03:08

Laser Community

THE LASER MAGAZINE FROM TRUMPF

WWW.TRUMPF-LASER.COM

Profiled

Variety is the spice of facade

Minimized

Nanoparticles — the smallest laser product

The Pact

Right now hybrid laser welding is on the verge of breakthrough → Page 10

UNERRING

DR. MARKUS MERK ALWAYS TRUSTS THE FIRST INSTINCT → Page 15

PUBLISHER TRUMPF GmbH + Co. KG, Johann-Maus-Straße 2, 71254 Ditzingen, Germany, www.trumpf.com
RESPONSIBLE FOR CONTENT Jens Bleher *EDITOR-IN-CHIEF* Holger Kapp, Telephone +49 (0) 7156 303 – 31559, holger.kapp@de.trumpf.com *DISTRIBUTION* Telephone +49 (0) 7422 515 – 121, Fax +49 (0) 7422 515 – 175, laser-community@trumpf-laser.com
CONSULTING Helmut Ortner, Dr. Eckhard Meiners *EDITED BY* pr+co. gmbh, Stuttgart, Norbert Hiller, Martin Reinhardt, Steffen Beck
CONTRIBUTORS Niko Baersch, Dr. Stephan Barcikowski, Jürgen Eberl, Catherine Flynn, Prof. Andrzej Klimpel, Dr. Markus Merk, Martin Reinhardt, Ralf Schluricke, Julie Steinen, Monika Unkelbach *PHOTOGRAPHY* Krzysztof Bialy, KD Busch, Angelika Grossmann, Brent Haywood, Udo Loster, getty images, Gernot Walter *DESIGN AND PRODUCTION* pr+co. gmbh, Stuttgart/Germany, Gernot Walter, Markus Weißenhorn, Martin Reinhardt *REPRODUCTION* Reprotechnik Herzog GmbH, Stuttgart/Germany *PRINTED BY* frechdruck GmbH, Stuttgart/Germany

03:2008

IMPRINT

Title: KD Busch

Many in the industry believe that the future in lasers belongs exclusively to the fiber laser, even for multi-kilowatt applications. We believe otherwise for a reason and have articulated this frequently in the past. Clearly, we are placing our bets on disk lasers for multi-kilowatt applications. With this philosophy, we stand out markedly from most of our competitors — and we do so very successfully.

In October 2008, the British fiber laser company, SPI Lasers, became the newest member of the TRUMPF Group. Does this acquisition of the world's second largest industrial fiber laser company mean that we are changing our philosophy? The answer is a resounding no. We continue to believe that the disk laser is the better tool for multi-kilowatt applications. But: The market for fiber lasers in the low to medium power range is growing rapidly. A broad and rapid participation in this growth would have been considerably more difficult for TRUMPF from within. That is why we have acquired SPI Lasers.

Our Industry Remains Colorful and Lively!

Regardless of the above, the takeover of SPI Lasers still illustrates a notable trend in the laser industry. The major companies in the laser industry are enhancing their product lines and services systematically through acquisitions, either through the addition of important expertise or by improving their market access. The list of examples is long. Just recently, a large German-American laser manufacturer took over a Chinese laser manufacturer to improve market penetration in China. An important Russian laser company, in turn, acquired necessary technological expertise with its takeover of a CO_2 laser manufacturer.

The described trend, large laser manufacturers taking over smaller competitors, however, does not mean that a wave of consolidation in the laser industry is happening. To the contrary, the rapid technological development of the laser as a tool is resulting in new innovative products and new laser companies. Our industry remains dynamic, colorful and lively. In my opinion, this is a good thing!

PETER LEIBINGER

Vice-Chairman of the Managing Board
Head of the Laser Technology / Electronics Division
peter.leibinger@de.trumpf.com

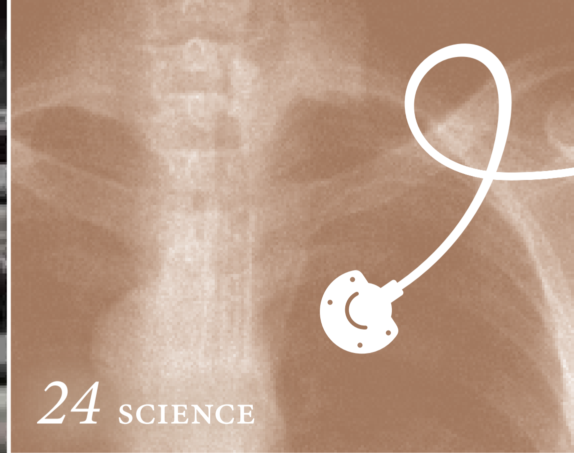
COMMUNITY

TOPIC

STATEMENT


MONTANSTAHL 16


22 ISI AUTOMOTIVE


24 SCIENCE


CYMER 19


26 PROF. SEIJI KATAYAMA

2008

S P O T

--- FROM COIL TO TUBE

Weil Engineering of Müllheim has dedicated itself entirely to tube processing. Company founder **Wolfgang Weil** and his 110 employees are now celebrating the 20th anniversary of the company's founding. Weil sees itself as a world market leader in the production of short stainless steel tubes and pipes. *www.weil-engineering.de*

--- MASTER IN OPTICS

The **Leibniz University** of Hanover recently set up a new interdisciplinary masters degree program in optical technologies. The co-initiators are members of **HOT**—the Hanover Center for Optic Technologies. *www.uni-hannover.de*

--- LITHUANIA GOES SCIENCE

The laser research center at the **University of Vilnius** is reclaiming a leading role in fundamental laser research. With its methodology for reinforcing very short light pulses, the Baltic country is successfully supporting research labs around the world. *www.vu.lt/en/*

--- UNITED BY LASER

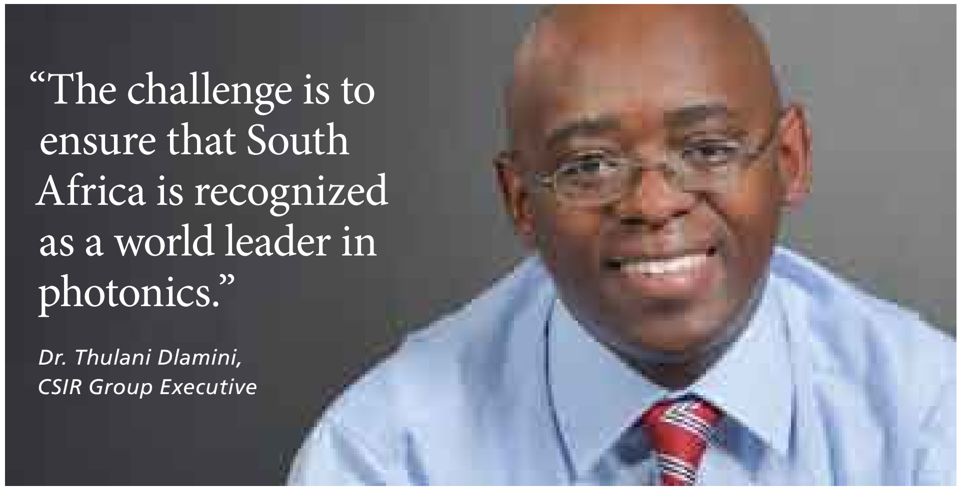
The **Fraunhofer Institut für Lasertechnik ILT** has developed a laser-based joining method for hybrid components made of plastics and metal. The laser beam heatens the metal component passing through the plastic, before pressing the metal into the plastic component. *www.ilt.fraunhofer.de*

--- CARL ZEISS INVESTS

The optics company **Carl Zeiss** has acquired almost 40 percent of the Karlsruhe start-up company **Nanoscribe.** The company that emerged from the 2007 work group headed by **Prof. Martin Wegener** has an innovative laser-direct-write process for 3D nano structuring. *www.nanoscribe.de*

--- JOINING TECHNOLOGY FOR CERAMICS

A research team at the **TU Dresden** has explained how high-performance ceramics can be joined with lasers. The **Institute for Energy Technology** presented industry-suitable high-temperature soldering in the minute range. *www.tu-dresden.de*



Cape of Good Photonics

South Africa creates a national initiative to pioneer in photonics

The **photonics initiative of South Africa (PISA)** gathers momentum. The **National Laser Centre** of the **Council for Scientific and Industrial Research** (CSIR) and the **Laser Research Institute at Stellenbosch University** are driving the project. The initiative aims to stimulate multidisciplinary research and human capital development as well as create economic benefits for South Africa. “We need to develop a coherent, comprehensive and multidisciplinary research and development strategy for photonics” said **Dr. Thulani Dlamini,** CSIR group executive. With South Africa facing a serious shortage of photonics technicians, a task force was created to develop a curriculum leading to a photonic technicians course. The aims are high: “The challenge is to get industries involved and ensure that South Africa is recognized as a world leader in photonics.” *www.csir.co.za*

Dr. John Taylor's mechanical chronophage measures time with light.

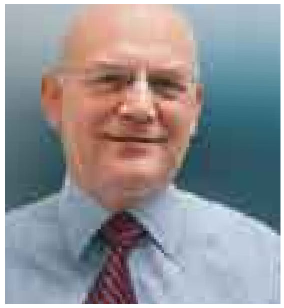
Time Devourer

A very special kind of clock

On the campus of **Corpus Christi College** in Cambridge, England, **Prof. Stephen Hawkins** unveiled an unusual clock—one that is both a work of art and a time-measuring device. Instead of a traditional clock face and its related numbers, this clock is a 1.5 m round sheet of stainless steel with laser-cut slits for measuring time. LEDs mounted behind the slits indicate the passing seconds and the exact time. The escape wheel normally found in clocks also adds to the look of time passing: A huge grasshopper on top of it relentlessly devours time in rocking motions and is meant to warn of wasted time, says inventor and clockmaker **Dr. John Taylor.** *www.corpus.cam.ac.uk*

From pure impulse transmitter to innovative diagnostic device, the pacemaker continues to evolve.

"No other technology can replace the pacemaker," explains Dr. Gerhard Dohnt, director of the department for the manufacture of active implants at BIOTRONIK.



"An Ideal Medical Device"

The pacemaker turns 50: Why the technology continues to advance, according to Dr. Gerhard Dohnt

The pacemaker has turned 50. When did the laser enter its life?

The laser has been used to produce pacemakers since the 1980s. Since that time, the housing has been made of titanium, which doesn't trigger allergic reactions and is permanently resistant to bodily fluids. However, the melting point is 1,650 °C and the components inside the housing are sensitive to heat. That is why we use laser welding. It is the only production process in which the energy can be so finely dosed and precisely focused.

What kind of development advances have been made in the last few years?

A major advancement is the sensor-controlled pacemaker. Early on, pacemakers were still rigid switches with permanently set cycles. Today, they are able to process signals in such a way that one single response emerges. The pacemaker broadly behaves as the body would, for example, with a faster heartbeat during physical activity or mental stress. We have implemented this feature through complex algorithms combined with advancing miniaturization. This is where the laser comes into play again because the miniscule connections between the components in the device are spot laser welded. The laser is also used for marking work. It requires no foreign materials — this also prevents allergic reactions.

How will the pacemaker continue to develop in the next 50 years?

Physicians will use pacemakers for many decades to come. They are easy to manage, relatively cost effective and very compatible. We will continue to improve the pacemaker's intelligence and its diagnostic abilities. With the automated home monitoring system developed by BIOTRONIK, heart data can be transmitted via wireless connections. EKGs, blood pressure values, pulse rates — doctors will be able to diagnose almost the entire heart and circulatory system from data gathered remotely.

Contact: Dr. Gerhard Dohnt, BIOTRONIK GmbH & Co. KG,
Telephone +49 (0) 6 89 05 2800, Gerhard.Dohnt@biotronik.com, www.biotronik.com

Michael Teuber has shown how from ambition and plastic two equally precious metals can emerge.

Winner Types

With an iron will and laser-sintered plastic orthoses, bicycle racer **Michael Teuber** won a gold and silver medal at the Paralympics in Beijing. To stabilize his ankle and his completely paralyzed lower leg, the professional racer has so far used carbon othoses. The new solution: laser-sintered plastic orthoses. Developed especially for Teuber, they are precisely fitted to the shape of his leg, giving him improved bearing comfort and high stability, as well as being very light. And this lightness adds seconds that can be decisive in winning or losing a race. *www.ortema.de*

Grand opening in Breslau with Prof. Edward Chlebus and Prof. Ulrich Buller (left to right).

Border Crossers

Shaping the future together — that is the goal of German and Polish engineers and scientists who will soon be working together at the **Fraunhofer Project Center for Laser Integrated Manufacturing** in Breslau, Poland. The focus of the new center is rapid prototyping technologies. "Integration creates synergy", emphasized **Prof. Ulrich Buller,** senior vice president research planning. *www.iws.fraunhofer.de*

NETWORK NODE

INTERNATIONAL LASER CENTER OF MOSCOW STATE UNIVERSITY

ILC

Education and research go hand in hand at the ILC, a division of Moscow State University, in Moscow. The institute provides training for students and scientists in well-equipped laser laboratories and by internationally renown scientists. Organizationally and structurally, the International Laser Center is a division of Moscow State University. The institutes areas of research mainly cover various fields of laser physics, including lasing processes, nonlinear optics and spectroscopy, interaction of laser radiation with matter, and numerous other laser applications. Experts and lecturers from Russia and abroad teach at the ILC as well as host scientific meetings and conferences. The ILC is, for example, responsible for the organization of International Conferences on Coherent and Nonlinear Optics (ICONO) and International Conferences on Laser Applications in Life Sciences (LALS). The ILC also operates the Laser Graduate School whose sessions are held annually and include courses on the most urgent questions regarding laser physics. *www.ilc.msu.ru*

Reliable and Tough

In Wolfsburg solid state lasers are welding the next generation Golf

Laser Welding at the new Golf VI

The body of the **new version** of the **Golf** is welded with solid state lasers just as the old one was. The 4 kW laser convinced **VW** of its reliability and toughness in the production of **Golf V** over the past five years. So the Wolfsburg-based company will continue to use the lasers with the latest model. More than 200 solid state lasers in use at the Wolfsburg plant are joining about 70 meters of weld seam, including the roof seam and center pillar on the Golf VI. Beginning with the first application in 2003, productivity has increased because laser welding consumes less material, heightens torsion stability and needs less room to work. *ww.volkswagen.de*

In a Flash

The winners of the Berthold Leibinger Innovationspreis 2008

Four **Bosch employees Dr. Jens König, Dr. Thorsten Bauer, Ulrich Graf** and **Dr. Markus Willert** were awarded the **2008 Innovationspreis from the Berthold Leibinger Foundation** for developing a technology that enables high precision manufacturing of very small components in large production runs. The team works with ultra-short pulse laser technology to burn extremely thin holes in the components. This technology created the sophisticated fuel channels in the common rail injection nozzles. **Dr. Richard Sandstrom** and **Dr. William Partlo of Cymer Inc.** came in second for their development of LUV lasers for modern lithography. Third place was a tie between **Dr. Cary Gunn of Luxtera Inc.** for his work in silicon photonics and **Professor Jürgen Czarske, Dr. Lars Büttner** and **Dr. Thorsten Pfister** from the **University of Applied Sciences in Dresden.** They developed a laser sensor with a Doppler effect that precisely measures as well as defines both the speed of the measured object and its position. Biochemist **Xiaoliang Sunney Xie** was awarded the **Zukunftspreis (future prize) awarded** since 2006. Xie has worked on single molecule biophysics and nonlinear optical microscopy. *www.leibinger-stiftung.de*

Dr. Markus Willert, Ulrich Graf, Dr. Thorsten Bauer and Dr. Jens König, Robert Bosch AG

"A good program but no time to attend," said Allan Jaunzens of Evatec Process Systems.

Small Community

SEMICON EUROPA, the International trade show for equipment, material and services for the semiconductor and photovoltaic industries, took place in Stuttgart in October 2008. We asked **Allan Jaunzens**, marketing manager, **Evatec Ltd** whether the visit was worth it.

Would you come back next year?
Definitely! I enjoyed the trade show. Our booth for 2009 is already booked. At SEMICON all of the important companies in the industry are present. The semiconductor industry is small; people know each other. The trade show is therefore, a place to meet old friends, make new ones and have a glance at the competition. Moreover, it offers an interesting supporting program. This year, I unfortunately had no time for the numerous symposia, workshops and seminars, but my colleagues told me only good things about the program. So I plan to attend some of it next year.

WORTH A TRIP

Photonics West

With numerous superlatives, the largest photonics trade show in North America, **SPIE Photonics West 2009** — to be held January 24 through 29, 2009 — is expected to attract an estimated 17,500 visitors from 50 countries and 1,100 exhibitors to California. The accompanying **BiOS, LASE, OPTO** and **MOEMS-MEMS** symposia to be held in 75 conferences and 70 technology courses will provide an interdisciplinary and a uniquely comprehensive look into research and development in the field. Make contacts, get informed and see the big picture: All of this requires a visit to the San Jose Convention Center.

Berthold Leibinger Stiftung, Canon Communications, Evatec Process Systems, GL-Events, SPIE, Volkswagen AG

CALENDAR

SPIE PHOTONICS WEST CONFERENCE: North America's largest photonics trade show

MEDTEC: Trade show for manufacturers of medical products

SALON INDUSTRIE: Trade show for production technologies

SEMICON KOREA
January 20–22, Seoul, Korea
More than 500 exhibitors at the largest technology trade show in that region, www.semiconkorea.org

SPIE PHOTONICS WEST CONFERENCE
January 24–29, San José, USA
www.spie.org/photonics-west.xml

EALA
February 3–4, Bad Nauheim, Germany
European user conference for laser production in automotive engineering, www.automotive-circle.de

MD&M WEST
February 10–12, Anaheim, USA
World's largest trade show for development and production in medical technology www.mdmwest.com

MEDTEC
March 3–5, Stuttgart, Germany
www.medtecstuttgart.com

SALON INDUSTRIE
March 10–13, Lyon, France
Trade show for production technologies www.industrie-expo.com

LASER WORLD OF PHOTONICS CHINA
March 17–19, Shanghai, China
World's leading trade show for optical technologies, www.world-of-photonics.net

EUROSTAMPI
March 19–21, Parma, Italy
International exhibition of dies and molds, presses and injection machines, www.senaf.it

KOREAN WELDING SHOW
April 21–24, Changwon, Korea
Welding devices and materials www.weldingshow.co.kr

LASER
June 15–18, Munich, Germany
World's leading trade show for optical technologies, www.world-of-photonics.net

Automated welding at high speed through thick plates with huge components and difficult base materials? Hybrid laser welding could be the right choice.

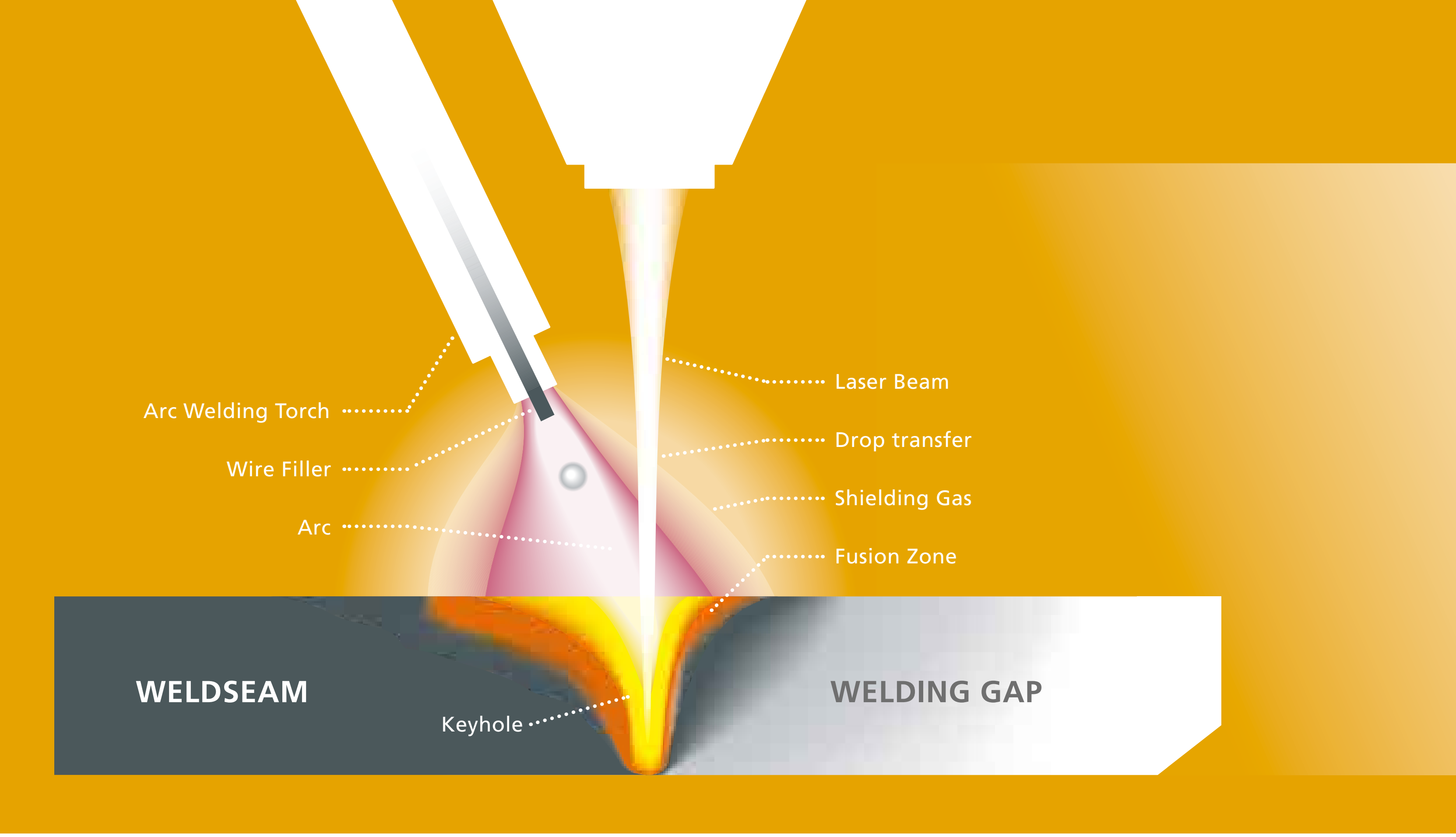
Joining powers

The arc and laser beam have been working closely together for years. Powerful solid state lasers and automation solutions in the niche technology of hybrid laser welding are now opening up new areas of application.

When Dr. Frank Riedel explains hybrid laser welding, he likes to use the expression: “Opposites attract because each looks to the other for the strengths that it is missing itself. This is the case with hybrid laser welding.” Riedel works at the Fraunhofer Institute for Machine Tools and Forming Technology (IWU) in Chemnitz. His work group “thermal joining” was set up two years ago. A focus of his work is hybrid laser welding. As a rule, this technology combines arc welding — metal active gas or metal inert gas welding (MAG / MIG) — with laser welding.

Like many other engineers, Riedel believes that the procedure for welding applications has enormous productivity potential in certain industries. “Hybrid laser welding then becomes interesting theoretically if you want to machine weld thicker components at a higher speed, using low heat input while making high quality seams. The conditions are against you,” he explains giving examples: “Say you have large and unwieldy components, the weld seam preparations for the laser are too expensive, the metal sheets very thick; processes such as metal protective gas welding require special weld joints and multiple layer welding often with too much heat input. Or you want to process materials such as highly resistant steels that can be welded using conventional procedures but, only with major production costs and much effort.” Hybrid laser welding actually makes it possible to overcome the hindrances in the above-described scenarios.

Researchers and engineers are highly interested in hybrid laser welding primarily because of the development of solid state lasers in recent years. The combination with the new laser beam source has the potential to expand hybrid laser welding beyond its previous niche market of shipbuilding into new markets. Hybrid laser welding was developed in the 80s when CO_2 lasers achieved the necessary performance gains for deep or keyhole welding. In this process, the laser beam not only fuses the material, it also partially evaporates it. A deep, narrow steam capillary develops around the beam, surrounded by molten metal. In this effect lie the strengths and weaknesses of deep welding using the laser as a tool. On one hand, very thick metal sheets can be welded in one step across the entire face, which is not feasible with most other processes either economically



or technologically. On the other hand, the beam requires a small focus to achieve the necessary power density.

This means that the joining gap has to be so precisely prepared and the components clamped so exactly that the tolerances of the faces on the entire workpiece length measure in the tenth of a millimeter range. This is no problem as long as the components are somewhat manageable, the sheets are thin and the productivity gain or the demands made on the future product balance out the work effort and the equipment for precise preparation. Otherwise, the expense and effort will not be worth it.

That's how the idea arose to combine the laser beam with an electric arc. In that process, the metal gas welding (MSG) melts more material into the surface, applies filler materials to the seam, and therefore, better fills in the gaps. The welding depth, however, is comparably low because the arc only affects the surface.

If the sheets become thicker, nothing is left to do for weld preparation other than milling the offsets in a V shape and closing the "valley" that develops with numerous welding beads in multiple layers. However, this highlights an additional disadvantage in arc welding: The process itself already generates in one or two layers, a lot of energy in the workpiece. As the weld seams are cooling down, the welding beads shrink, leading to large deformations and residual stresses — an effect that naturally adds up if there are multiple layers. And, finally, there are the costs for production time and the use of additional materials. Laser hybrid welding solves this problems. While the arc improves the filling in of the gap, the laser increases the weld depth and the welding speed, thus considerably reducing the heat input. This enables the seam to be stretched in only one step despite major tolerances. In addition, with a higher processing speed, the melted welding volume is considerably lower so that much less heat is applied to the surrounding material. And, lastly, the plasma that the laser generates during its work stabilizes — plasma that the arc requires for its work. However, there is a catch that puts the brakes on distributing the process and puzzled the customers of Dr. Thomas Harrer, Director of the Laser Application Center at TRUMPF in Ditzingen. Though TRUMPF itself does not build hybrid laser welding machines, its lasers do work in many different applications. Because the output of the solid state lasers was not sufficient for long, CO_2 lasers have always been used for thick sheets. Harrer describes the problem thusly: "The arc requires the plasma to do its work. However, this is a hindrance for the CO_2 laser because the plasma absorbs its beams." Added to that is the fact that the CO_2 laser itself produces plasma; it ionizes the metal steam cloud from the keyhole. When welding with CO_2 lasers, this plasma is "thinned down" with gases such as helium that are hard to ionize. One non-ionizable helium cloud, however, is the last thing a MAG weld burner needs between the electrode and the workpiece. "That in itself makes the hybrid process with CO_2 lasers difficult to handle," explains Harrer. "Moreover, the CO_2 laser has additional limitations. Because its beam is not able to be conducted via a fiber optic cable, networks are not possible. In addition, it is mostly a matter of components with extreme dimensions. That is why the traverse paths are large and controlling the beam in the optical path becomes a challenge."

All of that changed when the disk laser broke through into the high performance ranges. The light from the solid state lasers ionizes the metal vapor cloud very little or not at all. It is not absorbed by the plasma anyway so that the arc plasma is no longer a problem. In addition, it can be distributed

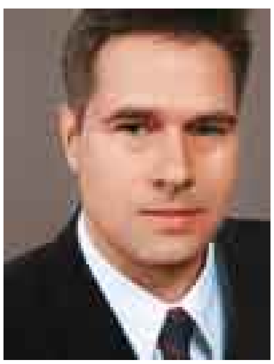
Typical photo: Using a MIG burner to support fusion produces a seam with a broad head. The slender shape of the laser keyhole is visible in the deeper portion of the weld.

HYBRID LASER WELDING

Hybrid Laser Welding combines laser welding and arc welding. In principle, using the two methods together unites their strengths while cancelling out their respective weaknesses.

The arc acts on the surface and provides a broader seam, which, in turn, bridges gaps. It also transports additional material into the melt. These characteristics give the welder a direct influence on metallurgical properties and adhesion to the seam flank.

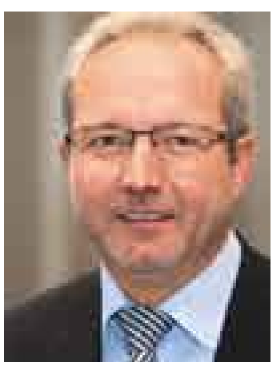
Laser welding ensures a deep weld and high process speed while lowering thermal entry. It also reduces thermal warping to a level below that attainable with arc welding alone.



Dr. Frank Riedel of the Fraunhofer Institute for Machine Tools and Forming Technology in Chemnitz.

"Opposites attract. This is the case here too."

"Two methods in one but each can be controlled seperately."



Christian Paul, manager of application technology at Cloos Schweißsstechnik in Haiger

across a laser network and the distance between the processing head and the beam source or traverse path is no longer an issue. For the light from the solid state lasers, the metal vapor plasma is no longer a hindrance. The light can be distributed through the TRUMPF LaserNetwork and, ultimately, the processing head now has all of the freedom of movement that it needs. The laser can even be installed on welding robots.

In 2000, Cloos Schweisstechnik in Haiger, Germany, launched its own hybrid burner that can be operated by a robot. With its freely programmable robot axis, optimal adjustment angles can be achieved for both processes. Since its launch, the company has continued to improve its technology. Christian Paul, manager of application technology at Cloos, describes the challenge therein: "It's about housing two complete working heads — one laser optic and the metal gas burner in the smallest working space, not to mention the feed lines for the filler materials and the media line of both processes. It is already tight." And it will get even tighter. "Our customers are increasingly requesting inline solutions for quality assurance and seam monitoring as they are also successfully used in other processes." Also, sensors that follow the seam progression during the welding process have to be integrated.

Despite all of these challenges, automation is tailor-made for thinner and thicker sheets. With thinner sheets, hybrid laser welding achieves high welding speeds. With thicker sheets, seam preparation is again no longer necessary. In fact, the laser and the arc mutually support one another here, as Paul emphasizes: "Through the intensity and output density of the laser beam, a corresponding weld penetration on the beginning of the seam is guaranteed." In the process, the laser ensures pore-free

Dr. Frank Riedel; Udo Loster; Illustration: Gernot Walter and gap-free smooth seams and the MSG burner adds filler materials which influence the metallurgy and adhesion to the sidewall of the seam.

If automated process control is added, the process can fully play out its superior speed, which can then be converted into productivity gains. The corresponding systems are already integrated into the Cloos robot control system. This allows the productivity to be considerably increased again. A logical development for Christian Paul: "Although hybrid welding combines two processes, each one is separately controlled. This allows all parameters to be specifically influenced at any time. Provided that you know which tire you have to rotate."

The path to complete automation has now truly begun.

At the moment, complete automation is found in large, single or double axis machines that are designed for a high feed rate. But even if there are currently solutions, many questions remain. Dr. Frank Riedel in Chemnitz lists several: "First of all, there is naturally the issue of space. And even if there is space, the lasers have to be installed close to two entirely different energy sources, which is often limited due to the accessibility of the components," he says, adding: "They have the arc whose wave spectrum disrupts many sensors and they have a very light focal spot from the laser and the arc, which makes optical recording of the welding ranges almost impossible. And then there would be the price." That is why the automation solutions are primarily individually constructed and are correspondingly expensive. Yet Riedel is confident that the growing market will correct that. And until then? "It does not have to be the same inline all-around package," says Riedel. "The process is also already fairly impressive." ■

Contact:
Fraunhofer IWU, Dr. Frank Riedel,
Telephone +49 (0) 371 5397 – 1300
frank.riedel@iwu.fraunhofer.de
Carl Cloos Schweisstechnik GmbH, Christian Paul,
Telephone +49 (0) 2773 85 – 565, christian.paul@cloos.de

Hybrid laser welding generates immediate cost reductions in several areas, making processes more productive and keeping labor and material costs low for sandwich panels such as the test panel shown here.

A look at the numbers

Does it really make a difference? Every application is different, after all. In the final analysis, however, hybrid laser welding looks very promising.

Costs and productivity are two highly concrete reasons for recent interest in hybrid laser welding. The technique does more than provide new solutions to structural problems: Hybrid laser welding can yield double-digit savings on material and labor costs for sandwich panels or welded carriers in such fields as steel construction and ship building. The method often pays for itself directly, especially when it follows welding processes involving metal shielding gas. U.S. manufacturer ESAB Welding and Cutting Products, for instance, anticipates 300 percent to 500 percent gains in productivity with cost reductions of 55 percent.

Cost of consumables By this calculation, hybrid laser welding cuts the cost of consumables by roughly half. It follows then that the energy costs for producing a fillet weld (e.g., for a T-beam) are reduced by around one quarter. Costs for welding wire fall by two-fifths and costs for process gases go down by four-fifths.

Productivity Increases in productivity are most apparent when the laser-hybrid technique can be performed at its full speed, which can reach 3.8 meters per minute for fillet welds on sheet metal 5 millimeters in thickness. Metal active gas welding, on the other hand, only achieves speeds of 0.6 meters per minute. Butt welds on sheet metal 10 millimeters in thickness can be produced at a rate of two meters per minute, as opposed to 0.5 meters per minute with submerged arc welding.

Thermal warping Eliminating deformations on welded components results in significant follow-up costs without adding any value to the product. In shipbuilding, for instance, ESAP estimates these processes to cost roughly 600 US dollars per square meter. ■

From his many years of experience on the soccer field, Dr. Markus Merk knows how to make superior decisions.

"Trust Your First Instinct!"

Decisions made quickly can be the basis for reliable and convincing decisions, says the former world's best soccer referee Dr. Markus Merk. The necessary authority can be learned in exchange.

There are born decision-makers. Yet these same people are also refining their decision-making skills in a continual learning process and recognize that certain situations require their ability to make decisions by following spontaneous intuition. Decision-makers need the courage to be responsible and decisive. This is required of anyone holding a position of leadership because decisions have to be consistently made but, also calmly. Only in this way can I achieve sustainability, predictability and personal credibility. To achieve this though, I have to be guided by a higher level of technical expertise. A large number of decisions leads to the storage of appropriate examples that can be continually called upon when needed.

I long considered the quick decision as an alibi for debatable or incorrect decisions. Today, I see in it all the more opportunity. The old saying holds true: "The first instinct is the best!" For me, the quick decision is the basis of a reliable and convincing decision; it reinforces the personality, authority and acceptance of the person in charge. Quick decisions also save hours and days of inner tension and document a high level of certainty in the environment.

I spontaneously feel the value of the decision made, but I must be uninfluenced by it because further decisions must be made. Because each decision evokes a reaction from the respective party and requires a reasonable response. You may not let your sympathies and antipathies guide you in the process. Fairness is the constant aspiration, with full knowledge that decisions are often received as unfair by those affected. Decision-makers may never make concessions in the process. Correcting one mistake with another mistake, means having made two mistakes. This destroys credibility on a sustained basis. Naturally, I have to admit to making wrong decisions. Decisions can and must be corrected to be useful on the way toward achieving a goal. Unfortunately, our environment construes this mostly as uncertainty. Tolerance is low when it comes to corrected decisions and often leads to an inflexible behavior. If I correct a decision and admit my mistake, I am given approval — the first time. After all, who wants decision-makers who are permanently correcting themselves? Learning from your mistakes is the best way to learn; however, it's the most painful.

Good communication in the team is important in the process. Together, critical decisions can be made. Speaking a common language as a team makes the decision more effective and leads to a higher level of acceptance. If I have the opportunity, I consult with my colleagues because making a quick decision does not mean an overhasty decision. Your first instinct always remains at the back of your mind during the decision-making process. In case of an uncertain decision-making situation, I always fall back on it. Confident decisions are made in a give-and-take process between rational and intuition.

Information: www.merk-es-dir.de

Dr. Markus Merk

Profile Professionals

At Stabio, left of the highway E 35 heading to Italy, Michael and Wolfgang Stumm roll and weld the future at their company Montanstahl.

Mountains, chocolate, banks — typical answers to the question "What comes to mind when you think of Switzerland?" Admittedly, the mountain panoramas are grand, the sweets are delicious and the banks are discreet. Yet this alpine country still offers many other gems. Best example: Montanstahl AG — a family-owned and operated company with roots in the Ruhr region and company headquarters in Stabio in the Italian region of Switzerland in the Tessin Canton. Montanstahl is mainly a steel profile manufacturer that is impressing its customers the world over with its precision products. Founded in 1983 as a profile rolling mill, the co-founders Michael and Wolfgang Stumm turned their company into one of the world's leading suppliers for special steel and stainless steel profiles. This is a success story that is based on quality, industry knowledge, service, flexibility and speed, according to Michael Stumm, who is responsible for the commercial side of the company. Wolfgang Stumm, who heads up the technology and controlling areas, adds: "Quality is our top priority."

In its early years, the company produced steel profiles exclusively for hot rolling processes. Today, the Swiss company uses a variety of methods: Depending on the quality requirements, cold rolling and laser welding are also used and soon production will also include roll joining. Montanstahl made the decisive quality leap at the beginning of the century. "Invent the future — this is the most reliable method of forecasting it!" For the

“Invent the future — this is the most reliable method of forecasting it!”

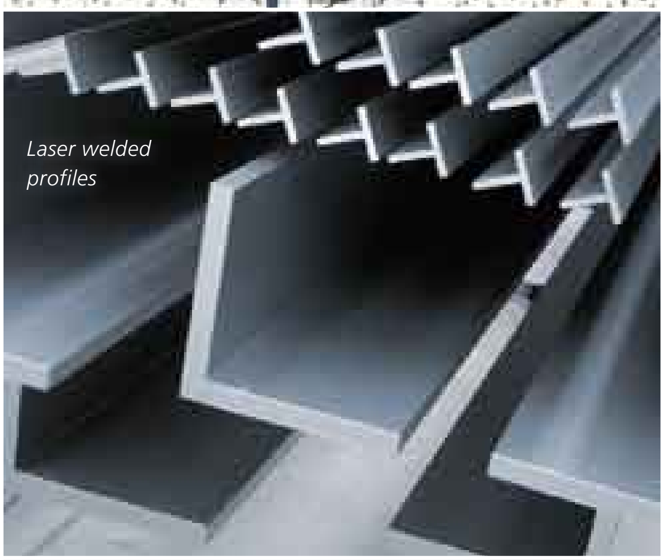
Michael and Wolfgang Stumm show their profiles

KD Busch

passionate sailors, the company’s slogan was already part of the program at the time: Always close to the wind. The starting point was Munich. To be more precise, the “Laser 2001. World of Photonics” trade show. Up to that time, Montanstahl had looked into and rejected diverse, new production methods as it searched for innovative solutions. None of them met the high quality standards and flexibility demands for machining, tolerances and batch sizes — until the trade show in Bavaria. There Wolfgang Stumm discovered laser technology. Since then, the company has been offering its customers a complete line of standard commercial stainless steel profiles such as brackets, beams, T and U profiles, closed profiles such as box and hollow profiles as well as numerous special profiles according to customer drawings. The specialist company is also offering customers many ways to save money, the narrowest of tolerances, minimized edge radii and flawless finishes. Montanstahl is striving to achieve delivery times of a maximum of four weeks for all laser profiles by the end of 2008. Most competitors can only dream of this kind of speed between receiving an order and delivering it.

Besides TRUMPF lasers for cutting and welding, the company has additional help in its fast precision production — clever feed systems. The ingenious in-house machines that Wolfgang and Michael Stumm have invested a lot of time into have now paid off. Using a clever feeding technology, the pre-material can be fed into the lasers in any conceivable position,


Roof struktur at Neue Messe Stuttgart


Laser welded profiles

arrangement and configuration that the lasers then weld into the profile shapes ordered. These machines, unique to Europe, allow for profile lengths of up to 15 meters and dimensions between 30 and 1,000 millimeters. An additional effect of laser welding: The profiles can be optimized based on their application. Accordingly, profile zones that are subjected to low stress are produced using reduced material strengths, and zones of higher stress with correspondingly higher material strengths are produced entirely to the specifications of the engineers and stress analysts.

The production plants' high flexibility also make it possible to do small projects with small batch sizes and even prototype production. "Our efforts include delivering to the client a high quality product," explains Michael Stumm, which is why a 100-percent weld seam inspection is part of the manufacturing process. The control system consistently checks the entire joint of a profile for a complete through weld and automatically detects potential irregularities. Whether in machine manufacturing, in the petrochemicals industry or in the architecture of building facades, Montanstahl laser profiles ensure at any time a constant level of strength, parallel flanges, exact edges and a homogenous surface structure, all of which cannot be claimed by conventional steel products. Aside from precision production and high quality primary materials, for the stainless steel products, a passivation process with a pickling solution developed in-house is responsible for the high Montanstahl quality. The fact that deposits are reliably removed from the stainless steel surfaces goes without saying. It does not get better than this. This quality does not remain unnoticed. Besides loyal industry customers, it has been bringing more and more architects on the scene of late. Steel profiles of this production quality offer entirely new design options for the visible, representative building facade design so that even star architects, such as Frank O. Gehry, architect of the famous Guggenheim Museum in Bilbao, Spain, are showing interest. In answer to the question, what comes to mind when you think of Switzerland? A future answer might be: "Mountains, chocolate, banks and laser profiles." And that is good praise. ■

Contact:
Montanstahl AG, Michael Stumm, Telephone +41 (0) 91 641 68 00,
m.stumm@montanstahl.com

FLEXIBLE FACADES

Montanstahl AG specializes in stainless steel profiles and beams. Thanks to the laser as a cutting and joining tool, it produces T and U profiles, boxes, hollow profiles as well as numerous special profiles according to customer specifications, even in small batch runs. In the process, profile lengths of up to 15 m are possible. Europe's state-of-the-art convention center relied on this know-how: Almost 150,000 square meters of Montanstahl profiles are in roofs and glass facades of the nine halls of the Neue Messe (Stuttgart, Germany) and the corresponding International Congress Center.

In searching for thinner-faster-stronger solutions, you need to have a good sense of humor, says Bill Partlo.

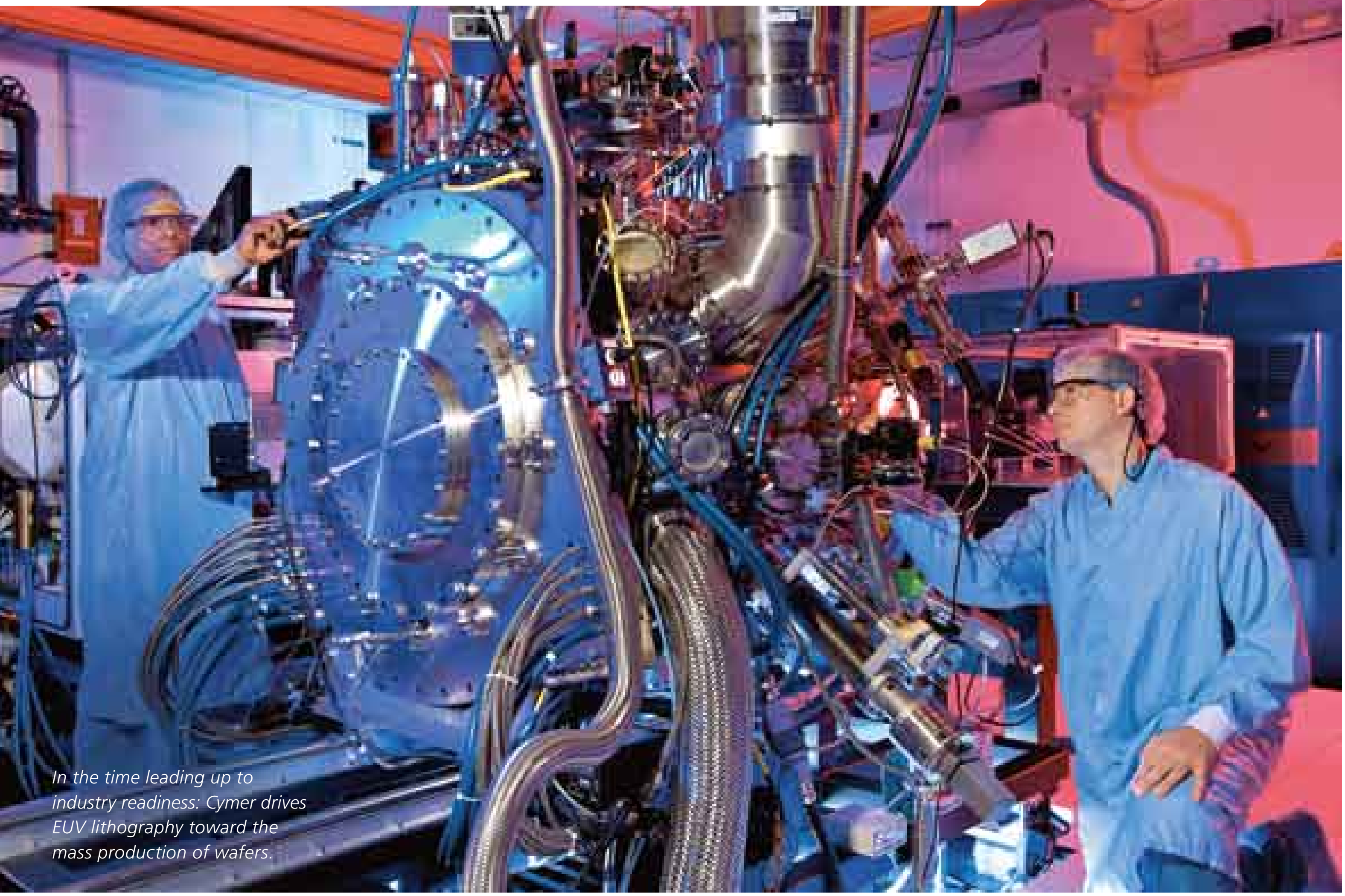
Brent Haywood

"We Push the Limits"

Electronic devices grow smaller, faster and more powerful: Bill Partlo, Cymer's senior vice president and chief technical officer talks about being ahead of technology—and behind it as well.

Tell me a little about Cymer and its beginnings. Cymer provides excimer laser light sources for lithography systems to chipmakers and scanner manufacturers globally. The company began in 1986 as a small research and development team investigating technology for 248 nanometer (nm), deep ultraviolet (DUV) lithography, used in the manufacture of integrated circuits (IC). The resulting DUV technology was validated in partnership with scanner manufacturers and chipmakers, and Cymer has been leading the photolithography industry ever since.

Why are light wavelengths important to the production of integrated circuits? Lithography systems image the patterns held on ICs. A wavelength of light exposes the pattern through a sacrificial layer (photoresist) acting as



In the time leading up to industry readiness: Cymer drives EUV lithography toward the mass production of wafers.

a stencil. That stencil transfers the chip design onto a pure silicon wafer that — after multiple passes through the scanner — holds a multitude of individual ICs. Features patterned onto ICs are proportional to the wavelength of light, meaning the smaller the wavelength, the smaller the circuitry that can be patterned. And as the geometries of features become increasingly smaller to accommodate the creation of the powerful, memory- and logic-dense chips needed in today's most advanced electronics, increasingly shorter wavelengths are continuously needed.

Why are smaller feature sizes significant?
For memory ICs, smaller feature sizes mean a higher density of information can be stored. For logic ICs, smaller feature sizes translate into faster processing speeds.

What is the role of the laser in EUV?
The 13.5 nm wavelength light used in EUV lithography is produced when a CO_2 laser is "shot" at a drop of molten tin (Sn). The laser heats the micro-droplet of tin to the point of evaporation, and the atoms then shed their electrons and become highly ionized. The plasma created by the interaction of the laser pulse and tin begins emitting photons, which are collected by a highly reflective mirror. The mirror reflects and directs the 13.5 nm wavelength plasma energy and focuses it through an aperture and into the wafer scanner.

How is EUV different from the previous lithography technologies?
The EUV process is conducted entirely in a vacuum, the first production lithography technology of its kind to do so. Due to of the short 13.5 nm wavelength required, the light must be transported inside a vacuum so that it isn't absorbed by air. Glass materials traditionally used as lenses in DUV lithography would also absorb this short wavelength, which is why Cymer uses mirrors to transport the light from its source. The light is carried through optics that shape and condition it to reflect off a mask and ultimately, into the photoresist on the wafer. Unlike DUV, for which Cymer directly creates the wavelength of light inside the laser, for EUV, laser energy is converted into light via plasma.

Why was a CO_2 laser selected?
The CO_2 laser combined with tin produces a very high-conversion efficiency, and as a result, we can create a cost-effective solution. The high-conversion efficiency makes the economics of the source viable.

Cymer investigated both gas discharge-produced plasma (DPP) and laser-produced plasma (LPP) methods of achieving EUV source power, why did it choose LPP?
The simple answer: The capability to produce higher power makes LPP superior. We're developing LPP because we are confident that power production can evolve through generations of EUV equipment and thus, we're building a tech-

“Lithography only makes sense economically if you can expose many silicon wafers at very quick speeds.”

nology with extendibility. In addition, LPP is optically a much purer source than DPP. LPP is a very small point source, which is advantageous for transmitting through the imaging tool.

What was the biggest obstacle Cymer faces in developing EUV lithography?
Getting to high power. Lithography only makes sense economically if you can expose many silicon wafers at very quick speeds. So the system has had to produce enough power to expose hundreds of wafers to the light over a specific period of time. We worked to get the laser to produce the amount of power in the mode we needed to operate. Instead of a continuous wave, the laser is pulsed. It fires in very short pulses at a repetition rate of 50 to 100 kilohertz.

Did you overcome the obstacle?
We recently reached a major milestone. We achieved 25 watts of average EUV power continuously for 1.5 hours. That’s 25 percent of the way to the power required to meet the benchmark of 100 wafers an hour. We used to be hundreds of factors away, now we’re only missing it by a factor of four, and we expect to achieve the 100 watt milestone shortly.

How do you keep pushing the boundaries of what is possible?
Cymer’s creative physicists and engineers aren’t satisfied with the status quo. Their passion for problem solving and capacity to rise to a challenge are called upon every day to create solutions for our customers. In this way we are able to repeatedly bring new technology to market, and ramp it to volume quickly. Speed is critical in this industry, especially as we move in lockstep with the 18- to 24-month cycles demanded by Moore’s Law. The speed at which you introduce new technology is as critical as the technology itself. New technology has to be available when needed.

How do you maintain that pace and keep your sanity?
Balance through humor is a core value at Cymer. We are driven to do great things, constantly, and repeat that over and over again. The challenges our people face every day are extreme. They are pushing the laws of physics and are continually up against the limitations of human knowledge. In order to balance that kind of stress, we have to have a good sense of humor. You’d be amazed at how elaborate the April Fool’s jokes get around here! ■

CONTACT:
Cymer Inc., Julie Walker, Telephone +1 858.385.5532
julie_walker@cymer.com

EUV LITHOGRAPHY

Lithography with extreme ultraviolet light represents a major technological advance. Current lithographic techniques with deep ultraviolet light (DUV) involve laser light to structure chips. The extreme ultraviolet light used in EUV lithography, on the other hand, is emitted by laser-produced plasma. Because air simply absorbs this extremely short-wave light, the entire process must take place in an optical path vacuum. In addition, the light cannot be guided and shaped with optical lenses, but instead requires the use of mirrors and masks.

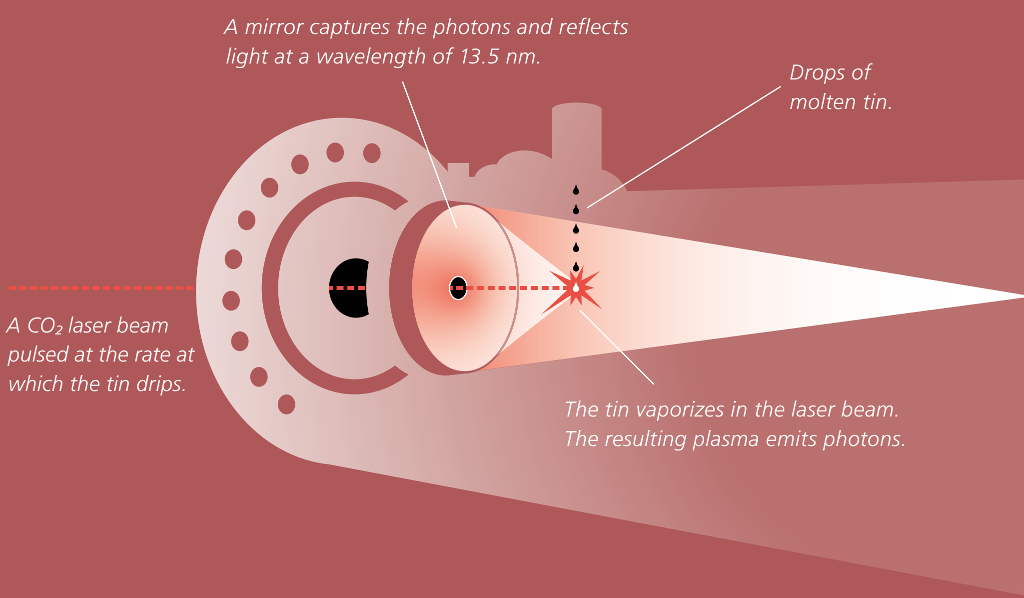


Illustration: Gernot Walter

The CO_2 laser welds pyrotechnic fuse and gas bottle. While one workstation is welding, the other station discharges the welded component and clamps in a new one.

Double Charges

Welding on a gas bottle filled with 620 bar helium? No problem for the CO_2 laser. For iSi Automotive, it even works in alternating rhythms.

Fifteen milliseconds — the equivalent of about a quarter of an eye blink. This is the time it takes for a cool inflator to save lives. Signaled by a sensor, an electronic control system ignites a small pyrotechnic fuse. This opens a membrane on a small, cold gas bottle filled with 620 bar helium. Helium flows out rapidly and fills the airbag. Since the mid-1990s, Vienna-based iSi Automotive has produced cold gas bottles for automotive suppliers for further processing into airbag modules. "The gas density and, especially, its long-term, reliable storage were unsolved problems for a long time. Even today, only a few companies have this knowledge," explains Dietmar Schäfer, who was responsible for the company's expansion and has managed operations for ten years. "As a company of the iSi Group, we had access to decades of experience in producing gas pressure containers for the food industry. We were subsequently able to expand when we finally developed a helium-based solution for the high requirements in the automotive industry.

"In 2001, in order to extend our supply chain, we began producing not just gas pressure containers, but we also developed our own cold gas generator, the Cool Inflator," says Schäfer. "As early as the end of 2005, we concluded the first mass production contracts with the automotive industry." A great deal of intense research and development went into it in the intervening years. One of the central challenges in building the production machine was welding the release unit, which was developed in-house and patented worldwide, to the gas pressure container filled with up to 620 bar helium. "Various tests quickly showed that only the CO_2 laser met our extremely high requirements at an affordable price: Only one laser has such high precision with a concurrent minimal energy input," explains Schäfer. Both the gas pressure container as well as the welded cold gas generators are subjected to leakage tests. The machines test for leakage rates of less than 10 – 9 mbar/s. "Today, only containers and inflators with a calculated pressure loss amounting to a maximum 5 percent over 10,000 years leave our plants."

In addition to its precision in the welding process, the CO_2 laser offers a series of other benefits in Schäfer's opinion. Based on the closed-beam guidance, no special preventive measures have to be made for beam protection so that the production machines can be operated transparently and are easily accessible. In addition, for standard components for beam redirection, the Viennese company has created an extremely efficient machine with a maximum laser capacity. In this machine, each of the four TRUMPF CO_2 lasers works on two respective workstations in an alternating rhythm. While the laser is welding on one workstation, the other station discharges the welded component and clamps in a new one.

From the gas pressure container to the cool inflator: Dietmar Schäfer keeps the supply chain in the company

Today, iSi Automotive has a workforce of 130 employees who produce these safety products for about 7.5 million vehicles per year in three-shift operations. All measured data for quality control, leakage and testing of the weld seams are completely documented with related process and machine parameters. Barcode stickers with individual serial numbers ensure exact traceability. "Because we have the complete supply chain within the company, we are able to meet all individual needs of our customers. Volumes of 15 to 120 liters, gas venting either radially or axially — the number of variations is unlimited," explains Schäfer. Also, he sees no alternative to CO_2 lasers in the future. "We produce all parts in the laser-optimized design. In addition, we have compiled a lot of specific knowledge internally. With the CO_2 laser, we are ensuring a continued competitive edge in the market." An edge that should be maintained through product innovation. "There are few limits to the areas of application for our cold gas generators. In the meantime, these are even being used for airbags in motorcycle helmets."

Contact: iSi Automotive GmbH, Dietmar Schäfer,
Telephone +43 1 24644 211, dietmar.schaefer@isi-automotive.com

By Dr.-Ing. Dipl.-Chem.
Stephan Barcikowski
and Dipl.-Ing. Niko Bärsch

The Direct Path

When the laser hits the basic material nano particles are created every time as well. The Laser Zentrum Hannover turns this side effect into a new method of gaining nano particles.

Nano technology is considered an important engine of the future for technology industries such as energy and IT as well as biomedicine. Most of the mechanical, chemical or biological "nano" effects are achieved with the help of tiny particles. Many substances become surprisingly active as soon as their surface greatly increases in relationship to weight. This is the case if you obtain such small particles from substances that the number of atoms that are located in the surface become significantly bigger. This is what is referred to as nano particles. Invisible nano particles from ceramics, whose diameter is smaller than the wavelength of visible light, are used today to ensure scratch-free auto paint.

There are many ways to produce nano particles. One conventional approach is synthesis through chemicals. Gas-phase synthesis facilitates the production of free nano particles in multi-ton quantities. However, it is primarily suited for metal-oxide and easily leads to lumps in the nano powder. The Sol-Gel process is the most frequently used wet chemical method for generating colloids. They are liquids that are mixed with nano particles. The cleansing that is subsequently required to remove chemical deposits is very expensive, however.

In view of this complicated production process, the Laser Zentrum Hannover uses an approach that is actually very close to it: Nano particles are dissolved directly from the starting material without the indirect route through chemical reactions. For this purpose, we in Hanover use a laser deposition process in a liquid environment. In this approach, no powders are formed; the particles generated are easy to manage and the liquids can be selected in accordance to the further processing method preferred.

The laser process can solve several problems at once: Nano particles can be produced from new materials — whether it is metals, ceramics, alloys or material compounds. Adapting the liquid medium contributes to its stabilization and prevents agglomerations. In addition, the existing nano particles are charged, which is advantageous for their stabilization and for further use. In most cases, the laser deposition products are nanoparticular right from the start. By setting relevant processing parameters such as the radiation intensity or the fluence (the energy that refers to the radiated surface), the repetition rate and the pulse overlaps, different particle sizes can be produced. In principle, all types of lasers can be used. Pulsed lasers with the wavelength ideal for the respective liquid medium offer the most benefits for the controlled production of small particles.

Ultra-short pulses (in femto to picosecond range) even make it possible to generate particles in combustible liquids without igniting them because they do not apply any heat to the surrounding material. Such short pulses have already been used for the last decade in microprocessing to prevent the formation of molten metal and are now helping to produce nano particles directly in organic solvents. The possibility of also directly binding chemical groups during production opens up the use of laser-produced nano particles in many biotechnology applications. The process is used often to generate new kinds of colloids with a freely selectable structure. It is interesting due to its material variety and combinability and also due to the fact that it can generate nano particles with multiple functions — for example, the generation of nano material that is both resistant to wear and tear as well as anti-bacterial.

Nano particles from silver are the most well-known biotechnological application so far. They prevent the formation of biofilm and thus pro-

Silver, titanium, ceramics: Laser can produce nano particles from virtually any material.

Port catheter: nano particles can help making implants biocompatible.

tect against infections. Such bioactive effects are attributed to various metal particles. If metal ions are released on the large surface of nano particles, this can influence the growth of biological tissue, which can be of great use for medical implants. Should implants therefore, be "painted" with nano particles? There are good reasons to speak against it. Paint can flake off and other types of coatings can also wear off. The dissolution of entire particles that previously released a continually low dose of metal ions would be toxic in almost all cases. In addition, besides the desired particles, the colloids obtained on the market also contain deposits from additives or intermediate products (so-called precursors), from which the nano particle nucleation occurs during chemical synthesis. This starting situation led the nano material group at the Hanover Laser Center to an entirely different approach. The free selection of carrier fluid in the laser deposition process allows for the production of nano particles in monomers — liquids that can be networked to plastics. From these types of laser-generated colloids, pourable biomaterials are synthesized on the direct path in which the desired particles can be evenly embedded. Implants, which are made of plastics or are coated by them, contain nano particles solidly and securely encased, but nevertheless allow the medically effective release of metal ions from the particles near the component's surface.

As part of an ongoing project, cochlear implant electrodes that establish the nerve connection in the inner ears of severely hearing impaired newborn babies are encased with plastics that contain specific concentrations of different metallic nano particles. These have a selective effect on certain cell tissue types. This is how the surface of the cochlear implant grows hearing nerve cells with a suitable interaction between the particles and at the same time suppresses growing tissue. No other procedure allows scientists to so effortlessly generate, combine and embed any preferred nano particles. This method is equally suitable for subsequent material production studies.

Producing nano particles using lasers does not compete with the chemical process of producing nano particles by the multi-ton. Production rates with lasers can range, depending on type and process, from milligram to gram per hour. Yet one nano particle does not equal another nano particle. While one gram of titanium oxide particles converted for one cent is available, the calculated market price for one gram of semiconductor particles is 1,000 Euros. Because the market is dominated by only a few types of nano particles, the laser deposition process is therefore, also offered for development projects for all materials for which the chemical industry knows no synthesis procedure or shies away from its development time and expense. The "right" material is a valuable item, whether it's for energy storage, micro systems or medical implants. ■

Contact:
Dr.-Ing. Dipl.-Chem. Stephan Barcikowski, Dipl.-Ing. Niko Bärsch,
Laser Zentrum Hannover e.V., Nano Materials Group, Hollerithallee 8, 30419 Hanover,
s.barcikowski@lzh.de, n.baersch@lzh.de

Illustration: Gernot Walter

"We Do It the Japanese Way"

The laser is the tool of the future claims Professor Seiji Katayama. Over the last 35 years his own research paved the way for making this claim come true.

Katayama-sensei, you have been a member of Osaka University for about 35 years. Have you never considered going to another institute?
I had several opportunities to get a job or a higher position outside of Osaka University. But Osaka is one of the best and most prestigious universities and it is well known for welding. The working conditions are great and so I would like to stay as long as possible.

Since the beginning of your career you have been researching material processing. Did you start examining materials as a child?
No, not really. When I was still in school, my plan was to become a mathematics teacher so that I could live close to my parents' house and take care of them when they are old. I am the eldest son and in Japan it is usually my duty to tend to my parents and to farm our rice field.

Why did you change your mind?
When I was finished with senior high school, there was no entrance examination at the University of Tokyo. And I sensed that the engineering field was becoming important in Japan, because the country has no natural resources. So I changed my mind and began to study engineering.

When did you first stumble upon the laser?
I began to conduct research on laser materials processing when I started working as an assistant professor together with associate professor Matsunawa — who is now Late Emeritus — at JWRI in 1981. He had a pulsed YAG laser apparatus of 200 watt maximum average power and we focused on "interaction between the laser beam and induced plume."

Is there a typical Japanese way of doing research — different from approaches in other countries?
I think, yes. At the universities or institutes in Japan, for example at JWRI, a professor can conduct research basically on what he wants. One professor, an associate or assistant professor and one student work together as a team to perform some experiments for one project. In Germany and other European countries, a group for a given project consists of some specialists of a certain field, including graduate students. They do the experiments of their special field in depth, but they do not perform an experiment that is slightly out of their field. That is one aspect of the Japanese way of doing research.

In 1969 the JWRI was founded to ensure Japan a leading role in welding technology. Does this mission still excite you?
I think that welding and joining are the most important key technologies for manufacturing many structures and products. In particular, the laser is known as the tool of the future for materials processing. And so the utilization of the laser excites me. This is why I am fascinated by the laser. I like researching this field since there are still a lot of topics to research and problems to be solved.

What will laser welding look like in ten or 20 years?
In the next few years, I expect it to be used more widely. To realize this expectation, I must keep my mind on the establishment of several targets. The laser is still expensive, and we should be able to weld faster and deeper. We should establish micro-welding of smaller size than today. Sound

While Prof. Seiji Katayama is rooted in tradition, he is walking into the future of laser joining

LIFE

Born in 1951, Seiji Katayama wants to become a mathematician so he can stay close to his parents. As the eldest son, he is meant to manage his parents' rice field. In 2002, he becomes a professor of engineering in Osaka.

LASER

In 1980, he comes across the laser for the very first time as a research lecturer at the Joining and Welding Research Institute in Osaka.

ACHIEVEMENT

Katayama revolutionized aluminum laser welding as well as metal-plastic bonds.

"We can demonstrate mechanically strong joints between metals and plastics."

high-quality laser welds should always be produced. In terms of production of high-performance or highly-functional joints, welding of dissimilar materials, such as metal and plastics, is also one laser welding technology for the future.

One of your wishes is that the laser joining technology of dissimilar combinations you developed spreads. What is necessary to reach this goal?
We are still standing on the threshold of this technology and it is not known well in Japanese industry. In the case of laser joining of steel and aluminum alloy, for example, I inform as many engineers and researchers as possible of this technology by lecturing or demonstrating the welding process. In the case of direct laser joining of metal and plastic, we can demonstrate mechanically strong joints between metals such as stainless steel, mild steel, titanium and aluminum alloys as well as plastics. Some companies would like to establish a new combination of their interest. We have to set the joining conditions for the production of the joints resistant to high thermal cycles or high mechanical properties. We are setting these conditions now and I expect it might be ready for use in the industry in a few years.

What are your current challenges?
Research in laser-arc hybrid welding is almost finished. But we should further develop and establish a process for the production of deeply penetrated welds. We have to interpret melt flows perfectly to satisfactorily mix in the bottom part of hybrid weld beads. Monitoring and adaptive control may be required as a next step. A monitoring and adaptive control system is also one challenge for deeper penetration. We have developed and established a system by utilizing heat radiation signals for joining of thin sheets with a pulsed YAG laser or a continuous wave low-power laser. We are now trying to establish laser welding of thick plates of high strength steels to establish a sensing system. Another next step is to achieve greater process stability. I would also like to challenge laser or hybrid welding of copper.

When you look back on your successful career, what makes you proud?
This may be the design and manufacturing of portable microfocused X-ray transmission real-time in-situ observation system of a keyhole and melt flows inside the molten pool during laser welding. Here we could obtain a lot of knowledge of laser welding and hybrid welding phenomena and interpret the procedures for reduction in porosity. The improvement of the Image Intensifier, the development of a high-speed video camera and the help of Mr. Masami Mizutani, technical official of JWRI, led to the development of the system. I am also be proud of the development of one-pass laser welding process of steel to aluminum alloy by considering simultaneous formation of a lap and a butt joint in the materials with different melting temperatures. I am also proud of the development of direct laser joining process of the metal and plastics combinations with the corporation of Assistant Prof. Yousuke Kawahito. We are sure that this brand new process is promising in a lot of applications. ■

Contact:
Professor Seiji Katayama,
Telephone +81–66 879–8662, katayama@jwri.osaka-u.ac.jp

KD Busch

"Given the situation, the laser was never invented?"

5 QUESTIONS TO PROFESSOR POPRAWE

"It would be costing us € 10 per minute to phone the USA."

Which application seemed impossible ten years ago?
Today, LASIK and PRK are established processes for correcting defective vision up to about 6 dioptres. Even the riskiest micro cut is today replaced by femtosecond lasers. Millions of people have benefited from this application.

What do you wish lasers could do?
Penetrate human tissue in the most risk-free and accurate way so that all areas of the body can be reached with great precision and only where the desired diagnostic and therapeutic effect can be generated. In other words, "zero-invasive therapy."

What changes in laser technology are the most important to you?
It took more than 20 years before the industrial diode-pumped solid state laser with an acceptable level of efficiency could be produced. To do so, the design recipe is easy. Large areas in small volumes for the active medium. There are only three conceivable concepts: fiber, disk and rod.

Fraunhofer Institut für Lasertechnik; Gernot Walter

What event awakened your interest in laser technology?
During my study of physics at California State University in 1976, I had the opportunity to view the largest laser in the world in Livermore. When I saw it and heard the answer to my question that now seems trivial — why the mirrors did not break with such huge outputs and energies — I said to myself: "That has to be applicable in an industrial environment!" And I still say this to myself now.

Prof. Reinhart Poprawe studied physics at the University of Applied Sciences of Darmstadt and focused on development of lasers, plasma technology and applications. He has founded numerous companies, is a member of international laser organizations and, since 1996, has been head of the Frauenhofer Institute for Laser Technology, and holds a professorship in laser technology and is Prorector for structure, production, and junior scientists at RWTH Aachen.

More questions to Prof. Poprawe:
Reinhardt.Poprawe@ilt.fraunhofer.de

The elemental force of lightning. The mini super laser called "Teramobile" was developed to control it.

Diverting Lightning

High-performance laser pulses short-circuit earth and sky

Airplanes used to be Faraday cages and were a safe place for passengers during thunderstorms. Due to the increasing use of modern compounds, however, today flying can occasionally become more of a lightning risk. To divert lightning strikes from airports and other lightning-prone equipment in the future, physicists from Berlin, Dresden, Geneva and Lyon have developed an extremely powerful laser and managed to package it in a commercial truck container. The mini super laser called the "Teramobile" issues ultra-short impulses that generate in only 100 femtoseconds as much output as 1,000 large power plants. This is the equivalent of about four billion kilowatts. The air ionizes along the laser and there develops a power conducting plasma channel that "short-circuits" the storm clouds' connection to earth, "discharging" the clouds and directing the lightning along a path to earth, far away from endangered objects. So far, however, these artificially generated channels are still too short. During tests in New Mexico, scientists have already succeeded in generating electrical discharges by shooting at the clouds — a precursor to lightning strikes — using the "Teramobile." By increasing the laser output and the impulse density, they now intend to try to stretch the plasma channels so far that they run from the storm clouds to the earth. ■

Contact:
Freie Universität Berlin, Institut für Experimentalphysik, Dr. Kamil Stelmaszczyk,
Telephone +49 (0) 30 83 85 6119,
kamil.stelmaszczyk@physik.fu-berlin.de

The Forecast is Positive

Laser technology has been a main factor for the industrial development of Poland and the whole of Eastern Europe, says Professor Andrzej Klimpel of the Silesian University of Technology in Gliwice.

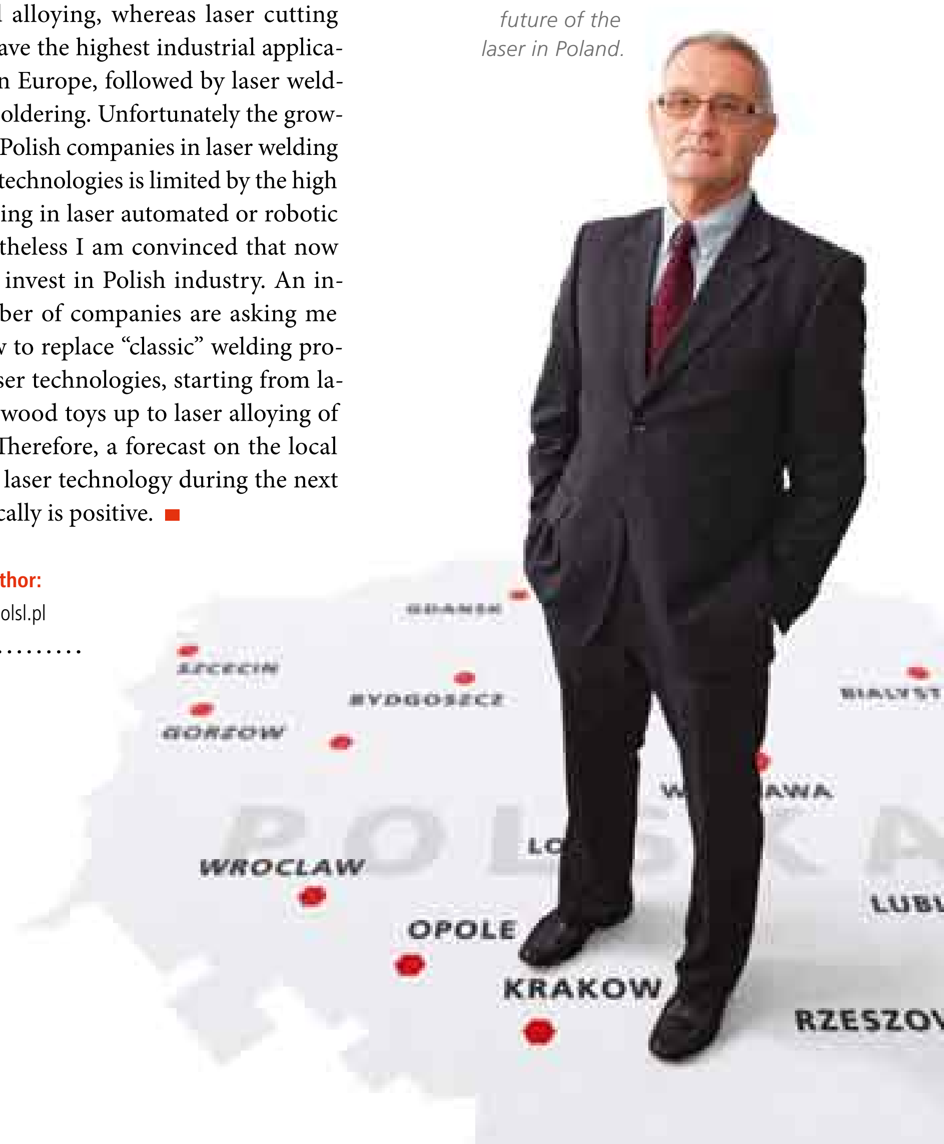
Laser welding technologies were established in Poland and its neighboring countries in the late 1980s. Apart from Poland, laser applications in heavy industry in Eastern Europe were at the beginning only used in the Ukraine and other former Soviet Union member states. The development of laser processing, especially of welding technologies, in Eastern Europe has been a crucial element of the overall industrial development in this region.

Many European and North American companies started their presence in Poland by taking over local companies, for example United Technologies buying WSK Rzeszów. As a result, the development and implementation of laser welding technologies in Poland has been steadily growing — even if not as fast as possible, yet. Dozens of small and medium-size Polish companies are investing in laser cutting to provide extensive services for larger companies. Larger companies producing car parts, established on the Polish market just a few years ago, are using modern welding and surfacing technologies to meet their customers' demands. An example is WSK Rzeszów, which is implementing laser repair technology of surface defects of precise nickel and cobalt superalloys castings in collaboration with the Welding Department of the Silesian University of Technology (STU) as a governmental project. Research and development concerning laser material processing in the region are growing strongly. Many studies run by universities or industrial institutes are supported by the Polish government and EU funds — even if they are often poorly coordinated. The Welding Institute Gliwice and the Welding Department of the Silesian University of Technology are basically involved in research and development of laser material processing.

At the stage of research, development and implementation in the local industry are laser surfacing and alloying, whereas laser cutting and drilling have the highest industrial application in Eastern Europe, followed by laser welding and laser soldering. Unfortunately the growing interest of Polish companies in laser welding and surfacing technologies is limited by the high costs of investing in laser automated or robotic stands. Nevertheless I am convinced that now is the time to invest in Polish industry. An increasing number of companies are asking me every day how to replace "classic" welding processes with laser technologies, starting from laser cutting of wood toys up to laser alloying of forging dies. Therefore, a forecast on the local application of laser technology during the next few years basically is positive. ■

E-mail to the author:
andrzej.klimpel@polsl.pl

Prof. Andrzej Klimpel surveys the industrial future of the laser in Poland.



Where's the laser?

ON THE COW'S EAR: Even in front of the freezer, consumers need to know on which field the cow once happily grazed. That's why even spotted mountain cattle need an ID tag which they wear on their ears. A number and a barcode are located on the breeding tag that definitively identifies each cow. Because the writing on the ID tag has to be weather resistant and durable, the laser is the ideal marking method. It writes large quantities of "cow IDs" fast, permanently and individually. For each ID tag, a unique data set has to be loaded. This means that the cow is no longer one of many, but an individual.

Krzysztof Bialy; Illustration: Gernot Walter