

Laser *Community*

THE LASER MAGAZINE FROM TRUMPF

And India?

A job shopper in a booming market

Flash, bright

Light polishes steel and titanium



Lightly into the future

Energy-efficient designs with a laser

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MORE FREEDOM

THE NEW
MACHINE FROM
MATHIAS BIHLER

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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, Phone +49 (0) 7156 303-31559,

holger.kapp@de.trumpf.com **DISTRIBUTION** Phone +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 **CONTRIBUTORS** M. Martin, Bernd Müller, Martin Reinhardt, Stefan Schanz, Julie Steinen,

Monika Unkelbach, Dr. Edgar Willenborg **PHOTOGRAPHY** KD Busch, Simon Koy, Ralf Kreuels, Udo Loster, Gernot Walter,

Monsoon Media **DESIGN AND PRODUCTION** pr+co. gmbh, Stuttgart/Germany, Gernot Walter, Markus Weißenhorn, Martin Reinhardt

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What do lasers have to do with the current energy debate? Not everyone will see this connection immediately. But when you take a closer look at the applications of a laser, it becomes much more apparent that without lasers we could not manufacture many everyday products in an energy- and resource-efficient manner.

Lasers occupy a central role in the production of alternative energy sources. For example, lasers weld and cut components used to manufacture fuel cells and wind turbines. Modern photovoltaic systems capture solar energy truly efficiently only if the solar cells are structured using lasers. This saves valuable surface space — which increases the efficiency of the solar cell.

Producing energy-efficient products without lasers is inconceivable. Cars, trucks, construction vehicles, trains, and ships are all means of transportation that have become ever lighter and use less fuel thanks to laser production. Laser beams can alter the surfaces of engine components to reduce friction.

Saving energy requires new ways of thinking!

And lasers are indispensable when it comes to using resources efficiently. Laser metal deposition allows us to protect tools and components from excessive wear and tear and allows us to repair them in case of a defect. For example, laser deposition can significantly reduce the abrasion and corrosion of drilling rods. Airlines can use lasers to repair damage to the blades of a jet engine. So the laser can spare valuable resources — and of course the user's budget.

There is no end to the examples you could list. But one thing is clear: Saving energy and resources will require new ways of thinking. We need different design concepts, different materials — and different production methods.

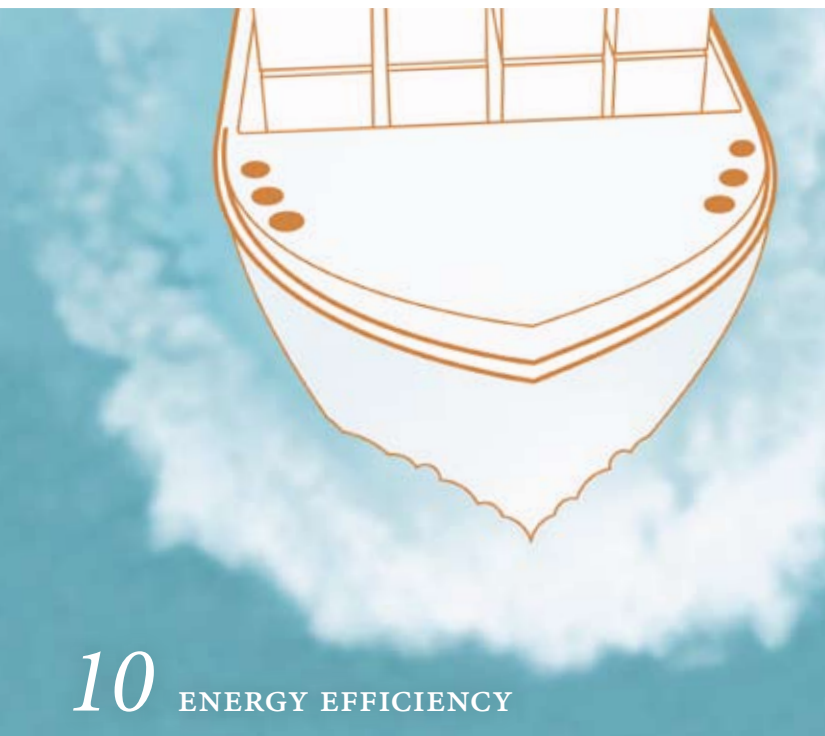
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JENS BLEHER

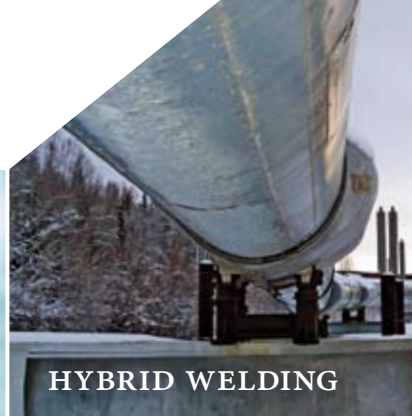
Managing Director

TRUMPF Laser- und Systemtechnik GmbH

jens.bleher@de.trumpf-laser.com



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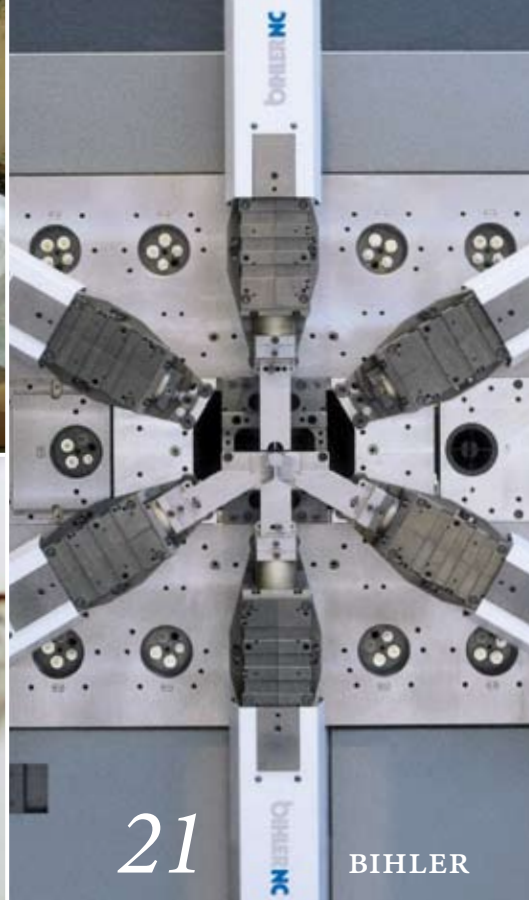
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Cutting-edge in India

Bal Govind Gupta is excited about the future. In the industrial center of Chennai, India, his lasers have put him ahead of the rest. [PAGE 16](#)

Hearing Beautifully

Phonak hearing aids are as individual as the people who wear them: A tiny, encoded plastic film is used as their "personal ID." [PAGE 18](#)

From thought to form

Large batches, small batches — why future users of the latest machine from Bihler can be at ease. [PAGE 21](#)

Shining Light

A research team from Fraunhofer ILT swaps sandpaper and polishing paste for laser light. [PAGE 24](#)

"It is about controlling chaos"

When light hits matter, it often behaves unexpectedly. But if you understand the "chaos" of nonlinear systems, you can find innovative options, says Prof. Cornelia Denz. [PAGE 26](#)

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S P O T

--- MONSTER WAVE

A team at the **University of California, Los Angeles (UCLA)** headed by Daniel Solli has proved that freak waves can also occur in optical fibers. Optical experiments can help explain the secret behind monster ocean waves. www.newsroom.ucla.edu

--- PHOTONICS FOR POLAND

By forming the **Photonics Society of Poland (PSP)**, Polish scientists have committed to laser technology as a promising market of the future. www.photonics.pl

--- 150 TERA WATTS

The **Dresden-Rossendorf Research Center** has been able to build a high-intensity laboratory in only one year. The ultrashort pulse laser installed there generates light pulses with 150 terawatts of power. www.fzd.de

--- IN PRACTICE

Beam sources with extreme ultraviolet (EUV) radiation will play a central role in chip production in the future. In Hawaii more than 100 EUV lithographers are working to hasten this technology from the laboratory into the practical realm. www.euvlitho.com

--- SMOOTH THROUGH GLASS

Researchers at **Laser Zentrum Hannover e.V.** are working on a project involving the laser boring of glass as an eco-friendly, versatile and cost-effective alternative to mechanical processing. www.lzh.de

--- INVESTOR SUMMIT

Bordeaux, France, will be the setting for the first **Laser Technology Investor Summit**. Both established and young entrepreneurs will meet with investors on December 11 and 12, 2008. www.invest-in-photonics.com

--- RUSSIAN PROJECTS

European and Russian experts identified ten promising joint projects during **PHOTONIKA in Moscow**. www.photonics21.org



“Wuhan is the Chinese boomtown of laser technology.”

Bo Gu from GSI electronics

Bright Future

Wuhan — from commercial metropolis to photonics stronghold

■ The Chinese city of **Wuhan** is booming. Many people, like **Bo Gu** from the **GSI Group**, predict a bright future for the “Optic Valley” in China. This confidence is not based on mere speculation. More than 100 companies are working on optoelectronics systems and solutions in Wuhan. No less than 56 research centers, 12 machine manufacturers and 14 development laboratories are focusing on laser technology and optoelectronics innovations. The only state-run Chinese research institute in the industry, the **National Laboratory of Optoelectronics**, is also located here. More than 200,000 well-trained employees are working on the future of laser technology in Wuhan. Bo Gu says, “Infrastructure, trained staff and vigorous state subsidies are boosting Wuhan.” For this reason, Wuhan is the setting for the upcoming **PICALO Conference of the Laser Institute of America (LIA)**. www.gsig.com

Powder for Planes

Joining Technologies embraces laser metal deposition



Dave Hudson of Joining Technologies is investing as promised.

■ Laser metal deposition is an effective repair technology for both aviation and aerospace. And the U.S. company **Joining Technologies** has now invested in this type of machinery, an investment for which **Dave Hudson**, the company’s president, kept true to his word. In the edition 1/2007 of **Laser Community**, Dave Hudson announced that he would install a powder-based laser metal deposition system within one year. He plans to use the new laser system primarily for repairs in aviation and aerospace technology. The system has a six-axis robot and a rotating workstation for complex jobs. Joining Technologies works for clients such as **Boeing** and **Pratt & Whitney**. www.joiningtech.com



Pipelines, ships, bridges: The high welding speed is especially useful for long weld seams.

"Hybrid Laser Welding helps the heavy industry to catch up in productivity," says Ed Hansen, Product Manager at ESAB Welding and Cutting Products in the U.S.



"A seminal combination"

Hybrid Laser Arc Welding: A sunrise technology?

Ed Hansen from ESAB explains

What is unique about Hybrid Laser Welding?

A laser beam and a gas metal arc are used as a common energy source to weld work pieces. The material processing head in this technique is a combination of a laser and a gas metal arc welding torch using either metal inert gas (MIG) or metal active gas (MAG) methods. The laser creates deep penetration and helps to stabilize the arc process. This leads to an increase of energy density, very high welding speeds and the ability to bridge gaps and create weld contours and fillets.

What industries benefit from refining Hybrid Laser Welding, and why?

Especially for "heavy" industries, such as pipeline construction or shipbuilding, it is becoming ever more important to introduce methods and processes that adapt to their requirements in material and production processes. ESAB has adopted this process with an eye on helping our customers manage their costs. Hybrid Laser Welding is an established technique for metal plates with wall thicknesses up to 15 mm — with the advantage of deeper penetration at small spot sizes with a lower total heat input. This minimizes shrinkage and weld-induced distortion, which is one of the factors limiting the opportunities for modernization and automation of heavy industries.

How do you assess the upcoming advancements?

We believe that Hybrid Laser Welding will become a dominant welding process within 10 to 15 years. This will coincide with the automation of many welding processes. ESAB shifted from using CO₂ Lasers to using primarily solid-state lasers. This has allowed great flexibility in the beam delivery and mechanization of the weld process, which will reduce costs and simplify the whole method.

Contact: Ed Hansen, ESAB Welding and Cutting Products,
Phone: +1 207 443-6906, ehansen@esab.com, www.esab.com



AKL Prizewinner: The RobScan Welding Robot

Innovative

For their development of the robot-guided laser welding process, **RobScan**, Bertold Hopf and Dr. Klaus Debschütz, from Daimler AG, received the innovation prize for laser technology from the **European Laser Institute (ELI)** and the **Arbeitskreis Lasertechnik e.V. (AKL)**. RobScan combines robot-guided scanner optics with a new process that uses an online quality control system. **Lumera Laser GmbH** was also recognized for its industrial-grade pico-second laser and **TRUMPF Laser GmbH + Co. KG** was recognized for an ultrashort pulse disk laser with up to 50 W of power.

www.akl-ev.de



Prof. Eckhard Beyer,
recent recipient of
the 2008 Schawlow
Award

Commitment

The 2008 Schawlow Award from the **Laser Institute of America** goes to Germany: **Prof. Eckhard Beyer**, director of the Institute for Surface and Production Technology at **Dresden Technical University**, has made major progress with fiber lasers in recent years. Since 1982, the Schawlow Award has recognized people who have made outstanding contributions to laser research as well as to laser technology applications in industry. www.laserinstitute.org

NETWORK NODE

CSIR NATIONAL LASER CENTRE

CSIR Laser metal deposition (LMD) is an important technology to the South African industry. As such, this powerful technique for the refurbishment of worn components and also for the enhancement of the wear resistance of components is a focus area of the CSIR National Laser Centre. The center conducts innovative laser research and is housed by the Council for Scientific and Industrial Research (CSIR), which is one of the leading scientific and technology research, development and implementation organizations in Africa. CSIR research and development efforts also include biophotonics, novel laser sources development, mathematical modelling and ultra short physics spectroscopy. Besides LMD the center is also progressing in deep penetration (keyhole) welding. The CSIR has strong links with German research institutes, and participates in European Union funded research programmes. It is committed to supporting innovation in South Africa to improve national competitiveness in the global economy. www.csir.co.za

From SAP to the World Beyond

New software solution guides laser markers with SAP



The marker: the data is managed using SAP software. It doesn't matter where the system is located.

Individuality is in demand — even for mass-produced items. This demand is the focus of the “Customized Identification” research project of the **Fraunhofer Institute for Industrial Engineering and Organization** in Stuttgart, and for several noteworthy industrial companies as well as for **SAP**. Based on SAP’s software for small and medium-sized businesses, the project partners have developed a process for transferring identification data from the SAP system to marking lasers worldwide, without being tied to a location. The Fraunhofer IAO is introducing the model solution at trade shows and at the Stuttgart institute. A robot-assisted **Teamos** system and a marking laser from **TRUMPF** — the 5,000th TruMark — are being used for the demonstrations. www.fraunhofer-iao.de

Lifetime Achievement Honored

Jury of the German Founders Prize honors Prof. Berthold Leibinger

Quantum Leap



Small beginnings

Prof. Gerd Herziger cuts precision slits for electron microscope by laser. It's the first use as a tool.

1963

German Chancellor **Angela Merkel** has already called him the leading figure for small and medium-sized German companies. Now **Prof. Dr.-Ing. e.h. Berthold Leibinger** has been awarded the **Deutscher Gründerpreis (German Founders Prize)** for lifetime achievement. The jury honored the entrepreneur “for his impressive career from apprentice to company owner.” What resonated with the jury is that, **Berthold Leibinger** guided the well-established machine manufacturer **TRUMPF** into the world of laser technology and turned it into a global market leader, revolutionizing an entire industry along the way. In addition, he has demonstrated a great commitment to



Award presenter Florian Langenscheidt (right) hands the prize to Berthold Leibinger.

social causes. The award recognizes a commitment to entrepreneurship, and it is an initiative of the magazine **Stern**, the German savings banks, the public TV station **ZDF** and **Porsche**. www.deutscher-gruenderpreis.de



"A successful concept, which can be further improved," says Dr. Thorsten Jäckel from Volkswagen AG.

Close quarters

■ In March the trade show for system solutions in laser material processing — LASYS — took place for the first time in Stuttgart. Its aim was to be a communication platform, marketplace and forum for visionary thought. We asked Dr. Thorsten Jäckel, department head of joining technology at Volkswagen, whether this goal was achieved.

Did LASYS achieve what it set out to do?

LASYS truly covers a very wide range of laser topics. The most important providers of a variety of technologies and applications were gathered together in one hall. LASYS was excellent because everything was close. My conclusion: a lot of information and contacts without it being too time-consuming.

A tip for the next LASYS?

The accompanying scientific conference, the Stuttgart Laser Days (SLT), could prove to be a draw for visitors. I would consider the ability to visit a conference and then meet the relevant suppliers at a trade show to be very attractive.

WORTH A TRIP

EuroBlech



■ Well before the 20th EuroBlech takes place in Hanover, it is becoming clear that the anniversary trade show will be the highlight of the year. About 1,370 exhibitors from 37 countries have committed to attending and demonstrating their systems and products from October 21–25, 2008. In eight halls over a total exhibition space of 85,000 square meters, the world of sheet metal will be illustrated around the trade show theme "Quality, Flexibility, Productivity" with a showing of innovative solutions to rapidly adapt production processes to the requirements of the global market.

C A L E N D A R



MINAT UND SEMICON EUROPA: International Tradeshow for Fine Mechanics, Ultra-Precision and Micro- and Nanotechnologies

CIOE

September 06–10, Shenzhen, China

The world's largest optoelectronics exhibition
www.opto-china.com

IMTS

September 08–13, Chicago, USA

IMTS 2008 presents the future of production technology, www.imts.com

PHOTONICS KOREA

September 23–25, Gwanju, Korea

The only photonics trade show in Korea
www.photonicskorea.org

MINAT UND SEMICON EUROPA

October 07–09, Stuttgart, Germany

www.semicon.europa.org

VIENNA-TEC

October 07–10, Wien, Austria

International industrial trade show
www.vienna-tec.at

EUROBLECH

October 21–25, Hannover, Germany

www.euroblech.de

GLASSTEC

October 21–25, Düsseldorf, Germany

International Trade Show for Glass, Glass Machines and Glass Production
www.glasstec-online.com

JIMTOF

October 30–November 04, Tokyo, Japan

www.jimtof.org

PRODEX

November 18–22, Basel, Switzerland

International trade show for machine tools, tools and production measurement technology, www.prodex.ch

COMPAMED

November 19–21, Düsseldorf, Germany

High tech solutions for medical technology
www.compamed.de

EUROMOLD

December 03–06, Frankfurt, Germany

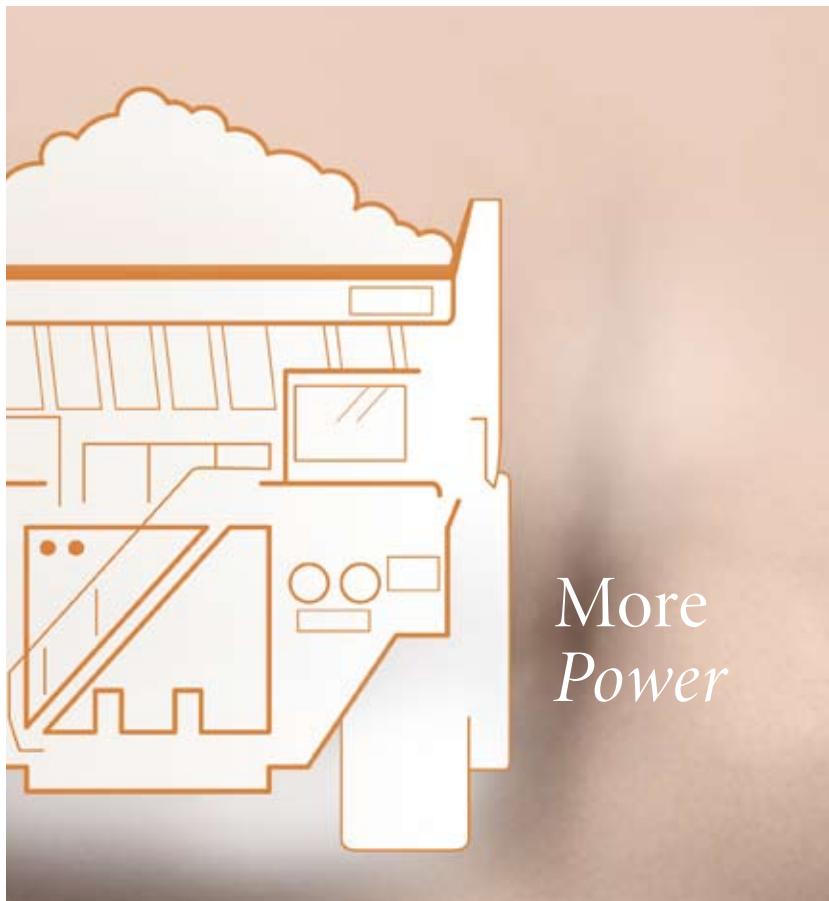
World trade show for mold making and tooling, design and product development
www.euromold.com



EUROBLECH: International technology trade show for sheet metal processing



JIMTOF: Japan International Machine Tool Fair



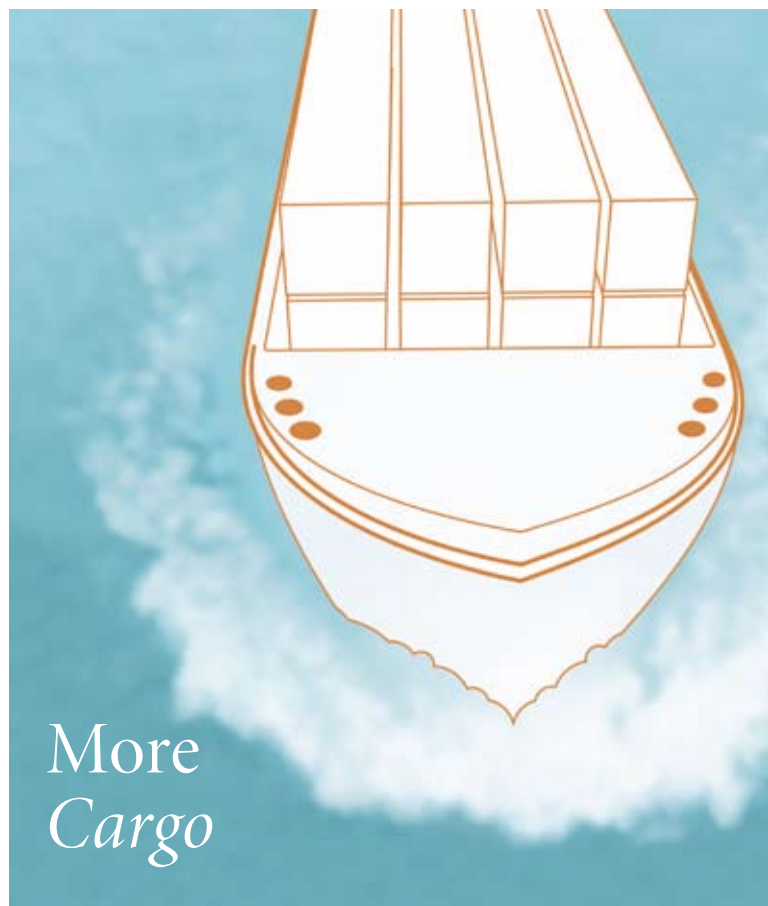
*More
Power*



*Less
Resources*



Less Fuel



*More
Cargo*

The New Lightness

More movement from less mass, more power from less energy,
more effect from less cause: More and more you see a laser flashing when
it comes to improving energy consumption and cutting costs

■ Everything has become more expensive: Butter, electricity, gas — and now even cruises. At the beginning of the year, most of the major shipping companies added surcharges of a few euros per day of travel. The reason: The price for a barrel of oil (159 liters) was approaching the \$100 mark. Now, only a few months later, the ship owners would be happy if a barrel were still \$100. By mid-June, the price of a barrel had in fact gone up to \$135, and travelers can imagine what will soon be greeting them when they book a cruise.

The topic of saving energy is being discussed everywhere — now even for ocean travel. And there is room for improvement for ships, the most energy-efficient means of transport. Weight is almost always the significant variable for reducing energy consumption. The German shipyard Meyer Werft, one of the giants in luxury cruise ship building, uses an innovative lightweight design for its ship structures. The engineers

in Papenburg, Germany, have developed sandwich panels called “I-core” that consist of two thin cover plates with connectors. A 12 kW CO₂ laser from TRUMPF welds the plates and connectors through the plate. A square meter of these I-core panels weighs 52 kilograms. Although that is not much less than a sheet metal design with welded profiles, traditional decks buckle after welding and need to be balanced out to achieve an even deck surface. In addition, impact sound insulation must be installed that is not necessary in the I-core panels. The I-core panels are also three times more rigid than the conventional design, which saves even more for the substructure. The bottom line is that a ship with several thousand square meters of panels sits several times more lightly in the water. “Saving energy is of growing importance to our customers,” says Thomas Reinert, development engineer at the Meyer Werft. “But the real benefit is more space.” →

I-core panels are only four to eight centimeters high and offer more space overall in the cabins or a lower total ship height, which is especially important for river cruise ships that must fit under bridges — a gain in efficiency that is pleasing to both passengers and shipowners.

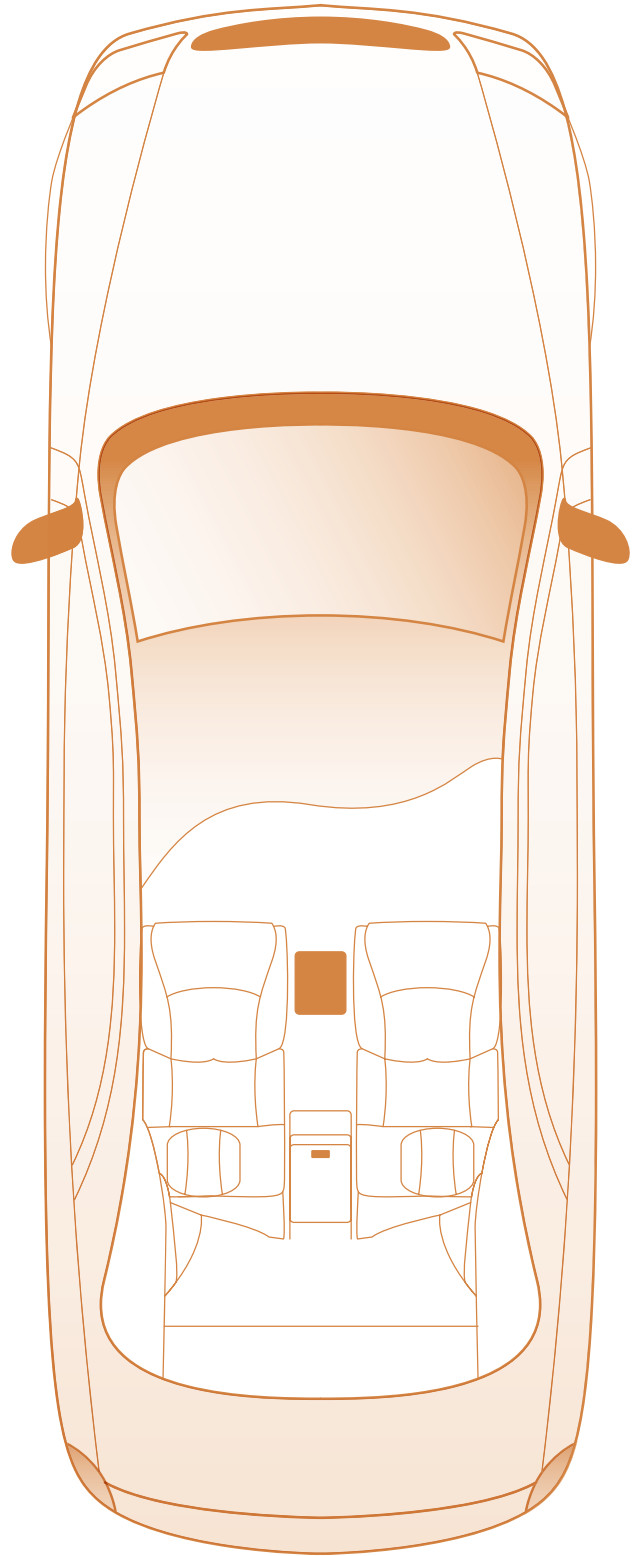
What vacationers may only experience once a year at a travel agency, however, plagues car drivers every day at the gas station. Gas prices are increasing uncontrollably. And with it the call for fuel-efficient cars and trucks is becoming louder. At the same time, the political pressure to build more environmentally friendly vehicles is growing. Again, weight is the variable. Ten percent less weight translates into four percent less fuel consumption. But buyers don't want to compromise on interior comfort. In fact they demand more. So carmakers are trimming down where drivers won't notice — in the chassis and the drive train.

Lighter designs have less to do with beliefs than with production technology

They are becoming lighter and lighter thanks to high strength and maximum strength steels. Only about 10 percent of a 1993 Fiat Punto consisted of such steel. Today the Grande Punto uses about 50 percent of it plus 15 percent ultra high strength steel. As a result of this diet, the vehicle has lost 32 kilograms, and about 150 liters of gas have been saved over the car's total years on the road, and 400 kilograms of CO₂ have been prevented from entering the environment.

The transition to maximum strength steels has less to do with beliefs than with production technology. These steels keep their promise: maximum strength, meaning they're difficult to cut using mechanical tools. For a noncontact tool like a laser, however, wear and tear is not an issue. And thinner plates are not very helpful if broad overlapping and thick weld seams are necessary to hold them together. The weight savings evaporate and the environment gains nothing. This is why high strength steels and laser welding complement each other. With the laser, two plates can be welded together with only a few millimeters of overlap. Even with the tailored blank method, where customized plates touch only at the front edges, the connection is extremely strong.

It is difficult to perform a perfect environmental assessment of energy savings from laser production because the true energy consumption, and therefore the carbon dioxide emissions, are not exclusively related to the power consumption of the laser and the fuel savings of the vehicle. A lighter chassis requires less steel, less shipping and less recycling expense for scrapping. "Material savings during production is the most direct path to energy



Reducing weight is one thing that contributes to greater fuel efficiency. The automotive industry is increasing its search for other energy savings in production to give even heavy luxury cars a bonus when they arrive on the streets.

“Even rapid-cycle processes have breaks in which intelligent concepts can reduce energy consumption”

Germany's Federal Ministry of Research has called for a major program for more energy efficiency in production. Does the automotive industry profit from this as well?

Definitely. In major chassis plants there is up to 50 percent waste for sheet metal. With increasing steel prices, throwing steel away is too expensive and re-using is, too, because of the lack of technical solutions. The greatest energy saver is therefore reducing materials and waste from the very start. But this has to be thought through very carefully. Thanks to high strength steel, the sheet metal has become increasingly thinner but may require more material for noise insulation. The question is how much added value do I generate per kilojoule of energy when I manufacture a crankshaft from a hunk of metal? The automotive industry has recognized that it has an opportunity to improve resource efficiency.

Where to start?

There is enormous potential for efficiency everywhere. Until now no one has looked at auxiliary processes, for example, like compressed air or air conditioning. It is also unacceptable for entire production systems to be kept on over the weekend. And even rapid cycle production processes have shorter and shorter breaks in which intelligent concepts can reduce energy consumption.

Sounds plausible. But many people fear production disruptions if production systems are powered down or shut off over the weekend.

That's why we have to develop new ideas. One possibility is separating control systems and engines through two circuits. You could then shut off engines without turning off the computers of the complex control unit and risk a readjustment. One big area of focus is retrieving and storing energy, for example using heat exchangers or innovative flywheels. This is where I see great potential for Germany's competitiveness.



Prof. Matthias Putz conducts research on more energy efficient production processes at the Fraunhofer Institute for Machine Tools and Forming Technology.

savings, and the laser makes an important contribution to this,” confirms Prof. Matthias Putz, head department director for system technology at the Fraunhofer Institute for Machine Tools and Forming Technology in Chemnitz, Germany.

Nonetheless laser manufacturers have had a rather difficult time, so far, of making an efficiency argument. No one has yet been able to provide a specific overall energy assessment. As Prof. Putz says, “Everyone knows that laser processing is a thermal process and uses more energy than a cold process.” That's why he wishes for an index number showing the increased value per process step in order to prove the favorable

Energy efficiency without cost efficiency will not be feasible in the market. Period

energy analysis, an initiative that the seven institutes in the Fraunhofer production association want to pursue. The German Federal Ministry for Education and Research recognized the problem as well and in March began an invitation for bids on energy efficiency and production.

So while the laser helps conserve energy, energy efficiency without cost savings will not be successful in the market. There are currently many examples of weight reduction through laser welding that result in cost savings — a situation that will become more common as energy prices continue to increase. SSAB Swedish Steel, for example, has worked out the calculations for the use of ultra high strength steels for a dump truck and semi trailer for large trucks. The shipping company saves 13,600 euros annually on the dump truck, with 11,560 euros a direct result of weight

reduction. The dump truck trailer, in fact, weighs almost three-and-half tons less and can transport this weight as an additional load, which in turn requires fewer trips. SSAB calculates that the shipping company saves 2,000 euros in fuel each year.

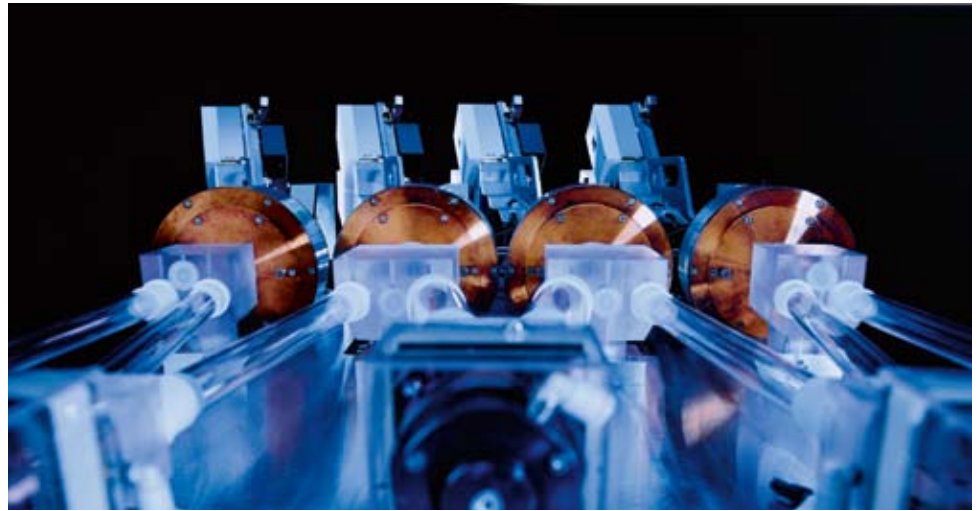
The less mass you bring, the more you can take

The lightest wood chip shipping containers in the world from the Swedish manufacturer CMT produce fuel savings of at least 5 percent. The walls are made of high strength steel and are only one millimeter thick. Folding the plates into horizontal ribs and a rounded transition for the welded wall and floor plates not only reduces weight but also air resistance. Another example of energy efficiency and cost savings involves the diesel electric locomotive “Euro 4,000”. The engineers at Vossloh Locomotives in Spain reduced the weight of the chassis by 25 percent. This allows the installation of a more efficient engine with lower emissions and greater load for the train.

Normally lasers heat metals, though sometimes they help to cool them, as well, and on top of that save energy. The efficiency of gas turbines, for example, can be increased by raising the temperature in the combustion chamber—currently to 1,350°C. The fact that the glowing turbine blades can withstand the inferno of flames is due to a cushion of air flowing from fine holes in the blades and lowering the metal’s temperature by 100° Celsius. The holes are bored by a laser. A Siemens gas turbine in conjunction with three steam turbines in the E.ON power plant in Irsching is expected to reach a record efficiency rate of 60 percent in 2009—and in comparison to a coal plant of the same power, 2.3 million fewer tons of CO₂ will be discharged into the air. ■

Contact:

Fraunhofer IWU, Prof. Matthias Putz,
Telephone + 49 (0) 371 5397-1349,
matthias.putz@iwu.fraunhofer.de



Disk laser: There is still much room for improvement for the laser. Ultramodern components and clever geometries result in increasing gains in efficiency.

More light

Lasers are close to equaling the energy efficiency of energy-saving lights. But the output can be increased even more

■ From three percent to 30 percent—the increase in efficiency for lasers in recent years has been huge. Diode-pumped disk lasers convert one-third of the electrical energy into light.

Energy efficiency can also be increased by shorter pulses. One example: The contact surfaces of the cylinders in an engine must be covered with fine grooves so the oil film does not tear later. That has been done for a long time with lasers, which create small beads of melted metal when the grooves are burned into the metal. These beads must be honed afterward. For the new short pulse lasers, a light flash lasts only ten billionths of a second—so short that grooves are created without beads. Honing is eliminated, which saves energy and lowers costs. Another approach is beam quality. As a result of longer resonators with better mirrors, the laser beam can be focused onto a sharper point. The welding depth increases, causing the speed to

increase. The energy consumption per meter of weld seam is also reduced by a few percentage points.

The permanent operation of machines during production is a pure waste of energy. Even if the assembly lines are stopped, as they are on weekends, the machines generally remain on to avoid having crashes and re-adjustments when starting up. The BMBF energy efficiency program in production is designed to develop solutions for this. “TRUMPF is also working on the issue of how to power down the laser during production pauses, in a controlled manner, and start it back up again as quickly as possible,” says Klaus Löffler, Head of International Sales for laser systems in the Laser Technology Business Field at TRUMPF. ■

Contact:

TRUMPF Laser- und Systemtechnik GmbH,
Klaus Löffler, Telephone + 49 (0) 7156 303-30962,
klaus.loeffler@de.trumpf-laser.com

*Dr. Siegfried Dais is
deputy chairman of the
Board of Management
of Robert Bosch GmbH.*

Building kites in times of globalization

Dr. Siegfried Dais believes that many of today's young technology users are the engineers of the future. But they have to be encouraged at an early age



■ *“What we urgently need ...”* Many appeals from the industry start out like this. They are correct but frequently futile. For example, more well-educated technical personnel are needed if industrial countries want to thrive in global competition with innovations. But it's not easy to achieve what is necessary. In Germany, for example, there are only 90 young engineers for every 100 older engineers — much lower than the OECD average. Calls from politicians alone are not very helpful; the causes are more deeply embedded in society.

Let's take as a prime example of a girl that easily uses modern communications technology. Sending text messages by cell phone, chatting on the Internet — no problem. That would seem to suggest a path to a technical education. And, in fact, our girl has even seen a factory from the inside during “Girls' Day,” which takes place in many German companies. But the spark doesn't catch fire. So how do you persuade a girl from the text message generation that becoming an engineer could make sense? Would the rather grown-up statement that innovation is needed in times of globalization help? Not likely.

Then one question arises: Why doesn't our kids' fascination with cell phones and computers easily translate into enthusiasm for a technical career? It has been repeatedly assumed that electronic media encourage a user interest but not a designer interest. If that's true, we could become a user society. What then?

The first thing is to encourage a design-engineering interest in technology as early as possible. According to findings in neuroscience, children's tendencies are much more established than many believe. So we have to

encourage playful, hands-on activities with little ones. During the 90s France established a program, *La main à la pâte*. It involved conducting simple and natural science experiments and adults were specially trained so they could participate with children.

Such investments in early child development, according to economic studies on education, bear considerable fruit. Companies can all make a contribution here. For example, in Germany there are private initiatives like the Wissensfabrik (“Knowledge Factory”) — cofounded by TRUMPF and Bosch. The participating companies enter into educational partnerships with schools and kindergartens. The goal is to stimulate children's technical interest through practical experience by working with a wide variety of materials and forces. What that means, specifically, is building kites in kindergartens and producing electric motors in elementary schools. If you want more engineers you have to support such projects.

This can happen quite literally. For example, our trainees go to kindergartens to build windmills and generate power with the kids. And the fact that the grown-ups get to know themselves again, too, is completely intentional. In any case, projects and practical assignments make up 50 percent of the trainee program at Bosch. The bottom line is this: If we want the next generation to continue the tradition of technological innovation, then we must devise innovative ways to reach them. ■

Information: www.bosch.com, www.wissensfabrik-deutschland.de



Cutting-edge in India

Bal Govind Gupta, CEO of Sheet N Blanks Pvt. Ltd., Chennai, India, counts on laser-aided fabrication, the booming automobile sector and India's growth potential

Long lines of late-model cars whizz past a busy highway in Chennai in south India—proof of the country's automobile boom. Bal Govind Gupta knows that this is one reason for his business' bright future. Sheet N Blanks Pvt. Ltd. specialized in laser-aided fabrication very early, a decision that turned out to be a good choice. "Many companies will have to come to us," Gupta says, referring to the fact that even small automobile companies are frequently introducing modifications and innovations in order to beat stiff competition.

A second-generation migrant to Chennai from the north Indian state of Haryana, Gupta has been running a family business named Subhas Steel Traders with his brother Subhas Gupta. The group that began business in 1965, then diversi-

fied in April 2002 and started another company, Sheet N Blanks. Based in the industrial area of Ambattur in the outskirts of Chennai, the company began working with modern technology very early, which secures them a competitive edge.

"Facing stiff competition, many companies will have to come to us"

Starting with a shearing machine, and later adding a turret punch press, the company brought in optical fibre laser when it was still a very new technology in India back in 2005. Gupta's latest addition to his machinery: A TRUMPF LASERCELL 1005. With its three-dimensional

precision work in five axes, it is still rarely available for jobs in the south Indian state of Tamil Nadu, a major scene of auto production and business. And so far in India, such precision machines are usually available only for big automobile brands for in-house use. "With the different kinds of new models and variations brought out by car and motorbike brands, many companies do not like to invest in dies and tools until their new offerings are proven in the market," Gupta says. For smaller industries that are getting more and more precision workload, he aims to provide services. "We have the machines and our production service is, in the long run, the cheapest and safest solution for many," he adds.

The automobile industry has a solid research and development, manufacturing and market-



Leading edge technology is the future for entrepreneur Bal Govind Gupta (left): The automobile industry in Chennai is increasing its call for international standards, which is why he is investing in modern technology and employees that know how to use it—even if manual work still continues to play a major role.

ing base spread in southern Indian cities like Chennai, Bangalore and Coimbatore. Gupta can foresee increasing action in the field in the coming years. In addition, the Bangalore-based aerospace industry, which has defense and private companies entering into business dealings with global businesses, creates yet another possible customer base.

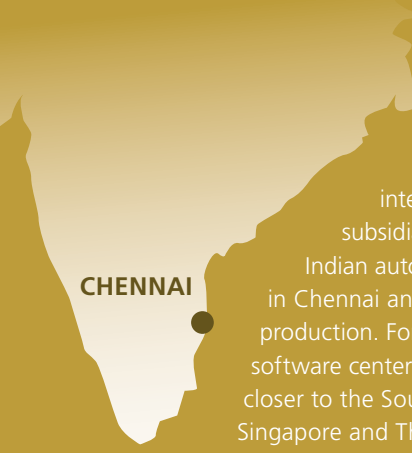
Gupta believes that the new laser technology gives him a competitive edge in India and abroad. “Foreign companies can give a lot of work to us because of competitive labour costs, world-class infrastructure and a highly intelligent, young work force,” he said. Gupta acknowledges that he is facing stiff competition in the market—with an array of companies offering competing technologies and playing the card of cost advantage. With exposure to international markets and competition worldwide, quality standards are drastically improving as well.

Another challenge for Gupta involves lack of access to a skilled workforce. Attracting talent to a small firm like his, with an annual gross profit of INR 30 million (three crore Indian Rupees or 0.45 million euros), is tough. People prefer to work for big brands. Still, Gupta has a young team of 40 employees with an average age of 30—and about 15 of them are technically quali-

fied. Gupta is approaching the human resource problem by providing a friendly, fun-filled atmosphere, which includes taking care of family and personal needs of his employees. Those at managerial position have access to medical insurance—apart from the state insurance—and get reimbursement for children’s school fees. Bonuses for achieving monthly targets are another incentive for everyone. “Our salaries for people working on the machines are the best here,” he says. Gupta’s next big plan is to step

into manufacturing. “There is something creative about manufacturing—you make something new and useful for the people around you.” He says the company might put “20 to 30 percent” of its investment into manufacturing, a move that Gupta estimates could involve a five-fold increase in the company’s profits. ■

Contact: Sheet N Blanks Pvt. Ltd., Bal Govind Gupta,
Phone: + 91 (0)984 102 05 67, bgupta@hotmail.com
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BOOMTOWN CHENNAI

The city of Chennai, India, the fourth-largest in this emerging country, has become a boomtown. A number of international companies have established subsidiaries there. Almost 90 percent of the Indian automotive supply industry is located in Chennai and more than 40 percent of automotive production. Formerly called Madras, it is also a modern software center and old commercial city. Chennai is closer to the Southeast Asian business centers of Singapore and Thailand than any other city in India.

Hearing *Beautifully*


How laser marking makes Phonak hearing aids unique and respectable



The marking laser cuts and writes (left) the plastic film (right) that tells hearing aid technicians everything they need to know.

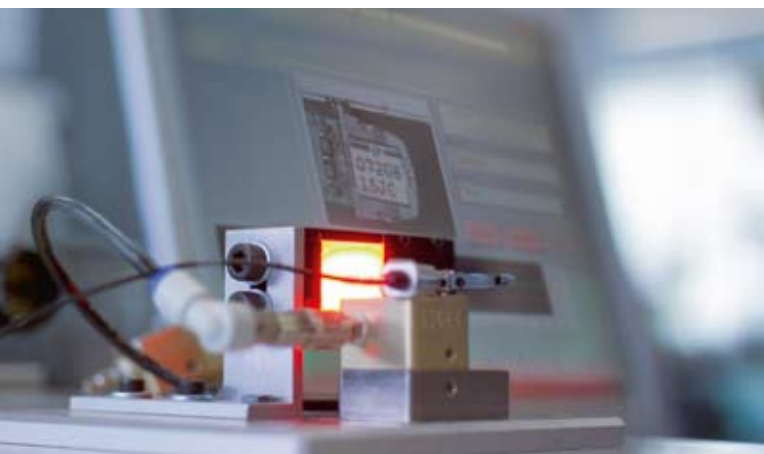
■ They have elegant curves and names like “Ice Princess,” “Flaming Passion” and “Fiery Love.” With attractive shapes, vibrant colors and imaginative names, the Swiss hearing aid manufacturer Phonak intends to keep its products away from the stigma of old age medicine. With the help of creative ideas from researchers and designers, the devices have gone from flesh-toned hearing crutches to fashionable lifestyle accessories. For a truly distinctive object like “Fiery Love,” which is created from 90 individual components, a lot of innovative technology accompanies the modern design and catchy name—as well as the 9-digit product code. This serial number, etched by laser onto a 4 x 6 millimeter piece of plastic foil, is the “personal ID” and code for the central software and hardware data of each individual device. This is data that the hearing aid technician will later need to turn the pretty, but still relatively “dumb,” high tech piece in an intricate adjustment process, into a highly functional personal communication assistant.

Individual piece from laser marking Creating this plastic foil with the serial number is a specialty of sustaining engineer Pius Köppel and his team: “It’s only a tiny piece of plastic,” explains Köppel. “But if we don’t have it ready just in time, the entire production process will soon be held up.” Every hearing aid is given a serial number at the beginning of production. The number is linked from the SAP system to a wide range of information about the production process, installed components and software version. In the final production stage, the film is inserted into the



*The vertical integration
at the Swiss Phonak
headquarters in Stäfa is
deep: Approximately
250 employees assemble
the tiny hearing aid
components, chips and
“designed by Phonak”
hearing aid software.*

A hundred product codes fit on one sheet. The laser writes and cuts them all in just 90 seconds



Above: A special camera reads the code, and the computer system programs the chip. Below: Phonak engineer Pius Köppel.

hearing aid for proper identification. A computer system then programs the hearing device based on this number plate, which is read by a special camera. This eliminates any misidentification. Hearing aid technicians can be sure that they will get the product data they need.

Originally, Phonak printed the serial numbers using an inkjet printer. But laser marking was adopted a few years ago to improve durability and legibility. Exactly 100 product codes fit on the 10 x 10 centimeter special foil. Printing takes place using the “color change” method, in which specific molecules — such as color pigments — are destroyed or structurally altered by the laser beam’s energy. The material’s color is changed by absorption of the laser energy above a certain energy threshold. The surface of the substance remains virtually undamaged. In the beginning, the serial number plates had to be punched out after being marked. One unattractive feature of the punching process was that if the geometry changed, a new, costly punching tool had to be created. Therefore Phonak developed a much more elegant solution: The Vectormark laser station from TRUMPF uses the color change method to inscribe the serial numbers in less than 90 seconds, and at the same time cuts out the labels precisely and flexibly. Köppel explains: “We tinkered around with this application for quite some time.” The greatest challenge was finding the right plastic and the laser parameters to both mark and cut at the same time. Features like marking quality (contrast, homogeneity, resolution and clarity) and marking time played important roles. Together with the specialists from TRUMPF Laser Marking in Grüşch, Switzerland, Phonak taught the laser to write and cut in one step, thereby greatly simplifying the production process. And orders for “Fiery Love” and her sisters can now begin. ■

Contact: Phonak AG, Pius Köppel,
Telephone: +41 (0) 589 28 62 54, pius.koeppel@phonak.com

Phonak hearing aid: In addition to the laser code card, the case is also marked.



MARKING LASER

There are marking lasers of varying power classes with different wavelengths and active laser media. Precise coordination of the process and the material to be marked is important. Marking lasers emit light in the infrared range with 1064 nanometers. There are devices with green (532 nm) and ultraviolet light (355 nm) that can be used specifically to process plastics and semiconductor materials. The UV wavelength opens up new dimensions and the shortwave light reacts directly with plastic compounds without heating the material and damaging it. Particularly in the case of critical materials, these lasers have a much higher marking quality and operate at a greater processing speed.

How steel strip becomes “punched strips”: The new Bihler machine can form each plate differently with its integrated laser.



From thought to form

With its new forming laser cutting system, Bihler gives users the ability to try new ideas on-the-fly in pre-production and production start-up

■ Traveling to the special machine manufacturer Bihler, you get the feeling that you're at the outer reaches of the world. Lush green grass, contented cows, and behind them sits the fairytale castle Neuschwanstein, which is built into the foothills of the soaring Bavarian Alps. Beyond that, there's only sky. Here lies peace and quiet that leads one to thought and reflection, which are especially welcome when you lead a high-tech company with 950 employees whose machines hum in workshops around the world.

The idea and the market Mathias Bihler is head of the company and serves as its technical visionary. He matured in the company and developed the notion that he had both the duty and challenge to take it further. Mathias Bihler sits at the

head of his meeting table, with the punched strips typical of Bihler technology placed nearby on a dark slab. They form a series of small sheet metal components still connected by a bar. Mathias Bihler demonstrates the original idea of the Bihler machines with them: Integrate the complete production process in one machine. Starting with the coil, production is fully automated and without manual involvement. This process, combined with the manufacture of the necessary tools that create extremely manageable modules that can be quickly exchanged, turns the machines into flexible wonders of productivity for everything from small parts to complex assemblies in all batch sizes.

Bihler describes why the company has developed a machine that hadn't existed in the market in this form before.

“In the manufacturing industry we are currently experiencing a second wave of consolidation,” he says, and with a few quick strokes draws a series of rectangles on the paper in front of him. “These are the manufacturers — cars, kitchen appliances, windows, electronics, whatever,” explains Mathias Bihler. “These manufacturers increasingly have to outsource production and design tasks to their suppliers.” Under the first row of rectangles he draws a second. “These are big suppliers. They are increasingly taking on the enormous cost pressure of the manufacturers.” Another row of rectangles appears, this time smaller ones and more of them. “The direct suppliers have to decrease their burden,” he says. “So more and more they look for suppliers that can participate in designing and developing components.” These companies are usually much smaller than their clients, and taking part in an invitation for bids while doing development work represents a huge technical and financial risk for them. They are the companies that Mathias Bihler believes have been waiting for his machine.

Lasers and freedom Although it is still a prototype which is being tested on the industrial floor, Mathias Bihler was able to sell many of

them at the most recent in-house trade show. “But that’s not our way — we only sell integrated systems,” he quickly adds. He explains that his customers were enthusiastic about this machine because of the freedom it gives them. They have the ability to make changes to products at any time during development without having to change punching tools. And they also have the ability to produce new, small series and preproduction series immediately with the changes that will be precisely the same as the later serial product in both design and quality. This flexibility is offered by Bihler at any time.

It is the combination of three technologies that makes this new freedom possible. Bihler technology is the cornerstone with its Bimeric NC forming system and the NC processing modules. The axis system from Itec represents the second technology, which is then used by the third technology, a laser cutting system from TRUMPF. This replaces the mechanical punching module and allows each plate shape to be varied. This design flexibility is retained during the mechanical bending stage, at which point the machine works with bending stamps made of standardized blocks. New tools can be hard-milled or wire-spark eroded over night.



The strip steel on the way to the laser. The Bihler principle applies: Automating the production process from the coil to the machine part.



The data can be used to produce – and vary – any part at any time in any quantity.

As for the suppliers that Mathias Bihler discussed earlier in his office, the design flexibility is not the only thing that matters. “What is important is that you can produce any part from the data,” he says. “Assume you have a customer that wants 10,000 components for test runs in its assembly work. You deliver them almost immediately. The next day they call and want a few changes as well as another 10,000 units. You make the changes and deliver them again, practically overnight. No manual work, no detours through low-wage countries, no quality fluctuations, although you’re probably only a small company with 30, 40 or 100 employees.” And what if the components ultimately are used in volume production and the customer wants millions of units? “Then the existing data can be used at any time to produce the right custom tool for production on a powerful Bihler punching/bending machine.”

Fascination and the future Mathias Bihler sits again at his meeting table. He talks about the lengthy relationship between his company and lasers. In fact, Bihler has at times built lasers. At the end of the 80’s, the founder, Otto Bihler, had the idea that the long, cumbersome resonator could, in fact, be folded. The result was a star-shaped configuration similar to what is used by laser manufacturers today. The company later ended this sideline. Bihler would not have been competitive on a long-term basis with the major manufacturers. But it was worth it, according to Mathias Bihler. “We acquired a lot of expertise which we still use in laser integration today.” The fascination has only grown since that time. “The laser actually fulfills an old dream of engineers.

It immediately gives shape to thoughts. And if you change your mind, you can have your workpiece right away in the new shape.” He leans back: “And that is precisely what this machine can do for our customers in the future.” ■

Contact:

Otto Bihler Maschinenfabrik GmbH & Co. KG, Mathias Bihler,
Telephone: +49 (0) 836 818-0, mathias.bihler@bihler.com

THE FORMING LASER CUTTING SYSTEM

The machine is a joint development by Bihler, Itec and TRUMPF. During the testing configuration, the steel strip from the coil first passes through the laser module at the back of the machine. There the processing head of the laser cuts the plates before the cut “punched strip” is further transferred by the central opening of Bimeric. The bending tools arranged in the front bend the plates over a punch into the finished workpiece. An HL 101 P with 100 W output is used as the beam source. Alternatively a TruDisk 1000 could be used. The beam source also supplies other laser modules through a laser network — such as for welding or cutting the workpieces.

*Mathias Bihler and
the prototype:
The NC drives of
the bending stamps
are shown. The
laser sits in the back.*

Shining Light

By Dr.-Ing. Edgar Willenborg

Laser polishing provides new possibilities and opportunities for automated surface finishing of tools and implants

■ Feel, look, durability, gliding properties, biocompatibility ... The surface condition of many components and products plays an important role for later use. The amount of roughness*, in particular, has a crucial influence on functionality. To achieve the desired properties, the metal processing industry primarily uses laborious and multi-stage grinding and polishing methods with alternating tools and intermediate cleaning steps. Even in a high-tech country like Germany, work is still often done manually. For certain polishing tasks — such as injection mold tools with interior surfaces — there are no suitable machines. But manual polishing is always at risk of damaging the components, which are already associated with high costs and long production times. In addition, manual polishing frequently requires processing times of between 10 and 30 minutes — not for each component, for example, but rather per square centimeter.

It is therefore not surprising that the industry is searching intensely for new methods to automate the polishing of three-dimensional metallic components. In the case of laser polishing, the laser beam remelts a thin edge layer. During the fluid state, any unevenness in the surface is evened out through self-organization as a result of the surface tension. This

polishing method uses a fundamentally different working principle: Instead of abrading material, which is what happens in conventional grinding and polishing, it is remelted.


A distinction is made between two variants for the laser polishing of metals. Macro-polishing eliminates “rough” imperfections like milling grooves, turning grooves or erosion structures. Continuous laser radiation remelts the surface up to a depth of 30 to 80 micrometers. Depending on the substance and the imperfection to be smoothed out, the processing time is between one and three minutes per square centimeter of metal. For micro-polishing, a pulsed laser is used. This reduces the micro roughness and increases the shine of a surface. During micro-polishing, the processing depth is only a few micrometers, so “rough structures” remain intact. Processing time is only 0.02 to 0.2 minutes per square centimeter.

For even test surfaces made of tool steel 1,2343 the roughness of turned surfaces can be reduced by laser polishing from $R_a = 5 \mu\text{m}$ to $R_a < 0.1 \mu\text{m}$. Although this is not a “perfect high shine polish,” this figure is quite adequate for many applications. The particular challenge now is to achieve the results obtained on even surfaces on three-dimensional workpieces, as well. It is not only a matter of refining and optimizing the machine technology but also of developing the process. It is already possible to process simple three-dimensional geometries. For example, test objects were the halves of a glass mold in which the base and stem of wine glasses are manufactured. The tool surface must be polished so that the glasses formed in the mold are then truly shiny, smooth and clear. At the same time, the surface has a complex geometry that is also difficult for machines to reach. Nonetheless, the laser needed 25 minutes to polish an entire mold half. The machine is still programmed by hand. What is required to actually use the process in tool engineering is a computer-aided manufacturing system (CAM). A large number of various applications show the wide-ranging potential

*The amount of roughness describes the smoothness of a surface: R_a describes the mean value of highs and downs.



The laser polishes one half of this glass shape in about 25 minutes.



The laser melts the metal.
The smoothing process
polishes the surface
tension of the melt

Complex geometry and high surface quality: Whenever these two meet, as they do with glass shapes, there is great potential for automated laser polishing.

for laser polishing. For example, in tool and mold construction, there is a great need for automated processes to polish three-dimensional surfaces. Laser polishing with processing times of one to three minutes per square centimeter can significantly reduce production times and costs. Another very promising field of application is the polishing of titanium components in medical technology. Conventional grinding and polishing methods produce minor grooves in titanium and smeared surface defects as a result of subsequent grinding steps. The residue of the grinding agent and other impurities can be deposited here. There is also the subsequent danger that bacteria might inhabit the grooves. By contrast, laser polishing rigidifies the surface from the melt. Therefore, sharp edges, smeared grinding grooves and undercuts do not appear. In addition, titanium and titanium alloys can oftentimes only be polished at great expense using conventional abrasion methods because the material smears — meaning that there is grinding between the tool and workpiece.

But these problems do not even occur in the first place when lasers are used for remelting. On diamond-milled surfaces with a roughness of $R_a = 0.3 \mu\text{m}$, laser polishing achieves a roughness of $R_a \sim 0.1 \mu\text{m}$. Processing time takes three seconds per square centimeter. The advantages described here also benefit many products from the pharmaceutical, food and biotechnology fields.

Ultimately laser polishing gives the user many advantages. The processing of three-dimensional surfaces can also be automated using these methods. Laser polishing achieves high process speeds and high process

reliability while reducing production times and costs. At the same time, it is very flexible in its treatment of various degrees of roughness and shine — even within a surface. In addition, it provides a high local resolution of approximately 100 micrometers, which means that new service surface designs can be generated. The workpiece itself, on the other hand, is hardly stressed because the laser works without contact, thermal entry is minimal and no grinding implements are used. And, finally, there is no grinding or polishing waste, which considerably reduces the environmental impact.

Developments in the field of laser polishing at the Fraunhofer Institute for Laser Technology are currently focused on testing and optimizing the method for processing complex three-dimensional surfaces. A supporting CAM system for laser polishing will be developed for laser polishing based on the Catia V5 CAD program. But reducing roughness will also continue to be a current topic. For all research and development needs, laser polishing can already be used for volume production. But for small batches, the intensive machine programming is a barrier to profitable use. It will take one to three years at most until the appropriate CAM system is in place. Given these developments and the use of the method for additional materials and applications, laser polishing offers new perspectives for industrial production. ■

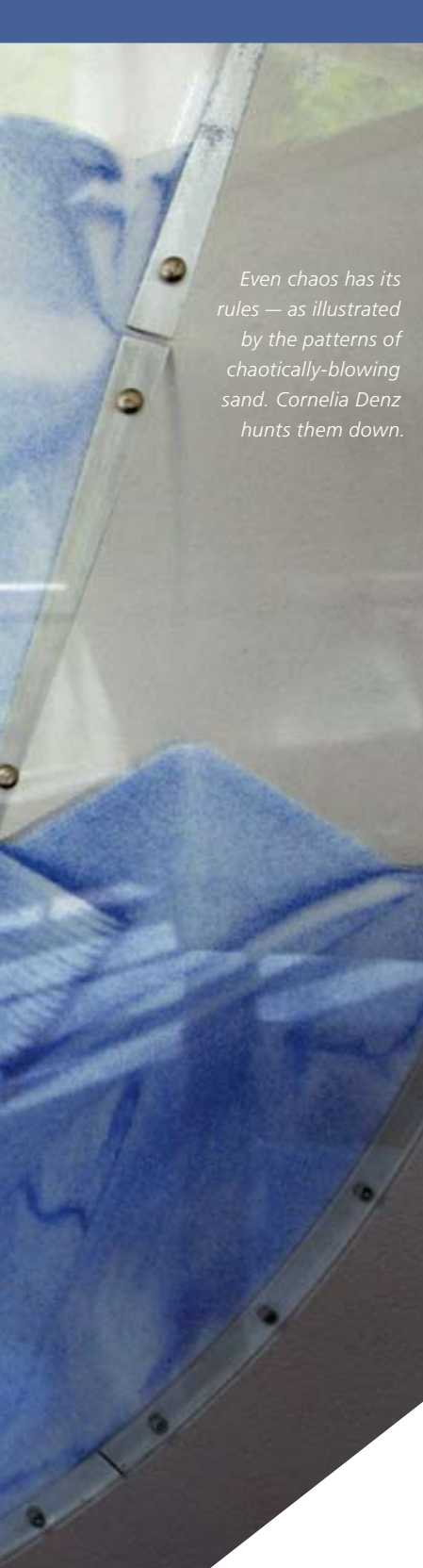
Since 2000, Dr. Edgar Willenborg has worked at the Fraunhofer Institute for Laser Technology (ILT). In 2005, he got his doctorate from RWTH Aachen with the thesis "Polishing tool steels with laser beams." He currently coordinates laser polishing at ILT.

E-Mail to the author: edgar.willenborg@ilt.fraunhofer.de



“It is about
controlling chaos”

Nonlinear systems are sensitive. A bit of energy or a small change make them unpredictable. Prof. Cornelia Denz explains why her research on photonics has value for precisely this reason



Even chaos has its rules — as illustrated by the patterns of chaotically-blowing sand. Cornelia Denz hunts them down.

■ *Prof. Denz, what fascinates you about chaos?*

Chaos occurs everywhere. Quite a lot of systems do not exhibit any linearities. This means that if you add energy to the systems they behave differently from what we would expect. That's true, for example, of cloud formations in the sky, as well as for technical things like a laser beam entering a material. And this range—from explaining nature to exploring possibilities, such as those for technical applications—is what is really fascinating.

But isn't natural science about finding order?

In principle, sure. We want to tame and control chaos to develop new applications.

And you try to do that with the power of light?

Our major goal is to implement new ideas in information processing through nonlinear processes. You can structure materials with light—for example, you can inscribe integrated circuits or wave guides directly with light. Data storage and data security is also a possibility, or the filtering of signals in telecommunications. Another area is biophotonics—light that interacts with biological material. We are developing new microscopy techniques and new techniques for cell research with nonlinear effects.

You are working on holographic storage devices. When will the CD become obsolete and when do we feed our PC data cubes?

Holographic data storage is a paradigm shift compared to previous technologies. Because—as with electronics—you always store serially, meaning point by point (or bit by bit). CDs have only a few megabytes, which is too little data from today's perspective, while for DVDs the densities have increased. You can now store more than 4 Gigabyte. HD-DVD or Blue-ray disks have even greater density and more layers

but the fundamental process is the same. With holography, by contrast, you store the data “all at once” as two-dimensional data sides within the volume of a material. The data information is overlaid with a reference and this overlay is stored. One data side can already hold one megabyte of data. These data sides can then be further overlaid within the volume by encoding the images with simple physical parameters, such as wavelength or writing orientation, which maximizes the use of the storage area.

A simple everyday example is the hologram on debit cards, which now also includes data in addition to the security feature. The trick is that the image is generated in the top material layer. But it is possible to retrieve deeper digital data using a reading device. Digital holographic codes are also planned for product security to prevent fraud and plagiarism.

As a pioneer among women who are involved in the natural sciences, have you encountered many challenges?

I discovered the natural sciences very early on. At school, physics fascinated me as a discipline that explains nature and our origins, which is why I chose to specialize in physics. As a woman, I never felt isolated in my field. But there certainly were times later on in my science career when I had to ask myself whether it was because of my abilities that I wasn't advancing, or because people had less confidence in me as a woman.

Transitions are always difficult. For a doctorate or a position as a university assistant, the competition is so intense that women sometimes have fewer opportunities. And the selection process for a professorship is even more intense. It's frequently the case that women compromise—especially when it comes to family planning—which puts a damper on a very promising career. →

PROFESSOR CORNELIA DENZ

Cornelia Denz researches nonlinear processes and is working to help photonics replace electronics. Her projects include optical data storage and information processing, telecommunications and biophotonics.

As managing director of the Institute for Applied Physics at the Westphalian Wilhelms University of Münster, she heads the “Non-linear Photonics” workgroup and is the spokesperson for the university’s Center for Nonlinear Science. In 1999, Prof. Denz was awarded the science prize from the Adolph Messer Foundation. In 2003, she received the women’s support prize from the WWU Münster for the experimental laboratory MExLab, which introduces students to the fascination of light and nonlinear phenomena.



“Electronics is in fact coming up against its limits with binary logic. Optical systems, on the other hand, can work associatively like our brains.”

But you haven’t let that affect you ...

I always wanted children and a family, so I was quite grateful that my former boss at the Darmstadt Technical University supported me when I was pregnant. Professional results are all that mattered to him. Flexible hours made it possible for things to run smoothly, which encouraged me to have a second child. My husband was very supportive. He took parental leave, which, as you know, has been an option for fathers for many years now.

Based on your personal experience, you now make an effort to attract female students to the field of physics.

Yes, because especially as adolescents, girls have a hard time reconciling their socialization as a woman with their intellectual development. And they are usually associated with language, arts and humanities. They have to find the courage to choose physics. Which is why, as part of the German Federal Ministry’s effort to support girls in MINT professions (Math, IT, Natural Sciences, Technology), we have started a project that will give girls age-appropriate information about the exciting things going on with light,

optics and photonics. With “light up your life,” we want to show girls the role that light plays in life and technology. Younger girls have fun with hands-on activities, while older girls are interested in how physical phenomena relate to their everyday lives.

Could the image of physics be a reason for the fact that so few women are attracted to it?

A lot of people are unaware that male and female physicists work in teams and often on an interdisciplinary basis. The importance of knowing foreign languages is also underestimated. This versatility is actually very attractive to women. But physics is unfortunately associated with being stodgy, isolated and incompatible with having a family.

The future of both male and female physicists, from a professional perspective, is very good in photonics. Ultimately, light seems to be the future while electronics is at its end.

Electronics is in fact coming up against its limits. One example is that our computers all work serially and are based on a binary logic that always has to fit precisely. Our brains on the other

hand work differently, namely associatively. For example I only need to see half of a word or a section from a picture and can fill out the rest. Optical systems are perfect for implementing this principle. In holography, data with the appropriate reference is stored in the material in an encoded form. The reference is the “key” to retrieving data. But I can retrieve the stored data even with incomplete information and receive the most appropriate reference. This enables a fast and effective — in fact associative — data search at the speed of light. Light is not only the fastest information medium but it also transfers data with the greatest capacity. Which is why we say that photonics will determine the future, while established electronics has reached its limits for information processing in the 20th century. Initial efforts are showing that optics is an ideal information medium. But until we have the photonics century, there are still a lot of exciting and interesting questions to answer. ■

Contact: Universität Münster,
Prof. Dr. Cornelia Denz, Phone: +49 (0) 251 83 335-17,
denz@uni-muenster.de, www.uni-muenster.de/Physik.AP/Denz
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“What if the laser
was never invented?”

5 QUESTIONS TO NEIL S. BALL

*“This would be a
tremendous tragedy”*

Which application seemed impossible 10 years ago?

There are many, but I believe breakthroughs in nano applications, such as micro via drilling, that have had a significant impact on the miniaturization of all electronics is impressive. Surface texturing for biocompatibility is also an area for recognition.

What do you wish lasers could do?

Personally, I would like to see more lasers utilized in multiple applications such as cutting and welding combination heads. An excellent example of this type of technology being utilized is at Volkswagen, where one laser head performs cutting and welding on the frame and bumper flange.

What changes in laser technology are the most important to you?

The barriers to market entry are

still high due to cost and complexity of existing technology. However, breakthroughs in disk technology and fiber laser are changing this obstacle.

Do you have any laser technology role models or “idols”?

Many! Albert Einstein, Theodore Maiman, Charles Townes, Gordon Gould, Arthur Schawlow, Helmut Hgel, Friedrich Dausinger, Paul Seiler, Reinhard Ifflander, Klaus Lffler, William Lawson, William Fredrick, William O’Neill, Herman Reedy, Paul Denny, Stan Ream, Jyoti Mazumder, Michael Green, David Belforte ... just to name a few.

Neil Ball is the president of Directed Light Inc., of San Jose, California, which is a laser technology company serving the industrial, medical and scientific laser communities worldwide. He is a member of the Laser Institute of America and is on the Board of Directors; in addition, he holds memberships with the Society of Manufacturing Engineers, American Welding Society, and Fabricators & Manufacturers Association.

More questions to Neil S. Ball:
neil.ball@directedlight.com



Three lasers can make worn-out treasures sound as though they were just bought at the record store.



Gentle scanning

Laser disk players combine vinyl sounds with high-end technology

■ For hi-fi enthusiasts it has nothing to do with nostalgia: There has not been a sophisticated digital technology yet that has approached the sound volume, warmth and transparency of a vinyl record. But, unfortunately, the life of a record is not infinite, even with the best care. The needle abrades the grooves during each rotation and the crackling sound that develops disturbs the listening pleasure. An American, Robert E. Stoddard, has made a dream come true: the reality of playing records without the needle touching the vinyl. His is an optical sound retrieval system that draws out sounds of the purest quality from old, scratched records. Even broken vinyl and shellac treasures that have been glued together again sound as though they were recently pressed. Two guide lasers that detect the left and right shoulders of the

record groove make this possible. The part of the laser beam that reaches the groove is reflected to the two-position sensitive detectors. The signal passes over an analog digital converter to a microprocessor, which guides the servo-motors in the playback head. They position the head directly over the groove. Two other laser beams contact the left and right groove wall and scan an area that contains all the audio information that has never been contacted by a playback needle. The hovering scanner effortlessly buffers external vibrations. However, such a sensitive touch carries with it the price of a small car. In exchange, music lovers are guaranteed the ability to play records as often as they want and enjoy them at recording studio quality. ■

Contact: www.elpj.com

Chip needs laser

EUV lithography is the new challenge for laser technology. That is the only way to keep the semiconductor industry in time with the innovation cycle, says Dr. Akira Endo.

■ Gordon Moore is responsible for the innovation cycle. According to his publication from 1965, the semiconductor industry anticipates a doubling of the number of transistors that can be placed on a chip every 18 to 24 months. The whole industry has arranged its medium and longterm development strategies based on this, and chip manufacturers plan to follow this cycle for the next 20 years.

As a doubling of the integration level minimizes the chips, the industry needs new manufacturing methods. Fast, in fact.

Experts in all large semiconductor companies worldwide agree that in a few years the photolithography used today will not be able to meet the demands anymore. That is why a consortium of nine industrial companies and seven Japanese universities has committed with Moore's Law being the catalyst — to EUV (extreme ultraviolet) lithography. Summed up under the initiative EUVA (Extreme Ultraviolet Lithography System Development Association) and encouraged by the Japanese Ministry of Economy, Trade and Industry (METI), the consortium works on a system that will be ready for the market in 2010.

Simultaneously, the team at Cymer Inc. is conducting research in the U.S. In order to create smaller structures, lithography with extreme ultraviolet (EUV) radiation is proving to be a key to unlocking new market potential. Instead of the "rough" wavelength of 193 nanometers, which is used today, EUV technology works with extremely soft, shortwave x-ray radiation with only 13.5 nanometers. This technological leap brings along a lot of challenges. The extremely short wave length is absorbed almost completely by air, gases and most materials. Due to the high absorption, refractive optics, like lenses, cannot be used. Consequently, completely new

systems in high vacuums and mirror optics have to be employed. This is not an easy task. At processing speed, which is between 0.5 and 2.0 m/s, mask and wafer have to be positioned accurate to nanometers. This is the equivalent of an express train running 200 km/h that had to follow its track accurately to 0.2 mm. The mirrors are a challenge, as well. If you applied the same constraints of evenness, the highest elevation of Germany — keeping in mind the given north-south extension of about 1.000 kilometers — might only be 0.2 cm.

Last, but not least, plasma excitation is a major area of development. Several lasers work as pre-amplifiers for the oscillator; a high-power CO₂ laser with 20 Kilowatt output is one of the main amplifiers, producing a plasma stream out of tin elements with focused laser radiation. The plasma stream has the desired spectrum of 2 percent and the central wave length of 13.5 nanometers. The goal is to produce a plasma stream with 100 Watt output; 90 Watt have already been achieved.

The signals of the SPIE Advanced Lithography Conference, the most important event in the semiconductor lithography industry, and the international EUV Lithography symposium in Sapporo at the beginning of 2008, have impressively proven that EUV lithography has established itself, compared to competing theories, and is the technology of the future. In 2016, two-thirds of the then-approximately 500 semiconductor production facilities worldwide will be working with EUV technology. ■

E-mail to the author:
akira_endo@gigaphoton.com
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Dr. Akira Endo, Chief Development Manager of Gigaphoton Inc.



Where's the laser ?

IN THE DENTURES: Neither a hefty bite into an apple, nor abrasive saliva nor time's ravaging appetite is permitted to affect implants. Dental technicians have discovered the rapid prototyping process of "Selective Laser Melting (SLM)" for the production of implant structures. Based on a three-dimensional digital image of the tooth, the laser welds metallic powder, layer by layer into a form-fitting metal structure. Reworking is no longer necessary. On the contrary, the raw surface of the metal structure is in fact an advantage. The ceramic coating, which makes gray dentures white, adheres better. And that guarantees a long-lasting, gleaming smile — for a long time to come.

10 000 000 000 000 lightbulbs

The strongest laser in the world packs the power of 10 trillion, 100 W lightbulbs into an infrared light that is brighter than a supernova. But it's also just as fleeting. The earthly light radiates into the universe for only one-tenth of a quintillion of a second.

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