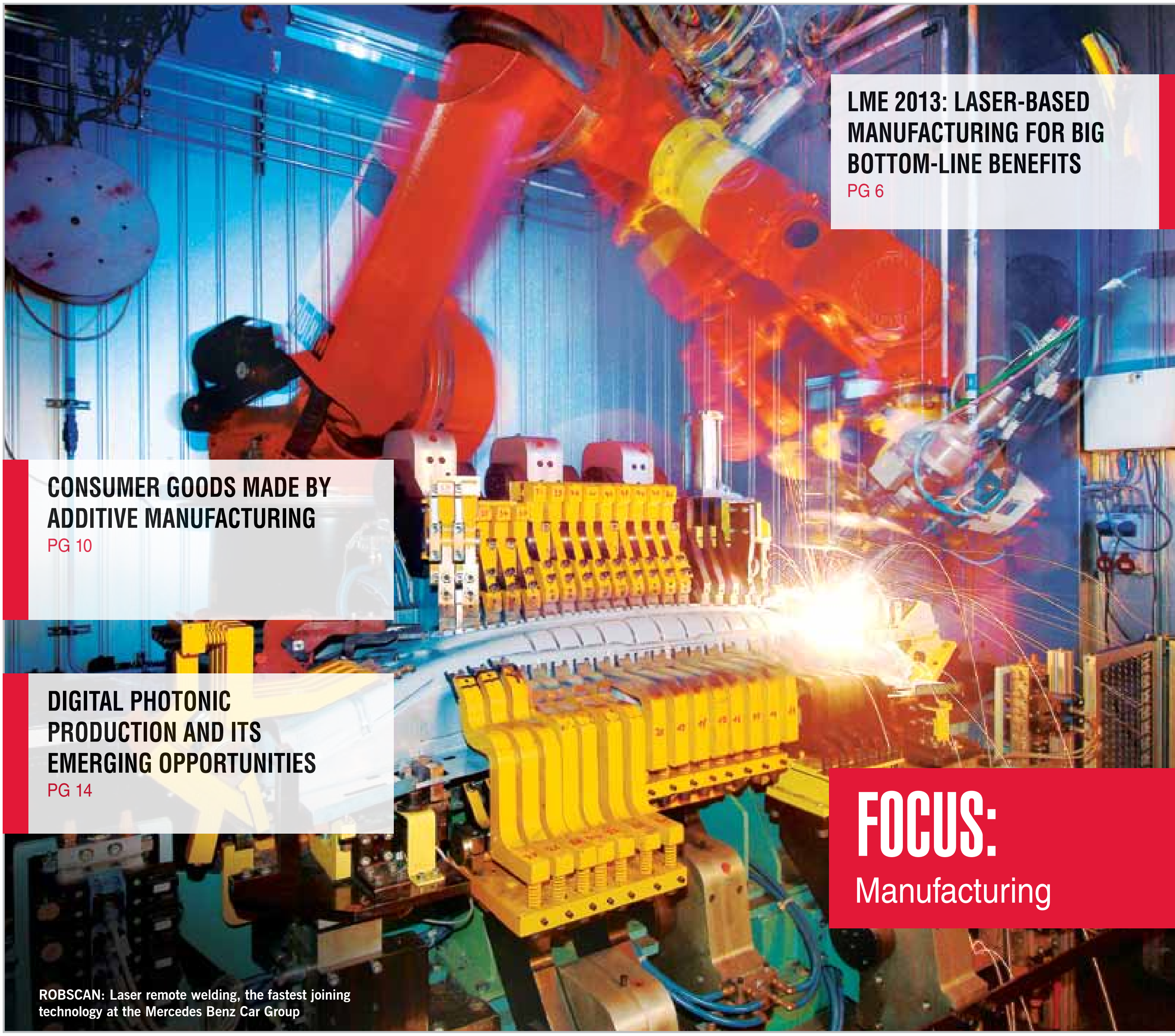
THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

LIA TODAY



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

13501 Ingenuity Drive, Suite 128
Orlando, FL 32826
Phone: +1.407.380.1553
www.lia.org

Laser Institute of America
Laser Applications and Safety

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LIA TODAY

THE OFFICIAL NEWSLETTER OF THE LASER INSTITUTE OF AMERICA

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

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EDITORIAL STAFF

Editor-in-Chief – Peter Baker

Managing Editor – Michelle Williams

Copy Editor – Barbara Sams

Contributing Editor – Geoff Giordano

BUSINESS STAFF

Publisher – Jim Naugle

Advertising Sales – Andrew Morrison

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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. 3-5, 2013	Orlando, FL
Feb. 25-27, 2014	Phoenix, AZ
Jun. 24-26, 2014	St. Louis, MO
Dec. 2-4, 2014	Orlando, FL

Laser Safety Officer with Hazard Analysis*

Oct. 7-11, 2013	Miami, FL
Nov. 4-8, 2013	Los Angeles, CA
Jan. 27-31, 2014	Orlando, FL
Mar. 10-14, 2014	San Antonio, TX
Jun. 2-6, 2014	Boston, MA
Sept. 8-12, 2014	Washington, DC

*Certified Laser Safety Officer exam offered after the course.

Medical Laser Safety Officer Training*

Sept. 13-14, 2013	Chicago, IL
Oct. 5-6, 2013	Miami, FL
Nov. 2-3, 2013	Los Angeles, CA
Jan. 31-Feb. 1, 2014	Orlando, FL
Jun. 7-8, 2014	Boston, MA
Sept. 6-7, 2014	Washington, DC

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

Advanced MLSO Training*

Oct. 17-20, 2013	Atlanta, GA

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

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

Oct. 6-10, 2013	Miami, FL

Laser Additive Manufacturing (LAM®) Workshop

Mar. 12-13, 2014	Houston, TX

Lasers for Manufacturing Event® (LME®)

Sept. 11-12, 2013	Schaumburg, IL

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

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3RD ANNUAL

PRESIDENT'S MESSAGE

Dear LIA members, friends, colleagues and readers of the *LIA TODAY,*

Good news, the laser based economy is growing further. New application trends are making their way into the industry. Digital Photonics Production has developed into a global trend. In North America it is part of "Harnessing Light." In Europe there is an increasing demand from the industry and research communities. Similar to the US and Europe, the same demand is also visible in China, where several research institutes are working on this topic.

This is amazing given the fact that laser cladding is one of the early laser applications. Why is it just now attractive? The easy answer: The time is right. Material is getting more and more expensive and it starts paying off. This issue of the *LIA TODAY* features two articles on this application. In the beginning the application was only used for "expensive aircraft turbines." One of the articles shows that even consumer goods are made in an economic way by additive manufacturing. The other featured article will discuss the tremendous opportunities in this new market for lasers.

Another high potential laser application field is the use of lasers in plastics manufacturing. Besides the more traditional use of lasers in metal applications, the use of lasers in plastics opens a new horizon. On one hand laser cutting of plastics, like "easy opening" in food packaging, is something that we take advantage in our daily life. Laser welding of plastic containers opens a wide field and this is still not "public knowledge." Another featured *LIA TODAY* article is addressing this potential.

The next few months will be very busy for the LIA staff and they will give you a lot of opportunities to have a close look into how lasers can help your business. If you or some of your friends would like to know more, the Lasers for Manufacturing Event® (LME®) will give you a great opportunity. More than 100 exhibitors, including educational classes, are available in one location. This premiere event will take place in Chicago, Sept. 11-12.

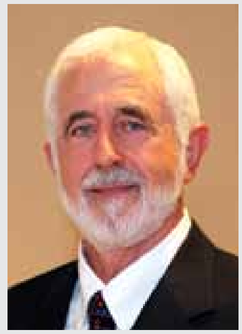
ICALEO® 2013 is also around the corner. It will be another exciting event from Team LIA, showing new technology and possibilities to make you and your business fit for the future.

I wish you good health, success in your business, and hope to see you at one of the LIA sessions or events.

Yours,

Klaus Löffler, President
Laser Institute of America

EXECUTIVE DIRECTOR'S MESSAGE



Lasers, Manufacturing and LIA

In the US there is a renewed and welcome interest in manufacturing. A confluence of factors is making it more attractive to manufacture in this country and there is a growing realization that advanced manufacturing, including additive manufacturers and 3D printing, is the key to success.

LIA's steadfast commitment to laser applications and safety puts us at the forefront of the advanced manufacturing movement since lasers are a key to many advanced manufacturing applications.

At our upcoming Lasers for Manufacturing Event® (LME®) Sept. 11-12, in Schaumburg, IL, Dr. Prabhjot Singh, who heads the additive manufacturing group at GE Global Research laboratory, will give a keynote address on additive manufacturing and 3D printing. LME will also feature free tutorials to bring new people up to speed together with exhibits featuring lasers, systems, robots and components used in advanced manufacturing. Many of the tutorials are featured in Laser U, our online training resource. Our Laser Additive Manufacturing (LAM®) Workshop, to be held next Spring, features the topic in more detail.

Finally, honoring our commitment to safety, LIA also published a brand new safety standard for lasers in manufacturing this year.

Get everything you need to know about lasers in manufacturing from the source – LIA!

Peter Baker, Executive Director
Laser Institute of America

FEATURED ARTICLE

LME 2013: LASER-BASED MANUFACTURING FOR BIG BOTTOM-LINE BENEFITS

By Geoff Giordano

In its third year, the Laser Institute of America's Lasers for Manufacturing Event® (LME®) has been established as an indispensable locus of advanced photonics knowledge, with industry experts, seasoned practitioners and enthusiastic entrants to the field converging to share insights into the 21st century production revolution.

The rubber hits the road Sept. 11-12 at the Schaumburg Convention Center just outside Chicago. Conveniently located near the heart of the US automotive industry and numerous job shops, LME is a first-of-its-kind experience, a one-stop shop for those seeking to discover what types of lasers and systems might be best suited for advanced production applications in a variety of industries.

"LME is aimed at manufacturers who understand that they need to use lasers to upgrade their processes to ensure that they remain competitive in today's economy," says LIA Executive Director Peter Baker.

With the National Additive Manufacturing Innovation Institute (NAMII) in Youngstown, OH, being the pilot facility of the National Network for Manufacturing Innovation, it is clear that laser-assisted manufacturing is a front-burner technology on the economic agenda of the United States. Lasers are, or likely will be, at the center of many advanced production methods in the automotive, aerospace, defense, energy and medical industries.

ADVANCED EDUCATION FROM THE PROS

LME 2013 promises even more must-have content at its unique Laser Technology Showcase Theater on the exhibit floor. This exceptionally focused networking opportunity will once again feature an Ask the Expert booth organized by Dr. Rob Mueller of Lasers-at-Work consulting near Toronto. The primary educational sessions will cover the types of lasers used in manufacturing, design considerations for industrial laser systems, laser safety and the economics of employing lasers.

At the inaugural LME in 2011, Mueller presented a course on choosing the low-cost method for manufacturing, examining remote laser welding, laser cutting and hybrid laser welding and comparing their cost structure and productivity with traditional processing methods.

The low-cost method for a manufacturer depends on production volume, Mueller advises. Without proper analysis of a project or product, "the break-point between traditional and laser processes is not clear, and one could easily choose the high-cost process. Recent advances in laser technology, efficiency and cost have also moved these breakpoints significantly, and laser processes that were technologically sound but not cost-effective, have become cost-effective for many applications."

In addition to the nuts-and-bolts courses, two 90 minute tutorials and four keynote presentations will explore the outer reaches of what lasers are capable of in 21st century production settings.

In the tutorials, Dr. Markus Kogel-Hollacher of Precitec will address process monitoring for laser applications, while Dr. Ron Schaeffer, founder and CEO of PhotoMachining in Pelham, NH, will share his expertise in microprocessing.

Kogel-Hollacher, head of R&D projects for Precitec, says he will stress the history, physical basics and industrial uses of process-monitoring systems.

ATTENDEES EXPERIENCE INNOVATIVE LASER TECHNOLOGY FROM LME EXHIBITORS

"Since CMOS camera technology has made an exceptional leap in resolution, speed, price and size, this technology has supported the reliability of process-monitoring systems dramatically," he notes. The success of process-monitoring systems has been "generated by all suppliers of such systems by carefully analyzing the potential applications so as not to integrate alibi systems in industry. This has led to confidence in the technology."

Schaeffer, author of the 2012 book *Fundamentals of Laser Micromachining*, has been a key player in the medical device

market. In fact, PhotoMachining realized some of its most profitable years during the 2008-09 recession, he said earlier this year.

Lasers factor heavily into the manufacture of catheters. “We’ve seen lasers being used for tipping applications (and) what we primarily do, drill holes in them for drug delivery,” he recalled. “There’s a lot of welding involved within the catheters. We do the ablation: hole cutting, drilling, slicing, tipping.”

As per his company’s website, PhotoMachining “makes precision laser micromachining of otherwise unmachinable parts and materials a routine job.” The ability for attendees to hear real-world success stories like Schaeffer’s makes LME an indispensable event. For instance, he has built about a dozen systems for a customer who uses them to mark catheters.

“You want to stick these catheters in a body, and you want to know how far you’re sticking them in, so you mark graduations on them,” he explained. “This could be done with printing, but a lot of times the inks don’t stick very well to some of these plastics.”

“Our customer initially was using a YAG laser to mark these parts. The marks looked good to the eye — very high contrast — but if you looked at them up close, you could see that they were burned in, which you would expect from an infrared laser. You could run your hand over it and feel the mark — and where they stick these things you don’t really want to be feeling (imperfections). We came in with a UV laser, which just marks the surface, doesn’t impart any heat (and creates) an indelible mark. You can’t feel it.”

KEYNOTES SHED LIGHT ON CRITICAL TOPICS

Reprising his state-of-the-industry presentation from LME 2012, past LIA President David Belforte will again illuminate for attendees the lucrative hot spots where laser-based manufacturing means big bottom-line benefits.

“At the midpoint of 2013, performance in the industrial laser marketplace was following projections made in January,” Belforte said in June. “Market growth in revenues was in the mid-single digits as global manufacturing continued to feel the restrictions of soft economies. Even the vibrant market in China was not immune from first-half uncertainty as that economy was not exempt from market pressure and North American and European exports were lower than anticipated.”

“Even so, the market appears on track to end the year up on a high note as economies return to normality and fourth quarter orders for first quarter 2014 shipments are expected to build. Leading the market resurgence in the second half of 2013 will be fiber laser revenues, which will continue to outperform the market overall.”

Silke Pflueger, general manager of DirectPhotonics, will enlighten attendees about the impact of and applications for ultra-high brightness direct diodes.

MANUFACTURERS SHOWCASE THEIR LATEST PRODUCTS ON THE SHOW FLOOR

“Laser cutting and welding have long become standard manufacturing technologies, helped by very reliable laser technologies that came into the market in the past 15 years,” she explains. “As the development of lasers has continued, a trickle has become a trend: Established players as well as a few start-ups are pushing into the laser material processing market with ultra-high brightness diode lasers, aggressively pursuing the space previously occupied by fiber, disk and even CO_2 lasers. This is made possible by several new architectures that are accessing the inherent brightness of the diode laser material,

(Continued on page 8)

leapfrogging current diode laser technology. Typically fiber delivered, they are starting to be used for cutting, welding and remote welding due to their high power levels and brightness."

Pflueger is confident that these devices will rapidly become industry workhorses.

"New ultra-high brightness diodes, enabled by advances in semiconductor and packaging technology, are well on their way to become the new standard lasers in the 1 μm wavelength range," she asserted. "With a good enough brightness to tackle most common metal manufacturing jobs, it will ultimately be their efficiency that will turn them into the leading lasers in the market. While immediate energy savings may not be large… diode lasers require fewer and simpler power supplies, smaller chillers (and) a less-complicated optical design, all leading to reduced cost, both for their operation and the original investment."

Noted additive manufacturing expert Prabhjot Singh will present key insights into state-of-the-art AM and 3D printing during his talk. Singh, manager of the AM lab for GE Global Research in Niskayuna, NY, since August 2011, served nearly seven years as a mechanical engineer in GE's product realization lab.

KNOWLEDGEABLE EXPERTS DELIVER PRESENTATIONS ON THE INDUSTRY'S HOTTEST TOPICS

"In our group, because we look at materials, technology and process all at the same time, I can go take a concept to the materials folks, and then we'll take it to a designer and if it's something that we want to pursue, we make that decision," Singh told Fast Company for an online profile last year.

During his graduate studies at University of Michigan, Singh developed a process-planning framework for the five-axis layered deposition complex 3D CAD models. In addition, he has developed a digital microprinting system for producing ceramics. The system is being employed to manufacture components in GE's ultrasound probes. He leads the metal additive manufacturing activities at GE Global Research with a focus on the industrialization of laser powder-bed processes.

WHAT LME MEANS TO YOU

Ultimately, LME is the place to get practical, applicable answers to your most pressing questions from the most knowledgeable experts.

"The idea of LME is to get in direct contact with the laser users and offer the opportunity to engage with the suppliers directly," Kogel-Hollacher sums up. "All testimonials from the recent shows prove" that LME is filling the niche for which it is intended.

Mueller concurs. LME attracts "people from outside the established laser-user community: engineers coming to see what lasers can do, what a system costs, how big these systems are and what it takes to run one."

> **LME OFFERS SOMETHING NO OTHER US SHOW HAS: CUSTOMERS WITH KNOWLEDGE AND A REAL INTEREST IN LASERS.**

For exhibitors, "LME offers something no other US show has: customers with knowledge and a real interest in lasers," Pflueger concludes. "Compared to other, larger shows, the quality of the visitors is excellent, both for systems manufacturers and components suppliers. There's no wasting time explaining to people what a laser is with the sure knowledge that they'll never buy from you. Spending time on quality interactions leading to sales is what makes LME stand out." ■

For more information, an advance program, and to register, visit **www.laserevent.org**.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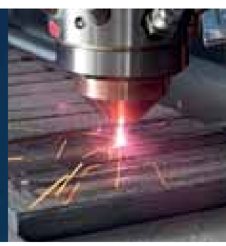

FEATURED ARTICLE

CONSUMER GOODS MADE BY ADDITIVE MANUFACTURING

By Bart Van der Schueren

Since being founded in 1990, Materialise has been active in the field of 3D printing and over the years, has seen this technology evolve tremendously. 3D printing has gone from a young, relatively unknown technology suited to producing realistic yet fragile prototypes, to a technology capable of capturing the world's imagination and drastically changing how the objects in our lives are designed and produced. Although a whole range of industries are affected by this technology, it is 3D printing's ability to directly involve consumers in the design process that has many truly excited.

MOVING BEYOND ONE-SIZE-FITS-ALL

To begin, it is important to state that over the past years, there have been some fairly dramatic changes happening in how consumers find, choose and purchase products – and the power of the individual consumer has been increasing as a result. From books, to shoes, to toys and beyond, people are able to find and purchase products worldwide from an ever expanding selection of online shops. Consumers are no longer limited to choosing from among the items in a nearby shop or catalog, and this is driving demand for better products that truly cater to their needs and desires. Now, thanks to 3D printing, consumers are able to take this demand for better products to the next level. More and more creative individuals are now discovering the possibility to design or customize an amazing array of items, many of them one-of-a-kind and suited to their exact needs and wants. And, as the barriers to digital design start to fall, this number will increase.

OVERCOMING THE CHALLENGES OF DIGITAL DESIGN

Up until now, one of the largest hurdles for consumers who have wanted to 3D print an object has been coming up with a printable design. Although CAD has been around for a long time, most of the available programs have been very difficult to learn and use, preventing all but trained professionals or determined hobbyists from designing objects for 3D printing. However, there are a growing number of design programs (like Tinkercad, AutoDesk 123D®, 3D Tin and SketchUp) that take much of the complexity out of the process, making CAD accessible to amateurs and, more importantly, children. There are also websites starting up that offer consumers the ability to customize available designs, bypassing the need to learn CAD altogether. By adding text and adapting the basic design through a set library of options, consumers can order unique 3D printed phone covers, jewelry, lamps, awards and a growing number of other products. There is even a website, called Thingiverse, through which people can share, adapt and download an ever expanding selection of printable files.

GPS HOLDER BY WANNES SCHUERMAN - PRINTED IN ABS PLASTIC BY I.MATERIALISE

BRINGING IDEAS TO LIFE THROUGH 3D PRINTING

With a design ready to print, all that needs to be decided is how and where to bring it to life. Some prefer to do this at home. With self-assembly kits available for as little as 500Euro (about $657) and assembled models for 1000Euro (about $1,314) and up, 3D printers are starting to make their way into the homes of enthusiastic early adopters. These home printers work by heating a strand of plastic filament and depositing the melted plastic on a build tray, layer by layer, until an object is created – working somewhat like a computer-controlled hot glue gun. Although there are limitations in terms of resolution, accuracy and strength for the finished objects, these machines are great for quick prototyping and for having fun. For individuals interested in a higher quality finish in a wider range of materials, there are also online 3D printing services like **i.materialise.com**. Through this service, consumers simply upload their design, choose the material and finish, and i.materialise takes care of the 3D printing and delivery. In this way, consumers can have their designs printed in plastics as well as in a range of metals, including precious metals such as silver.

EAGLE HEAD BOTTLE OPENER BY ANDREW MARTIN - PRINTED IN BRONZE BY I.MATERIALISE

GIVING BIRTH TO A NEW BUSINESS MODEL

Some i.materialise customers do more than just order a single print of their design from the site. If they feel that their designs have a wider appeal, they can offer them for sale through i.materialise's gallery and have them printed to meet demand – avoiding the upfront investment associated with traditional manufacturing as well as the financial risk of unsold stock. For example, a jewelry designer can offer their latest ring to a global audience and test the demand for the design. If there are no orders, no problem – and if there are, then the rings will be printed, delivered to the customer, and the designer will receive their share of the profit. And, with their product shown online, marketing can be achieved through Facebook, Twitter and other new media channels, quickly reaching a world-wide audience and driving demand for their product. This is perhaps the most exciting aspect of consumer 3D printing: the fact that consumers can not only create products that better serve their own needs and interests, but also start to sell the result to others like them. As this aspect of 3D printing grows, there is no telling how far it will go. ■

Dr. M.Sc. Bart Van der Schueren is the Executive Vice President at Materialise.

JAPANESE TEA RING BY FLAVIO BELLANTUONO - PRINTED IN SILVER BY I.MATERIALISE

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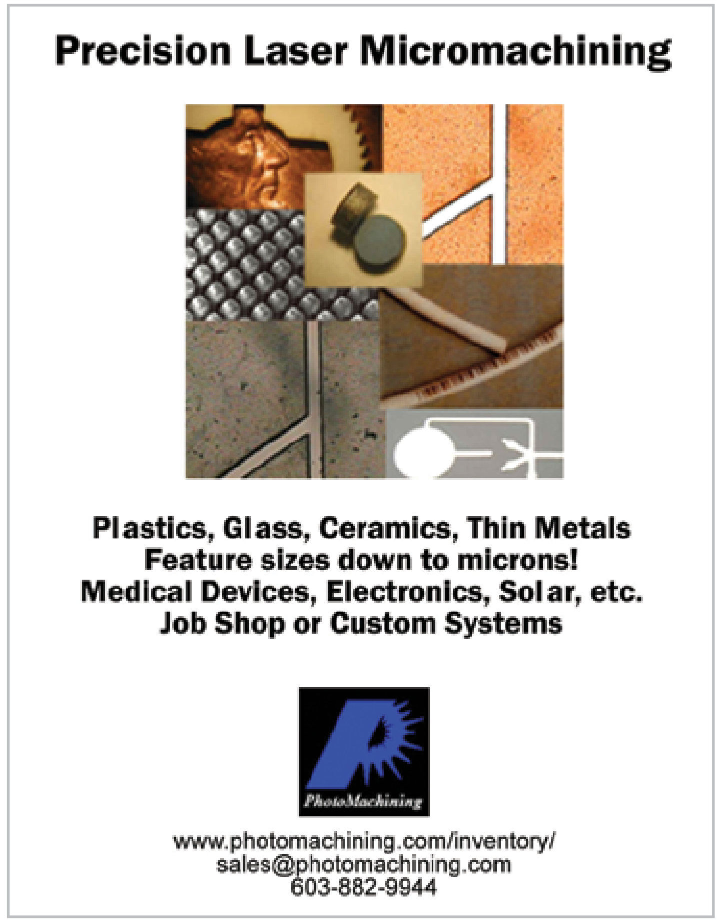
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DIGITAL PHOTONIC PRODUCTION AND ITS EMERGING OPPORTUNITIES

By Christian Hinke

Digital photonic production enables us to fabricate almost any component or product directly from digital data. Experts characterize the photon or the laser as the only tool that "works" as quickly as a computer "thinks." An office laser printer functions according to this principle and reveals what will be possible in future manufacturing with high energy lasers – when the fundamental interactions between material, light and photonic process chains have been understood and, based on this knowledge, digital photonic production systems have been put into practice.

Laser based additive manufacturing or 3D printing is the most prominent example of this principle. Actually 3D printing receives some recognition from general media and was even mentioned by President Obama in his recent State of the Union address. Technologies that were developed more than 10 years ago for rapid prototyping are now evolving into rapid manufacturing technologies. Currently, laser based additive manufacturing technologies are being tested for serial production in pilot plants in the automobile and aerospace industry.

Selective Laser Melting (SLM), sometimes referred to by the terms Direct Metal Laser Sintering (DMLS) or LaserCusing® is one of the most promising technologies in additive manufacturing. The SLM technology developed by the Fraunhofer ILT is an additive manufacturing process by which metallic components are produced directly from 3D digital data (see Figure 1).

It enables geometries of nearly unlimited complexity to be manufactured, as the component is built up layer by layer. This results in a new design paradigm: "Complexity for free." So additive manufacturing enables new ways of product design, only determined by functional requirements without any manufacturing restrictions (see Figure 2 and Figure 3).

Digital Photonic Production goes far beyond laser based additive manufacturing. New ultra-short pulsed lasers enable, for example, very fast ablation, nearly independent of the material being processed (see Figure 4). This way, smallest functional structures can be fabricated all the way down into nanometer range.

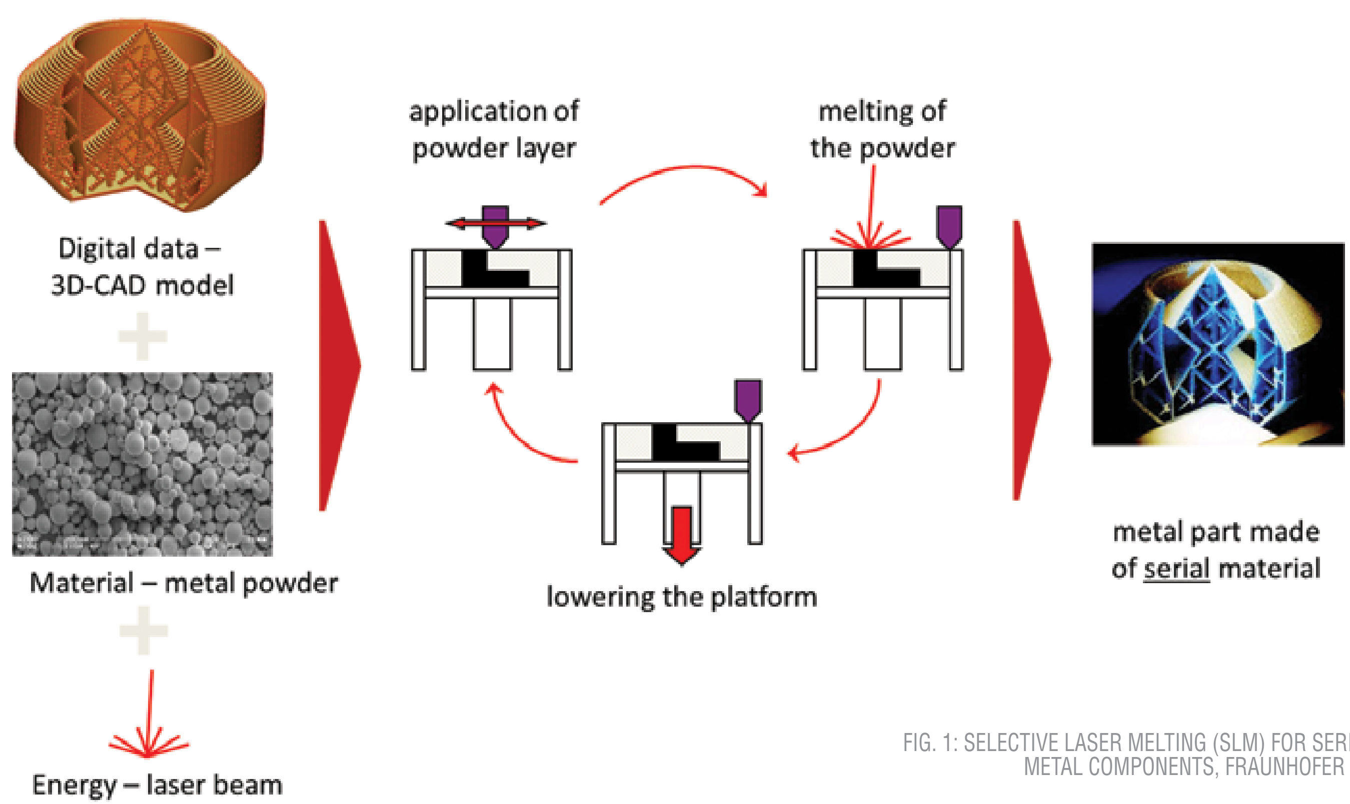


FIG. 1: SELECTIVE LASER MELTING (SLM) FOR SERIAL METAL COMPONENTS, FRAUNHOFER ILT

FIG. 2: LIGHTWEIGHT, TOPOLOGY-OPTIMIZED AUTOMOTIVE COMPONENT, FRAUNHOFER ILT, VOLKER LANNERT

FIG. 3: LIGHTWEIGHT AEROSPACE COMPONENT WITH LATTICE STRUCTURE, FRAUNHOFER ILT

FIG. 4: HIGH PERFORMANCE ABLATION OF METAL WITH ULTRA-SHORT PULSED LASERS

Digital Photonic Production also enables the selective modification of material. For example, molds can be polished with laser radiation, or 3D microfluidic systems for medical applications can be "written" directly from digital data. These applications show the potential of Digital Photonic Production and are the first examples of the vision: "From Bits to Photons to Atoms."

Some experts see a new industrial revolution enabled by these new manufacturing technologies and especially by the direct production from digital data. Essentially, the revolutionary potential of Digital Photonic Production is based on a fundamentally different relation of cost, lot size and product complexity compared to conventional manufacturing processes (see Figure 5). There is no increase of costs for small lot sizes (in contrast to e.g., mold-based technologies) and no increase of costs for product complexity (in contrast to e.g., subtractive technologies).

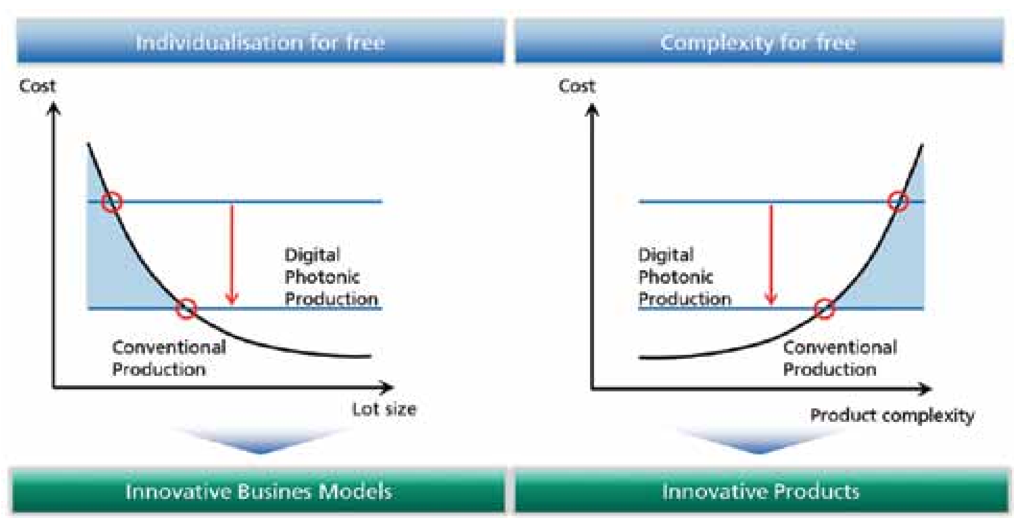
The new production paradigms "individualization for free" and "complexity for free" will result in new innovative products and new business models. Internet platforms like **shapeways.com**, **ponoko.com**, **imaterialise.com** or **thingiverse.com** are just the beginning and show the economic potential of these new paradigms.

In principle, the advantages of photon-based manufacturing have been known for a long time, but only practically used in niche areas, such as medical implants. The cost per piece using laser based manufacturing processes is independent of lot size and complexity, but until now was still quite high.

This has changed significantly: laser processes have become much quicker and less costly. At the same time, the costs for beam sources and machine costs have sunk considerably. For example, the build rate of SLM has increased by a factor of 10. Simultaneously, ultra-short pulsed lasers are now commercially available in the kilowatt range, which raises the ablation rate of 3D laser structuring by a factor of 10 as well.

(Continued on page 16)

FIG. 5: DIGITAL PHOTONIC PRODUCTION: "INDIVIDUALIZATION FOR FREE" AND "COMPLEXITY FOR FREE," FRAUNHOFER ILT



Laser based additive manufacturing processes, which formerly had been used in some niche applications, will now become attractive for series production when small and medium lot sizes are required. Thus, production technology faces similarly great changes as it did in the last 10 years when 2D laser beam cutting was developed and introduced for the processing of sheet metal. When series-ready additive manufacturing processes or 3D ablation processes become available, direct production of any kind of component will become possible from digital data. Hence, laser based manufacturing processes have evolved into Digital Photonic Production.

In order to exploit the full potential of Digital Photonic Production, process chains have to be viewed in an integrated way. Industrial process chains have to be redesigned, reaching from new up- and downstream manufacturing steps, over product design, all the way to completely new business models such as mass customization or open innovation.

The new research campus "Digital Photonic Production" in Aachen, funded by the German Federal Ministry of Education and Research (BMBF), is dedicated to exactly this integrated approach. More than 30 partners from science and industry will work together under one roof on fundamental research topics. But beyond the trend-setting topic, the even more important point is the long-term strategic co-operation of all partners in one place. ■

Christian Hinke is the RWTH Aachen University Chair for Laser Technology at Fraunhofer ILT.

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IMPACT OF LASERS IN PLASTICS MANUFACTURING

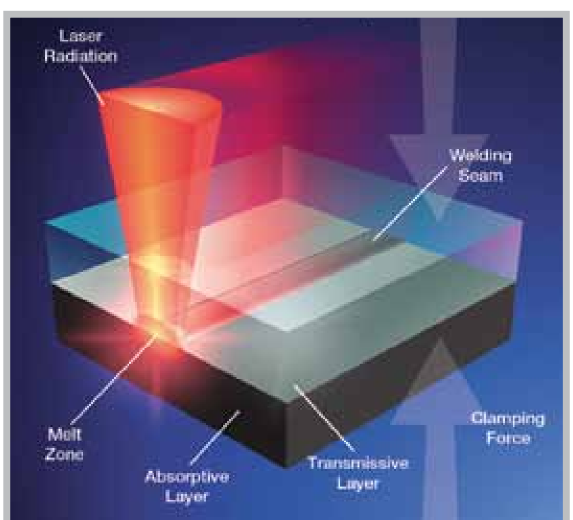
By Jerry Zybko

As manufacturing has evolved over the years, the methods needed for assembly have expanded. Plastics have certainly gained more widespread acceptance in a variety of industries including automotive, medical, industrial and consumer applications. Depending on part geometry, material/part requirements and financial constraints, a variety of assembly methods are available.

Assembly methods can be broken down into three general categories; mechanical, chemical and heat. Mechanical assembly consists of molded in threads, or snap features, or the use of mechanical fasteners (e.g., screws or rivets). Chemical assembly methods consist of adhesives and solvents. Heated assembly is accomplished either by creating friction (e.g., vibration welding, spin welding or ultrasonic welding) or applying an external heat source.

Welding plastics using external heat sources has been around for decades. It has evolved from directly applying heat (e.g., hot air or radiant) or a heated platen (e.g., hot plate welding) to other sources such as lasers.

The use of lasers for plastics assembly is gaining significant popularity as acceptance has increased and capital equipment prices have fallen. Typical issues experienced by users of other assembly methods have led to a broader acceptance of laser plastic welding for its many benefits. Below is a graphic showing the TTIR (through transmission infrared) welding concept.



PLASTIC WELDING LASER CONCEPT

LASER PLASTIC WELDING ADDRESSES MANY OF THE COMMON PROBLEMS ASSOCIATED WITH PLASTICS ASSEMBLY:

No complicated joint designs – Laser plastic welding does not rely on melting and flowing plastic material. Energy directors are required in methods that utilize friction to create the heat. Engineering these features could be complicated and add to overall project cost. Lasers require only a flat to flat joint design thereby lowering tooling cost and increasing molding efficiencies.

No particulate development - The parts are presented to the laser in their final assembled position. Since the parts are in intimate contact before and during the weld process, no particulate is developed during the weld cycle.

Minimal heat affected zone - In addition to being vibration free, laser welding minimizes the heat affected zone. Only the localized area is heated to the melting point by laser energy and the rest of the part is not. Sensitive components located in the proximity of the weld seam are not damaged by the weld process.

No material expulsion (flash) - Material flash or expulsion is the release or witness of melted material outside of the desired weld area. It occurs in other weld processes, since mechanical motion is required to generate heat.

Precise weld lines - Laser welding offers a clean, precise and aesthetically acceptable bonding solution. Since the resulting weld is contained within the area affected by the laser energy, the weld lines are always consistent and have a crisp edge definition.

No surface marring - One of the more notable problems with an assembly process where heat is generated due to friction is marring of the visual surface. In laser welding, this issue is addressed by gentle clamping of parts with no relative motion between the parts during the weld cycle. Laser welded parts are processed without scratches or other handling evidence.

No consumables (fasteners or adhesives) - With laser welding there are no consumables. You are simply re-melting the plastic in the weld area and the two components are bonding at that point.

Ability to weld dissimilar thermoplastics - Laser welding process is able to join a variety of plastics, including joining soft to rigid. The main requirement for successful bonding is chemical material compatibility and overlapping melting temperatures.

REQUIREMENTS FOR SUCCESSFUL LASER WELDING:

Transparent top layer and light absorbent bottom layer - The laser welding process is made possible by transmission and absorption properties of the two materials being joined. The top layer needs to be transmissive, allowing the laser light to pass through. The bottom component must absorb the laser energy, creating heat. Sufficient heat is then transferred to the top, transmissive piece, and a successful weld is achieved.

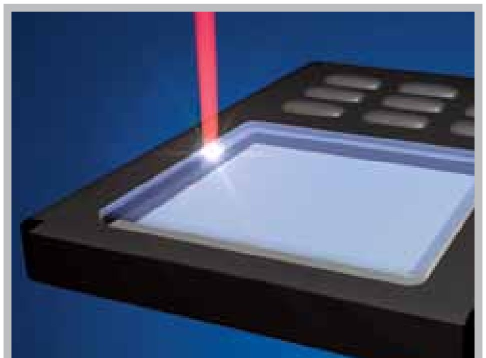
Effective nesting or fixturing - To assure a consistent and strong bond between laser transparent and laser absorptive surfaces a clamping force must be applied. Since the top layer is transparent to the laser, it can be heated up only through conduction, by touching the bottom piece. It is essential for both components to maintain intimate contact during the welding process.

Sufficient clamping - The most common approach is to place the parts into a clamping device. The components are placed in a fixture, or nest, and they are pressed up against a glass frame. In some cases, a metal frame can be utilized to clamp down on the top piece right next to the weld area. This method is often chosen when extreme clamp forces are needed. A patented Globo welding method can be used to apply localized pressure.

The last and most important element is the introduction of laser light to the assembly. The most common laser sources for plastic welding are Diode, Fiber or Nd:YAG. An important equilibrium must be achieved by balancing the proper amount of laser energy with the proper exposure duration. The beam is then positioned or aimed at the work-piece and, depending on the beam-shaping, is either fixed or moved throughout the areas of the assembly that need to be joined.

(Continued on page 20)

PICTURED ARE A VARIETY OF BEAM SHAPING TECHNIQUES:


CONTOUR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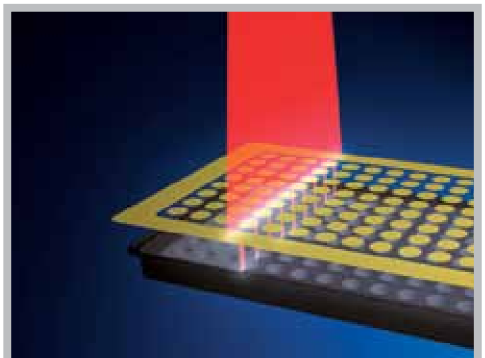
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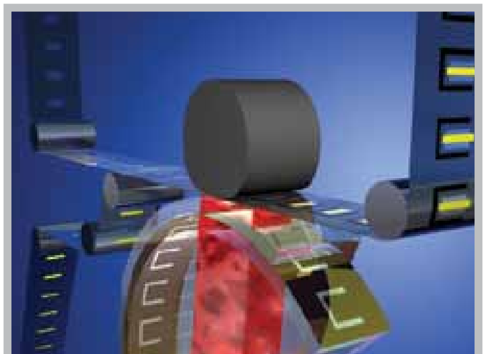
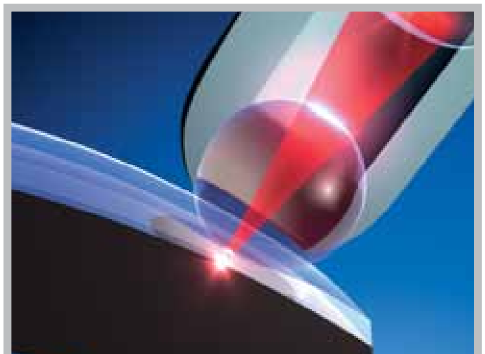
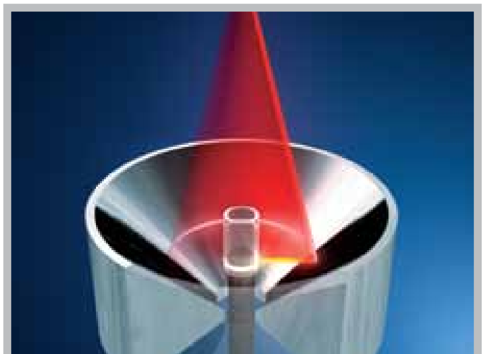

CONTINUOUS-ROLLER PATENTED


GLOBO-WELDING PATENTED


RADIAL-WELDING PATENTED

INTEGRATION LASER WITH OPTIC

WORKSTATION

Bringing the laser process into the production environment can be accomplished in two ways; self-contained standalone workstations or individual laser component sets for direct integration into automated production lines.

Lasers continue to gain popularity as a method for assembling plastic components. Thousands of applications using lasers for plastic assembly are in production and this number grows each year. New laser sources, beam shaping methods, materials (films, fabrics) and plastic combinations continue to push lasers as an acceptable technique for plastic assembly. ■

Jerry Zybko is the General Manager at Leister Technologies.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FEATURED ARTICLE

NEW ANSI Z136.9 PROTECT YOUR GROWTH AND PROFITS!

THE NEW STANDARD FOR MANUFACTURING CAN HELP ENSURE THAT YOUR CUSTOMERS AND EMPLOYEES STAY SAFE

Media reports these days are filled with stories of a coming revolution in manufacturing, particularly through additive processes. With lasers prevalent in the output of high-value components in many industries, the Laser Institute of America unveils its latest safety standard exclusively for those applications.

The ANSI Z136.9 *Safe Use of Lasers in Manufacturing Environments* standard is the latest in the line of laser safety guidelines stemming from the parent ANSI Z136.1 standard. LIA plans to have it available for purchase to coincide with the third annual Lasers for Manufacturing Event® (LME®) Sept. 11-12 in Schaumburg, IL.

This standard provides reasonable and adequate guidance for the safe use of lasers and laser systems that operate at wavelengths between 180 nm and 1 mm. Intended to protect individuals with the potential for laser exposure when lasers are used in manufacturing environments, this standard includes policies and procedures to ensure laser safety in these areas where lasers are used in manufacturing, both public and private industries, and product development and testing settings.

Development of the Z136.9 standard has been a study in collaboration and front-line input.

"We brought in an awful lot of people from industry to get involved," says Tom Lieb, chair of the Z136.9 development subcommittee and president of L·A·I International in Elk Grove, CA. "Especially in the early drafting, we had people from laser companies and using companies participate. I had a very large list of people who participated in the early meetings."

Until now, the parent standard has been "almost like the Bible" when it comes to regulating differences of opinion regarding interpretations of laser safety on the manufacturing floor, says subcommittee vice chair Randy Paura. "Our original mandate was to try to simplify things. Manufacturers want to err on the safe side. We said, 'OK in that case we can simplify a lot if we went with point-source exposures only,' which made it easy for the end user to do calculations. We explain that if you want to do extended source (calculations), go to Dot 1, but you will be on the safe side using point source. I've been in touch with a lot of customers who have been very receptive to that concept."

Using point sources only "simplifies for the average manufacturing operation what they need to know in terms of finding out how dangerous — or not dangerous — something is and how to calculate MPEs," Lieb explains.

The new standard comes at a critical time, as lasers continue to populate more processing lines in the aerospace, automotive, energy, defense and health care industries.

"The advent of really high-powered fiber lasers and the potential for femtosecond and picosecond lasers in actual manufacturing operations has increased the need for safety attention," Lieb asserts. Fiber lasers have enhanced the growth of an array of applications due to their relatively lower cost, plug-and-play capability and low use of floor space, he says. "They have expanded the marketplace."

In particular, Lieb notes, the major automotive companies have raised the bar on safety consciousness in the past five years. They have "put protocols in place that demonstrate their awareness of safety concerns for lasers in the workplace and put requirements on their suppliers that heretofore hadn't existed."

LIA, the recognized industry leader in laser advocacy and safety education since 1968, serves as secretariat and publisher of the Z136 series of laser safety standards, providing financial and administrative support to the committee. ■

To order the ANSI Z136.9 standard ($150 for LIA members, $170 for non-members), visit **www.lia.org/ANSI** or call LIA at 1.800.34.LASER.

NEW!

ANSI Z136.9

Safe Use of Lasers in Manufacturing Environments

PROTECT YOUR GROWTH AND PROFITS!

The NEW standard for manufacturing can help ensure that your customers and employees stay safe.

The ANSI Z136.9 *Safe Use of Lasers in Manufacturing Environments* standard is the latest in the line of laser safety guidelines stemming from the parent Z136.1 standard. This standard provides reasonable and adequate guidance for the safe use of lasers and laser systems that operate at wavelengths between 180 nm and 1 mm. Intended to protect individuals with the potential for laser exposure when lasers are used in manufacturing environments, this standard includes policies and procedures to ensure laser safety in these areas where lasers are used in manufacturing, both public and private industries, as well as product development along with testing settings.

The new standard comes at a critical time, as lasers continue to populate more processing lines in the aerospace, automotive, energy, defense and health care industries. Order your copy today!

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Published by:
Laser Institute of America
Laser Applications and Safety

CORPORATE MEMBER PROFILE
CLAIM, THE UNIVERSITY OF MICHIGAN

The Center for Laser-Aided Intelligent Manufacturing (CLAIM) is an application-based research and processing facility dedicated to providing academic understanding and valuable technical services to the laser industry. Committed to putting its scientific expertise to use in industrial applications, CLAIM's goal of integration makes it an incredibly resourceful asset to a wide variety of corporations and markets. With the research motto "Atom to Application," CLAIM actively pursues highly specialized solutions that can be put to use in the real world.

Part of the University of Michigan's research environment, CLAIM is largely funded by various federal agencies, including the National Science Foundation, the Defense Advanced Research Projects Agency and the National Institute of Standards and Technology. In addition to federal sponsorships, CLAIM receives funding through corporate partnerships with many Fortune 500 companies as well as smaller businesses throughout the country. With the help of academic, federal and corporate partnerships, the University of Michigan's CLAIM highlights the benefits of a wholly integrated laser society.

With corporate partners such as Fraunhofer, General Electric and Toyota, CLAIM offers in-house services to some of the largest industries in the world. Within the University of Michigan, CLAIM is capable of providing process development, online diagnostics, modeling and model validation through high powered lasers and various diagnostic tools, including ion lasers and detectors for absorption, fluorescence and emission spectroscopy. In addition to materials processing, CLAIM offers manufacturing applications such as welding, drilling, cladding, chemical vapor deposition, ablation, direct metal deposition and surface treatment.

While these services detail an important part of CLAIM's worth to industrial collaborators, it is the relationship with corporate partners—particularly the Center's emphasis on facilitating technological transfers to industrial firms—that truly defines CLAIM's mission. Actively pursued by CLAIM, these relationships are achieved and improved through research exchange programs and an industrial advisory board. CLAIM also contributes manpower directly by engaging students and graduates with the industry.

> **"CLAIM HAS A HISTORY OF SUCCESS[FUL] TRANSFERS OF TECHNOLOGIES TO THE USER INDUSTRY, AND IS RESPONSIBLE FOR LAUNCHING TWO START-UPS."**

"CLAIM has a history of success[ful] transfers of technologies to the user industry, and is responsible for launching two start-ups," said CLAIM's Director Jyoti Mazumder.

As well as strengthening CLAIM's position in the industry, the start-ups have enabled CLAIM to further increase their service capabilities through access to machining, wire cutting and drilling machines as well as other in-demand technologies.

Many of CLAIM's technological faculties and services are a direct result of past research, an area in which the Center demonstrates a keen understanding of the needs and demands of the industry. Research projects have included the development of a closed loop control system for direct metal deposition, as well as optical sensors for weld quality monitoring of zinc coated steel. The Center's varied interests and widespread expertise enables them to engage with industries and facilities across the globe.

Currently, CLAIM is undergoing a project with the Office of Naval Research as part of an ongoing federal sponsorship. CLAIM has also been an active ICALEO® sponsor since 2005, and became an LIA member in March, 2007. By partnering with the world's leading purveyors of laser applications, CLAIM continues their efforts to convert its "atomistic-level scientific understanding" into real world solutions.

For more information, visit **claim.engin.umich.edu**.

MEMBER INNOVATIONS

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CHROMAX Ind. Com. Ltda. – BRASIL
Rio de Janeiro, Brazil

Praxair Surface Technologies, Inc.
New Castle, PA

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

MEMBERS IN MOTION

ASML COMPLETES ACQUISITION OF CYMER

ASML Holding NV (ASML) and Cymer, Inc. announced that they have completed the previously announced merger pursuant to which ASML has acquired Cymer. As a result of the merger, each share of Cymer common stock outstanding immediately prior to the completion of the merger was converted into the right to receive $20.00 in cash plus 1.1502 ASML ordinary shares. ASML's share capital will increase by approximately 36.5 million shares as a result of the merger. For more information, visit **www.cymer.com**.

CCAT EXPANDS OFFICES FOR TECH-BASED START-UPS

Connecticut Center for Advanced Technology Inc. (CCAT), which operates a Connecticut incubator for start-up, technology-based businesses, is expanding its Pitkin Street facility in East Hartford, CT with 10 new offices totaling nearly 2,500 square feet to meet the office space demand by more new companies. The facility offers technology-based start-ups access to essential resources including offices, application laboratories for manufacturing including additive manufacturing, research and development space, and conference and meeting facilities. For more information, visit **www.ccat.com**.

INTERNATIONAL PRIMA POWER TECHNOLOGY DAYS IN FINLAND

During June 4–7 more than 300 visitors from 35 countries attended Prima Power Technology Days, organized at the Group unit in Finland. A specific theme was The Year of Three Birthdays. Due to a rare coincidence, the Group can this year celebrate a three-decade career in punching technology, 20 years of experience in 2D laser cutting machines and 15 years as a supplier of servo-electric solutions for sheet metal working. For more information, visit **www.primapower.com**.

LIN LI ELECTED TO ROYAL ACADEMY OF ENGINEERING AND RECEIVED WHITTLE MEDAL

In July, laser expert Professor Lin Li of the University of Manchester received one of the Royal Academy of Engineering's highest accolades, the Sir Frank Whittle medal, for his outstanding and sustained research achievements for engineering innovations in manufacturing that have directly benefitted the UK economy. Professor Li, Head of the University's Manufacturing Research Group and Director of the Laser Processing Research Centre, pioneered the development of laser and materials processing technologies for manufacturing in several industrial sectors.

Collaborating with Rolls-Royce and BAE Systems, Professor Li's team has developed a laser cleaning technique that has been deployed in the aerospace industry to replace conventional chemical cleaning for a range of component manufacture processes resulting in reduced scrap rates and environmental impacts. For more information, visit **www.raeng.org**.

ASC Z136 UPDATE

ASC Z136
Safe Use of Lasers
Accredited Standards Committee

Contributed by Randolph Paura, P. Eng., CLSO

As the Vice Chair of ANSI Accredited Standards Committee Z136 SSC-9, I would like to share a bit of the genesis, purpose and people of this first edition of the *Safe Use of Lasers in Manufacturing Environments* standard.

The parent document of the Z136 series of laser safety standards, the Z136.1, addresses all principles, fields and applications of laser hazards, exposure conditions, evaluations and control measures for every segment of the economy. From this, there are now several vertical consensus documents dealing with various aspects or applications of laser safety. In 2007 at the ASC Z136 annual meeting, yours truly got the nerve to advocate a vertical standard from the parent that could speak to the manufacturing community more directly, that was increasingly using lasers for their value-added operations.

A subcommittee drawn from the membership of ASC Z136 and representing the various facets of the Z136.1 standard was drawn together and I was welcomed by the Chair to "*the world's most expensive hobby*…" The mandate of the formative subcommittee was to remove those portions of the master document Z136.1 not relevant to the manufacturing environment.

Given the talented spectrum of participants of our Standards Subcommittee 9, it was quickly found that the majority of laser safety professionals serving the manufacturing sector utilized point source exposure principles that simplified analysis for hazard evaluations while erring on the side of caution. Analysis by the subcommittee determined that this prudence did not generate overly cautious assessments and was in keeping with the innate objective of stakeholders within the manufacturing sector for prudent safety measures, which could be succinctly and clearly determined.

Being the first generation of this vertical standard was not without its challenges. Z136 as a whole was dealing with improvements on multiple fronts. The difficult decision was made to put our efforts into a holding pattern while we awaited the gestation and delivery of completely revised laser safety control measures (affectionately known as Section 4) and then to implement the latest point source exposure limits.

Of course, each refinement impacted other associated connections within the draft standard. The review process internally and with the greater body as a whole, further strengthened and refined this industrial-grade laser safety standard.

The Z136.9 *Safe Use of Lasers in Manufacturing Environments* is a potentially extremely significant document for both laser users and management in this sector. The new generation of lasing processes including both diode pumped and direct diode, have gone from the R&D department into full scale, reliable production operations by companies that understand the potential of this enabling technology. Expect to see this standard become rapidly adopted for its intended use and continue to mature as we garner increased participation by all stakeholders that desire to have "Light Applied Safely, Efficiently and Reliably" (*quote attributed to Dr. David Sliney, ANSI Z136 ASC member, and then some*).

Together, the members of SSC-9 and the greater membership of ASC Z136 have provided an excellent cornerstone laser safety consensus standard that duly considered the safety culture and mindset of its target customer as its guiding compass throughout the process.

> **"THE REVIEW PROCESS … FURTHER STRENGTHENED AND REFINED THIS INDUSTRIAL-GRADE LASER SAFETY STANDARD."**

BLS
Board of Laser Safety

LASER U – THE GLOBAL LASER EDUCATION PORTAL

Recently launched by the LIA, Laser U is your portal into practical online training. Intended for laser professionals of all levels of experience, the Laser Application Training portion of Laser U provides access into the best presentations from LIA's industry-leading conferences and workshops.

Based on cutting-edge sessions from the Lasers in Manufacturing Event® (LME®), Laser Additive Manufacturing (LAM®) Workshop, International Laser Safety Conference (ILSC®) and LIA's annual ICALEO® conference, Laser U Laser Application Training offers a convenient way to learn when travel is not an option.

It also offers a way to earn BLS Certification Maintenance (CM) points!

Falling under the CM category of continuing education, completion of a course is worth .25 CM points, with the exception of *The Basics of Ultrafast Laser Machining* tutorial, which is worth .5 CM points.

Users are able to listen to audio of each speaker's presentation at their own pace, over the course of several hours to several days, with the option to follow each slide in order or jump forward or backward as they wish. Demonstrational videos used by the presenters are included in the course slides.

A link to Laser U is provided on the Board of Laser Safety's home page, as well as through the LIA website. By choosing *Application Training*, you will be able to enter the education portal and browse presentations by conference or speaker. There is also an option to browse by topic to find all applicable presentations for a given area of interest, e.g., laser cutting, automotive manufacturing, basic laser material interactions, etc.

From Jodi Ploquin, Medical Health Physicist and CLSO at Krivonosov Risk Management Consultants (KRMC) Inc., on *Main Laser Types Used for Manufacturing – Key Properties and Key Applications*:

> "As a CLSO whose experience has been focused on medical and research applications, I found this talk very informative and interesting. The material was presented in a very methodical, logical way, with a great balance of theory and real world application. Tom Kugler is an excellent speaker! I highly recommend this course to fellow CLSOs! This is a great introduction to laser use in manufacturing applications!"

What a great way to learn and earn CM points at the same time – thanks LIA!

LASER INSIGHTS

Laser Insights is a feature to give insight into the very latest developments in laser safety and the possible applications of laser materials processing. These overviews are designed to give you insight into the content and applications of the papers presented at our conferences and workshops. Visit **www.lia.org/laserinsights** to begin your search. View complete articles of the abstracts below online under the Featured Category.

FEATURED ABSTRACTS

DIRECT METAL LASER SINTERING (DMLS) MANUFACTURING CASE STUDIES

By Scott Killian

Laser sintering is the key technology for e-Manufacturing, the fast, flexible and cost-effective production of products, patterns or tools. The technology manufactures parts for every phase of the product life cycle, directly from electronic data. Laser sintering accelerates product development and optimizes production processes.

HIGH DEPOSITION RATE LASER CLADDING – RECENT ADVANCEMENTS

By Jari Tuominen, Jonne Näkki, Henri Pajukoski, Tuomo Peltola, Petri Vuoristo

Laser cladding is currently done with 3-6 kW gas and solid state lasers. Components to be clad or repaired are usually small or some discrete regions in larger components. Net deposition rates are typically 1-2 kg/h. In large area coating applications, conventional coating methods such as thermal spraying (HVOF, HVAF) and overlay welding (SAW) prevail due to higher cost efficiency based mainly on high productivity and low capital costs. For applications such as boiler tube panels in power generation and massive hydraulics in off-shore and mining industries, coating properties produced by conventional coating methods are often insufficient.

PORTABLE LASER CLADDING FOR THE NAVY

By E.W. Reutzel, T.A. Palmer, R.P. Martukanitz

Pennsylvania State University's Applied Research Laboratory has been developing laser-based weld repair techniques for the U.S. Navy for 25 years. Until recently, the repairs have all been realized in a shop environment, where accessibility is rarely an issue, and where the work space can be carefully controlled in order to realize a laser-safe operating environment. Laser-based weld repair offers several advantages over conventional techniques.

JLA UPDATE

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.

RESEARCH HIGHLIGHT

PASSIVE AND ACTIVE PROTECTIVE CLOTHING AGAINST LASER RADIATION

By Michael Hustedt, Christian Hennigs, Stefan Kaierle, Wojciech Gołębiowski, Dirk Wenzel, Andreas Hutter

In order to provide machine operators using, e.g., industrial laser processing machines or hand-held laser devices with adequate protection against accidental laser irradiation of the skin, passive and active solutions based on high-tech technical textiles have been investigated. These solutions can be used for personal protective clothing (PPC) or curtains. The passive solutions are constructed as multilayer systems with high passive protection levels with respect to near-infrared laser radiation. The incorporation of sensors into the multilayer structure is able to increase the protection level significantly by providing the ability to deactivate the laser source upon irradiation above a threshold and subsequent signaling. In order to classify the new laser PPC, a test procedure and a corresponding testing set-up have been developed, which could be the basis for an intended standardization process.

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LAM

LASER ADDITIVE MANUFACTURING WORKSHOP

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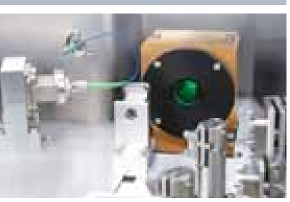

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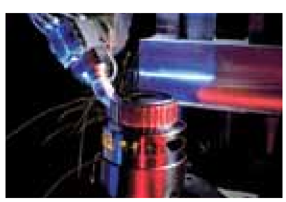

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