

02:07

# Laser *Community*

THE LASER MAGAZINE FROM TRUMPF

WWW.TRUMPF-LASER.COM

## Ironman

Sound Mind, Sound Business

## Insight

Soft Batteries needs Lasers

# Doctor's Tool

Surgical precision cashes in on laser technology

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NOBEL LAUREATE THEODOR W. HÄNSCH:  
**Enjoying Lasers** → Page 24

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# 02:2007

**IMPRINT**



Lasers are being used on an increasing scale throughout industry. More and more users are employing laser technology for more and more applications to handle production tasks effectively and efficiently. New, robust and easy-to-use lasers and laser concepts as presented at the LASER 2007 trade show are promoting this trend. Examples of this include lasers like the TRUMPF TruDisk laser or the new TruPulse series of pulsed solid-state lasers. Never before in the history of laser technology have lasers been so reliable, safe and easy to use as they are today. Concepts and devices from other manufacturers underscore this trend. At the same time, laser users have changed in recent years. In the early years of laser technology, users often had a pioneering spirit like the makers of lasers themselves, but today the willingness to compromise has largely disappeared. The laser has become a “normal” tool and is expected to be as simple, robust and intuitively operated as any other means of production.

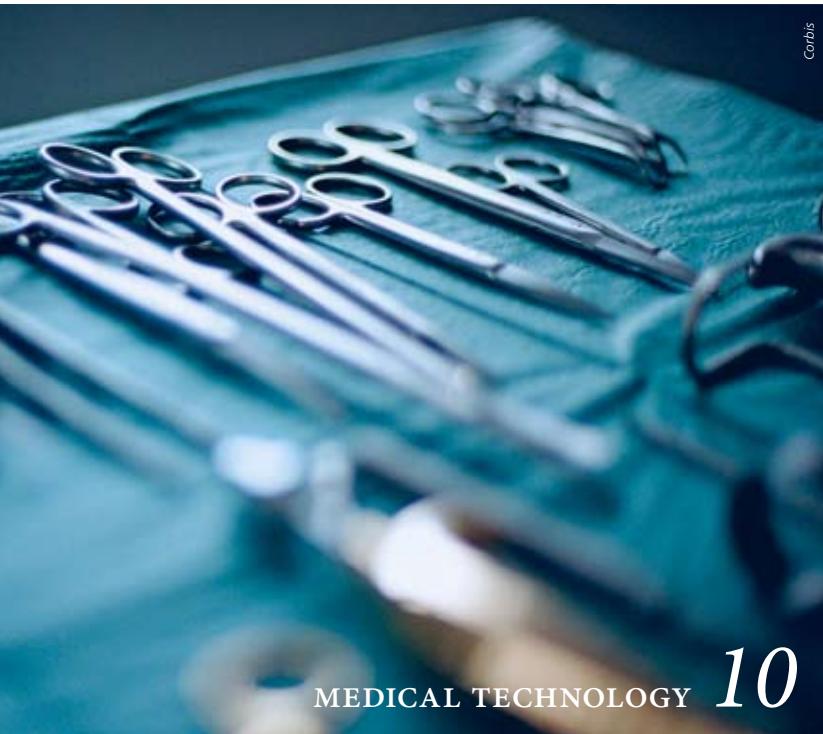
## Technological depth and breadth together!

This brings new challenges for laser manufacturers. On the one hand they are forced to offer a wide product range. After all, customers want the right laser light source for their applications, and a standard laser that masters all applications equally well simply does not exist. The trend is rather moving towards devices customized to specific applications. On the other hand, manufacturers must be at the top of their game in every area and with every type of laser. The market demands that laser companies provide a wide variety of technology on an in-depth scale. At TRUMPF, we welcome this challenge. We will remain the one-stop shop for lasers, offering the right laser for every application.

A handwritten signature in blue ink that reads "Peter Leibinger".

PETER LEIBINGER

Managing Partner of the TRUMPF Group,  
President of the Laser Technology/Electronics Division  
[Peter.Leibinger@de.trumpf.com](mailto:Peter.Leibinger@de.trumpf.com)



Corbis

MEDICAL TECHNOLOGY 10



ThyssenKrupp Steel AG

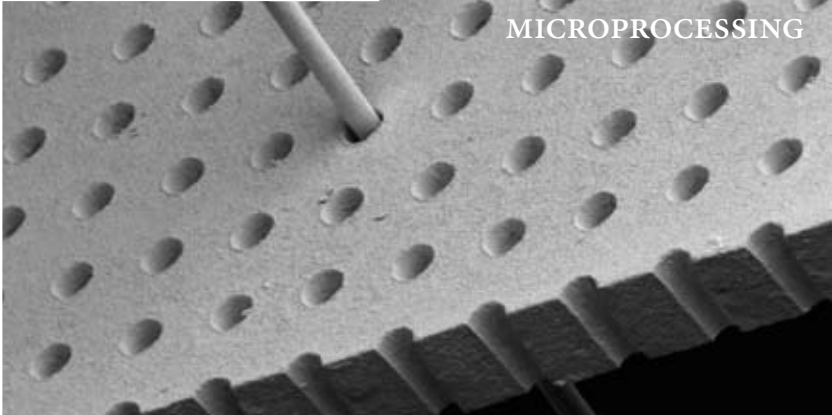
WELDABLE

06-09 WHO-WHAT-WHERE



Thomas Neckermann / Kochbuch, Rundum gen. / Lea Linster

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MICROPROCESSING

## COMMUNITY

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#### Helping Light

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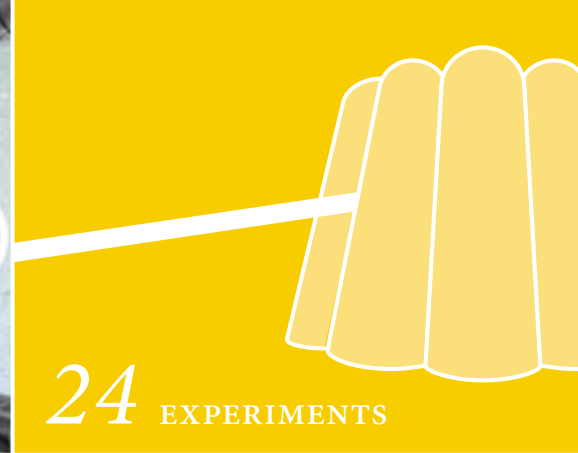
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Renowned chef Lea Linster on the secret  
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## The Joy of Welding

How BMW eliminates screws on the differential gear and gains efficiency and dynamic driving performance. [PAGE 16](#)

“The laser came along at just the right time”

Dominique Ligeois explains why Saft turned to lasers and why he'll never go back. [PAGE 18](#)

## Vrrroooooooooomh

Rolf Eisenmann makes steel play a very special music. Auto freaks love his sound. [PAGE 21](#)

## The First Edible Laser

Nobel Laureate Theodor Hänsch explains how Arthur Schalow and himself invented the edible laser — and why he recalls the toying around with a good conscience. [PAGE 24](#)

## Mr. Laser Australia

Laser research in Australia is a niche — but on a par with international research. Professor Milan Brandt is the man who made that happen. [PAGE 26](#)

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A REWARD FOR YOUR OPINION:

Take part in the reader survey and win a copy of 'The Laser as a Tool'!

## S P O T

### --- OPENING

After three years of construction the new German **Messe Stuttgart** site opened doors with two technology trade shows: the micro and nano technology fair MiNat and the trade show for sheet metal manufacturing Blechexpo. [www.messe-stuttgart.de](http://www.messe-stuttgart.de)

### --- MAJOR CONTRACT

**Hardwear Pty Ltd** announced the signing of a major contract for laser repair of turbines at the **Torrens Island Power Station** in South Australia. The **Swinburne University of Technology's** spin-off is specialized on in-situ repairs. [www.swinburne.edu.au](http://www.swinburne.edu.au)

### --- COATING JOBS

Starting in 2007 the job-shop **Eifeler Lasertechnik GmbH** offers laser cladding using a LASERCELL 1005 with laser powder deposition equipment. The German Eifeler corporate group with locations world wide is a specialist for hard coatings. [www.eifeler.com](http://www.eifeler.com)

### --- DISTINGUISHED PIONEERS

The founders of **Exitech Ltd.** – **Malcolm Gower** and **Phil Rumsby** – received the british **AILU AWARD 2007** for their pioneering efforts in laser material processing with excimer lasers. [www.exitech.co.uk](http://www.exitech.co.uk) [www.ailu.org.uk](http://www.ailu.org.uk)

### --- DESTINATION TURKEY

**ThyssenKrupp Tailored Blanks** built a new plant in West Turkey. Production of laser welded blanks will start in September 2007 and mainly targets the local auto manufacturing. [www.tailored-blanks.com](http://www.tailored-blanks.com)

### --- EXCEPTIONAL ACHIEVEMENTS

**Fraunhofer USA Inc.** will receive the **Merlin Excellence-in-Business-Award 2007**. It is awarded for exceptional achievements in German-American business. [www.fraunhofer.org](http://www.fraunhofer.org)

### --- CHANGE

As of July 1, 2007, **Dr. Michael Mertin** will follow **Alexander von Witzleben** as CEO of the technology group **JENOPTIK AG**. Witzleben will take over responsibilities at the German **Haniel-Group**. [www.jenoptik.com](http://www.jenoptik.com)

“It’s the combination of science and industrial practice, what makes the ‘World of Photonics Congress’ so unique.”

*Chairman of the World of Photonics Congress 2007  
Prof. Peter Loosen*



## The Entire World of Photonics

### World of Photonics Congress 2007 reorganized

It is already unique in the world – the combination of the “**LASER. World of Photonics**” trade show and the “**World of Photonics Congress**” headed by Chairman **Professor Peter Loosen**. Thanks to a reorganization of the congress, participants can now experience all of the current issues in photonics on an even greater scale. Two of the improvements from the reorganization are congress elements that are more directly oriented to applications and a better coordination of the conferences with company trade show exhibits. In addition, visitors can use the web-based databases to directly access more than 1800 contributions to the congress. One highlight of the conference taking place from June 17 to 22 is a lecture by Nobel Laureate **Theodor Hänsch** and **Jan Hall** on the topic of “Frequency Combs and Their Application.” <http://world-of-photonics.net/en/photonics-congress/start>

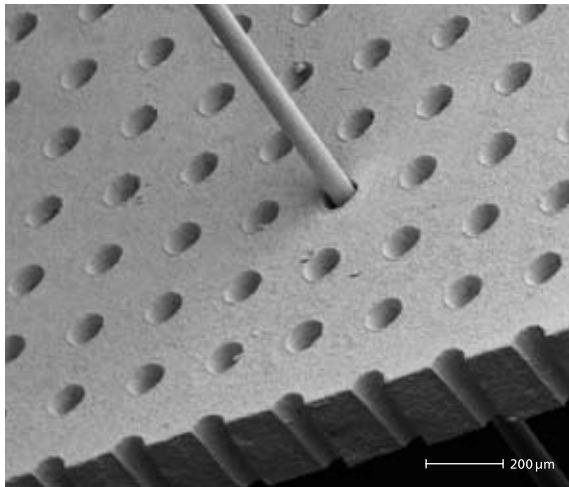
## Farewell to the Inventor

### The laser community mourns the loss of Theodore Maiman



*A short thick rod of ruby and a strong flash lamp made up Maiman's first laser in 1960.*

The inventor of the first laser, **Theodore Maiman**, died on May 5, at the age of 79. Maiman studied electrical engineering at the **University of Colorado** and **Stanford** with **Willis Lamb**, who won the **Nobel Prize** for physics in 1955. Maiman earned his PhD in 1955 – two years after **Charles Townes** invented the first maser, the laser's predecessor generating amplified microwave beams. In May 1960, Maiman made a breakthrough in the development of the laser: He was able to generate pulses of coherent light using a ruby rod irradiated with a flash lamp. In 1984, Maiman received the prestigious **Wolf Prize** for his achievement. In the same year he became a member of the **United States National Inventors Hall of Fame**.



Jeff Albelo, Director, Laser Singulation Solutions Group of ESI, is convinced of the large benefits lasers create in microprocessing.



## “CFO-pleasing ROI”

What is to be expected from laser micro-machining, we asked Jeff Albelo from ESI. Here is why he says to keep an eye on it.

### Why to use lasers in microprocessing?

In wafer scribing and dicing, for instance, they represent the only path forward for true air dielectrics and other ultra-low-k materials. Couple this with the ability to shrink the width of the dicing lanes, and you have a winning combination with CFO-pleasing ROI. Lasers enable very clean material removal. Ultra-short pulse, or so-called, ultra-fast lasers, bring this clean removal technology into the realm of production worthy, cost effective processes capable of supporting large scale manufacturing.

### What are your plans to harvest the potentials?

The potential market for laser micro-machining equipment will be in excess of 100 million US-dollars by 2010. ESI is aggressively pursuing laser and process equipment delivery for this year across multiple industries with a variety of wavelength, power and pulsewidth specifications.

### Which industries are likely to benefit?

Semiconductor manufacturing, consumer electronics packaging and production of TFT LCD televisions/monitors, to name a few. There are opportunities in circuit trimming, medical device production and processing of exotic compound semiconductor substrates and devices. Engineers have developed processes which deliver value at higher yield and throughput than conventional manufacturing processes. While this does not hold true for all products, this application envelope is rapidly growing with increasingly attractive process economics.

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## A Reader's Review

by Reinhard Aumayr

■ I have never found a book that covers the complete field of laser processing so completely and thoroughly as ‘The Laser as a Tool’. At LASER & more, we are hands-on people working with lasers every single day. Quite often we use the book like a reference work on a daily basis: Thanks to a clearly arranged table of contents and excellent layout, all information on a topic can be found quickly without having to refer to technical literature. ‘The Laser as a Tool’ also helps find specific solutions: Ideas that might be helpful for a problem are definitely described there. Of course we have to adapt them to the specific situation at hand – but the important thing is the trigger. Equally impressive is the completeness with which all laser sources are described, including their function. We have even used ‘The Laser as a Tool’ for arguments to convince customers or potential customers. For example, when changing the design allows using the more efficient laser technology. In my opinion, the book ‘The Laser as a Tool’ should be available at every company.



Reinhard Aumayr is the managing partner of LASER & more Edelmetallkomponentenfertigungs GmbH in Austria.

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**Placing orders:** [www.trumpf.com/laser-tool](http://www.trumpf.com/laser-tool)

Also available at book stores — ISBN 978-3-8343-3052-9



## NETWORK NODE

### FORSCHUNGSGESELLSCHAFT FÜR STRAHLWERKZEUGE (FGSW)



■ Ten years ago the German Forschungs-

gesellschaft für Strahlwerkzeuge (FGSW, High-Power Beam Research Incorporation) started its success story in Stuttgart. The nonprofit-corporation since then has developed industrial laser applications for reputable partners in the manufacturing industry together with its commercial subsidiary Technologiegesellschaft für Strahlwerkzeuge (TGSW). Presently the FGSW is researching advanced manufacturing-processes, laser development and the industrial application of integrated components. For these purposes it has access to the wide range of machinery equipment including systems for testing and diagnosis plus the latest laser developments. Currently the FGSW is engaged in the joint research project PROMPTUS of the German Federal Ministry of Education and Research to develop new applications of productive microprocessing with ultra-fast lasers. In addition a diagnostics centre has been installed which allows valuable insights into fast manufacturing processes. [www.fgsw.de](http://www.fgsw.de)

## Quantum Leap

### Power Packs

With advances in epitaxy and cooling in the mid 1990ies diode lasers became economically interesting for high-power applications.

~ 1995

## Open Door for Laser Robots

At Audi, scanner welding is slated for volume production

■ Robots will use laser scanner optics to weld the doors on the successor models of the Audi A4. Four processing cells produce 1800 doors per day. The scanner units are each powered by a 4 kW TRUMPF disk laser. Audi is now the second manufacturer in the VW Group to use the new technology. Starting in 2005, the company qualified the new welding technique in a pilot application on the VW Passat. Developing the clamping technology in particular was a special challenge for engineers trying to introduce laser scanner welding with a robotic arm. As a solution, the Audi experts developed a laser based method of pre-treating the components. This ensures a high weld seam quality despite the zinc coating.



*The exact look of the new Audi A4 is not disclosed. What is certain, however, is that in the future robots with scanner optics will weld 1,800 doors a day for it.*

## Less is more

■ A protective coating against corrosion developed by ThyssenKrupp Steel for fine steel sheets will reduce faults in the laser welding of overlapping sheet metal for automotive manufacturing. ZE-Mg LaserPro is the name of the coating whose zinc layer is only about three micrometers thick. The magnesium guarantees a comparable corrosion protection compared to current standard sheets – despite the zinc layer that is half as thick. With ZE-Mg LaserPro it is possible to weld the overlap joint without a defined joint gap. This simplifies production and process management, while lowering costs. The new coating was tested together with TRUMPF and the improved laser welding properties were affirmed. ThyssenKrupp Steel expects the market launch of ZE-Mg LaserPro to take place in 2010.

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[timo.faath@thyssenkrupp.com](mailto:timo.faath@thyssenkrupp.com)



*Laser-welded overlap joint on zinc-plated volume production sheets (top) and the magnesium coated sheet (bottom)*





*Yongxing Qian, from  
Yanfeng Johnson  
Controls Shanghai:  
"At LASER China  
I found everything that  
I wanted to know."*

## Regional Player

■ Though it was launched only last year, **LASER. World of Photonics China 2007** in Shanghai has already become a regional player with more than 7,000 visitors. We asked **Yongxing Qian**, advanced manufacturing engineer from **Yanfeng Johnson Controls Shanghai**, for his impressions of the event.

### What brought you to **LASER. World of Photonics China 2007**?

We are planning a project that involves laser technology. So I am quite actively looking for information. After all, we want to buy the right technology. This was my first visit to a laser trade show.

### Were your expectations met?

Totally. I found everything that I wanted to know. Laser welding, laser cutting and form hardening – I know all about them now. And I'm sure that I will end up with the right laser for my project.

## WORTH THE TRIP

### K 2007



■ When you offer the global market of plastics and rubber industry within 168,000 square meters, you have the luxury of affording the perhaps shortest tradeshow name in the world: "K" The German **Messe Düsseldorf** will gather about 2,900 exhibitors from every continent under this letter from October 24–31. They range from startups to corporate groups, encompassing everything from raw materials to innovative compounds, from system technology to new processes. And another letter will be playing an increasing role there: "L" as in "Laser." All the more reason for "S" as in "Stop-by."



*EMO: The World of Metalworking,  
[www.emo-hannover.de](http://www.emo-hannover.de)*



*MD & M: Medical Design  
and Manufacturing  
[www.devicelink.com/expo/minn06/](http://www.devicelink.com/expo/minn06/)*



*K: International Trade Fair  
for Plastics and Rubber,  
[www.k-online.de](http://www.k-online.de)*

## C A L E N D A R

### SEMICON WEST

*July 16–20, 2007, San Francisco, CA, USA  
Semiconductor Equipment and Materials  
[www.semi.org/semiconwest](http://www.semi.org/semiconwest)*

### EMO

*Sept. 17–22, 2007, Hannover, Germany*

### ALAC

*Sept. 24–25, 2007, Boston, MA, USA  
Advanced Laser Applications Conference  
& Exposition, [www.alac-iluc.org](http://www.alac-iluc.org)*

### SEMICON EUROPA

*Oct. 9–10, 2007, Stuttgart, Germany  
Semiconductor Equipment and Materials  
[www.semi.org/semiconueuropa](http://www.semi.org/semiconueuropa)*

### MD & M MINNEAPOLIS

*Oct. 17–18, 2007, Minneapolis, MN, USA*

### K

*Oct. 24–31, 2007, Düsseldorf, Germany*

### ICALEO

*Oct. 24–31, 2007, Orlando, FL, USA  
International Congress on Applications of  
Lasers & Electro-Optics, [www.icaleo.org](http://www.icaleo.org)*

### PRODUCTRONICA

*Nov. 13–16, 2007, Munich, Germany  
Trade Show for Electronics Production  
[www.global-electronics.net](http://www.global-electronics.net)*

### COMPAMED

*Nov. 14–16, 2007, Düsseldorf, Germany  
International Trade Fair Components,  
Parts and Raw Materials for Medical  
Manufacturing, [www.compamed.com](http://www.compamed.com)*

### FABTECH INTERNATIONAL & AWS WELDING SHOW

*Nov. 11–14, 2007, Chicago, IL, USA  
North America's largest metal forming,  
fabricating, and welding exposition and  
conference, [www.fmafabtech.com](http://www.fmafabtech.com)*

### EUROMOLD

*Dec. 5–8, 2007, Frankfurt, Germany  
World Fair for Moldmaking and Tooling,  
Design and Application Development  
[www.euromold.com](http://www.euromold.com)*

# Laser Technology Sets

Flexible, precise, reproducible:

Lasers have marked, cut and welded their way to the top of medical technology production.

■ Our health has never been as valuable as it is today. In addition to physician skill and medicine, medical technology is a decisive market factor for health and quality of life. About 11,000 companies and 150,000 people are working on the development and production of medical technology products in Germany. As varied as this industry is with the mostly small companies involved – innovation is the common lifeblood.

According to a study by the German Federal Ministry for Education and Research, German medical technology companies achieve more than half of their sales with products that are less than two years old. According to the 2006/07 annual report from the German Association of Medical Technology, an average of slightly more than seven percent of sales is invested in research and development. By comparison, the research-heavy chemical industry reinvests five percent in R&D while manufacturing reinvests 3.8 percent. According to the German Patent Office in Munich, medical tech-

nology heads the list for filed inventions with more than 14,700 patents, accounting for 11.4 percent of all applications. Next up are communications engineering with 10 percent and data processing with 6.7 percent. The situation is similar internationally. According to a survey of American doctors, technical products were six of the 10 most important medical innovations in the last 30 years.

## Technology for People

Innovative research requires innovative production. This is especially the case in an environment in which technology comes closer to people than any other field: Nothing cuts deeper than surgical instruments. Important implants like the aneurysm clip may look like a paper clip, but when it comes to neurosurgery it's a matter of life or death. And active implants like the pacemaker even become part of the human body. For good reason, the requirements for materials, production quality and process

*The sensitive electronics  
of a pacemaker may not  
be jeopardized by excessive  
heat input during welding  
of the housing.*

# the Pace







Bone Trephine



Nitinol Basket



Spine Implant

## WHAT LASERS CAN DO FOR MEDICAL TECHNOLOGY

### Cutting

- Precise and effortless
- Minimal radii for cut-outs of tubes and hollow parts
- Variable cutting angle
- Thickness ranging from < 0.1 to several millimeters
- Minimal heat influenced zone
- Minimal burr formation

### Welding

- Small spot diameter and narrow seams
- Noncontact and free of forces
- Minimal heat influenced zone
- Free of pores and leak-proof
- Corrosion-resistant
- Biocompatible like the base material
- Intricate contours
- Manual and automated

### Marking

- Durable and indelible
- High temperature sterilization resistant
- Biocompatible like the base material
- Minimal heat input
- Flexible and fast creation of words and images
- Metals and nonmetals
- Finest resolution up to 25 µm

documentation are high, making for a demanding environment for production technology and process planning – perfect for lasers.

Due to its versatility and special abilities, the laser is the best choice as a production tool for cutting, welding and marking medical technology products. “The laser is a pioneer of miniaturization and with minimal focus diameters around 25 micrometers for marking and 10 micrometers for removal and structuring it makes entirely new product designs possible. Even micro-welds on a magnitude of only a few micrometers are possible,” explains Dr. Alexander Knitsch, who is the responsible application manager for the Medical Technology division at TRUMPF. In addition, the laser can be accurately positioned

to about one micrometer – a value that as yet is still theoretical and limited by the mechanical axes and the overall ability of the system. The laser can be accurately adjusted while the heat input can be precisely controlled and adapted to the characteristics of temperature-sensitive materials. The laser’s wide-ranging flexibility is especially useful in the field of instruments, which have a large variety of products, but are needed in small batch sizes. Small units can be produced manually or semiautomatically. For volume production, the laser can be easily automated and integrated in the production line. Quick tooling times and simple transfer of CAD data to the machine control unit increases efficiency. And depending on the requirements and

the existing in-house abilities, turnkey solutions or individual system configurations of specialized integrators are available. Companies like integrator Innovative Laser Technologies Inc. (ILT) in the USA know what medical technology demands and recommend to consider laser options already in the planning process. “The success of the system really begins with the parts, how they are designed, and their joining applications,” explains Steven D. Weiss, co-founder and primary shareholder of ILT.

**Reproducible quality** Lasers work with the proverbial surgical precision. They accomplish their tasks quickly, reliably and the according pulse-to-pulse stability provided, with an



The laser works here: Seam welding and marking on the camera housing of a CCDEndocam and an NN instrument.



Welding of inlets: Multiple seams are welded in a clamp during automatic welding. Hard-to-reach areas on this endoscope can be manually welded.

consistent, reproducible quality. “The greatest advantage of the laser for us is that there is only minimal, if any, reworking of the workpiece necessary”, explains Wolfgang Karl, foreman of the laser department at the German endoscope specialist Karl Storz GmbH & Co. KG. “Using the laser also streamlines processes. We were able to reduce our throughput times by up to 50 percent for certain products,” he continues.

The quality of surfaces processed by lasers is flawless. No grooves, creases, burrs or furrows compromise hygiene. Laser welded seams on endoscope tubes, for example, have an impenetrable, smooth surface and the same biocompatibility as the base material. Filler materials are not necessary as a rule. Laser markings on

instruments like wound spreaders remain immune to high alkaline cleaning and high temperature sterilization with the appropriate set of parameters. The cutting angles on intricate implant systems for bone fractures, for example, have smooth surfaces and edges with minimal burrs. And laser welded spots are very stable: →

“The greatest advantage of the laser is that there is only minimal, if any, reworking of the workpiece.”

Tiny weld spots of only a few micrometers in size on nitinol baskets, for example, can withstand forces up to 70 Newton.

**Aside from the quality** of the individual workpiece, vital components in production are consistency, reproducibility and verifiability. Changing quality and wide-ranging tolerances are excluded from the production of medical technology products; a less-than-perfect pace-maker is inconceivable. Highly developed beam management ensures uniform, reproducible quality from the very first workpiece.

“The success of the system really begins with the design of the part.”

Up-to-date TRUMPF lasers compare the required power with the actual power on a microsecond scale – one million times per second. Every ten microseconds the pulse is regulated. For a pulse length of let’s say five milliseconds, consequently, the pulse formation can be modulated at will. The relevant parameters can be recorded and stored using a quality data storage tool. “With respect to the process quality, the laser has important advantages over other production methods. It works according to clearly defined parameters such as pulse length, pulse duration or pulse repetition rate that can be selected, stored, tested and reproduced at any time,” explains Dr. Knitsch. That’s a property of the laser that will become increasingly more important given the increasing demands of documentation and verifiability. ■

#### Contact:

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*Aggressive cleaning methods can disturb the oxide layers of stainless steel alloys. Corroded laser marking (left) and thanks to the right parameter set intact laser marking (right).*

## No Cause for Concern

Passivation and optimized parameter sets reduce annealing’s susceptibility to corrosion.

■ Whether an instrument or an implant, all medical technology products must be permanently labeled with a suitable marking process and be traceable. Noncontact and low impact annealing with the laser is now an established process: Stainless steel or titanium is heated in situ to below its melting point. This produces colored oxide layers on the workpiece surface. The surface quality remains fully intact; the color change is indelible, resistant to change during sterilization and biocompatible like the base material. The laser light functions without the addition of dyes, acids or solvents, and can even be applied with great accuracy to areas that would have been impossible to reach with other methods. In addition to serial numbers and plain text or data matrix codes, logos and images can also be created. Other advantages include high speeds and the ability to quickly change fonts without taking time for retooling.

**Medical instruments** and implants are often produced from stainless steels with various alloys. Stainless steel contains at least 10.5

percent chromium to obtain sufficient corrosion resistance. This resistance is based on an enrichment of the chromium on the surface, which in turn allows the formation of an oxide layer. High temperature sterilization and aggressive, high alkaline cleaning methods ( $\text{pH} > 10$ ), which is necessary due to the resistance of the Creuzfeldt-Jakob pathogen, for example, can result in disturbances in the oxide layers of the stainless steel alloy.

**Susceptibility to corrosion** and the risk of bleaching around the annealing increase as a result. An interdisciplinary task force made up of members of science and industry, including TRUMPF, has taken on this problem. Among the things tested were passivation methods to improve the corrosion resistance and optimized parameter sets for various laser marking methods. One result were suitable laser parameters for permanent annealing without corrosive tendencies. In addition, passivation after the marking can significantly improve the Cr/Fe ratio, thereby drastically reducing susceptibility to corrosion. ■



# “You don’t need luxury – but quality.”

In the end, it all comes down to materials, tools and passion. Lea Linster confirms.

■ Sometimes a patron will ask me if there is a secret to good cooking. My answer is short and sweet. It’s stitched on the top left of my apron: » ... avec amour «. Love is the most important ingredient in my kitchen. Loving what I do is a prerequisite for the quality that my patrons expect from me. And quality in gastronomy is a matter of attitude. You get the right results only with the right attitude. That’s certainly the case in many professions – but nowhere does quality taste as good as in mine.

**Cooking with love** to me means that I give my patrons my all: passion, joy, knowledge, ability. And a good deal of effort, hard work and attention to detail. But if you want to produce consistent results at the highest level, you can’t rely on talent alone. Top quality can be sustained only if the chef can pass along that inner fire to other team members in the kitchen, in the restaurant, or in the wine cellar. And we shouldn’t leave out the suppliers.

Our team always gives its best in the kitchen – and of course we only accept the best. Because when you’re talking about the quality of “raw materials,” there can’t be any compromising. An example perhaps? Let’s take a dish that we all know and love: chicken. For me a chicken is like a good friend – it never leaves you in the lurch. A good chicken that is lovingly and expertly selected is always best, arriving at the table in top form. If it has been raised under the best conditions from choice stock, then really nothing can go wrong! The only difficulty is getting the right chicken. I’ve solved this problem by having my chickens bred for me specially. They’re awfully spoiled and are given only the best grains and leftovers from my homemade bread. If there are happy chickens in this world, then these are the ones. At least until they reach my kitchen. Then they pass along their good fortune to me and my patrons. The quality of their meat is fantastic, and they taste superb!

Image: Lea Linster



## Hello from the Kitchen

*The daughter of a pastry chef, restaurateur, and overall gourmet, Lea Linster gave up her legal studies following her father's death and took over her parents' restaurant in the village of Frisange in Luxembourg. The family café/restaurant with its gas station, smoke shop and bowling alley became the gourmet restaurant named Lea Linster in 1982. In 1987, Lea Linster received a star in the Michelin Guide for the first time – a distinction she still carries. Only two years later she became the first and so far only woman to win the highest international prize for chefs, the Bocuse d'Or. She has studied under Fredy Girardet, Pierre Troisgros, Joël Robuchon and Paul Bocuse, among others. Lea Linster regularly writes for leading German women's magazine "Brigitte," has published several cookbooks ("Einfach und genial" [Simple and Resourceful], "Rundum genial" [All-Around Resourceful], "Best of Lea Linster") and has her own cooking show on the Saarland State Television Broadcast called "Lea's Joy of Cooking."*

**Do this, do that, leave that alone.** I'm not a fan of strict rules in the kitchen. After all, life has enough rules as it is. But I am very fond of one principle in particular because it is the cornerstone of true culinary delight: You don't need luxury – but quality! ■

**Information:** [www.lealinster.lu](http://www.lealinster.lu)



# The Joy of Welding

The fact that cast iron and steel can be welded with lasers pleases BMW.

The Munich carmaker's new manufacturing saves costs, weight and space on the differential.

■ The technological heart of the BMW Group beats in the north of Munich. The Research and Innovation Center, FIZ for short, is close to the Olympic grounds, the television tower and the main BMW factory. The futuristic complex is considered one of the world's most modern development centers in the automotive industry. Approximately 7,000 engineers, model builders, computer technicians and scientists research and develop new vehicles and technologies here. One innovative project is the creation of laser welding joints to replace the traditional screw connection of the ring gear and differential housing in the rear axle gear. Through an intensive cooperation between FIZ and BMW's Dingolfing plant, under the guidance of mechanical engineer Dr. Tim Angerer, this project was developed for mass production.

**In the axle differential gear** case-hardened steel and cast iron meet – two materials that just a few years ago were considered taboo in welding. The welding processes are much harder to control because the high carbon content in the two components results in cold cracks. But a new laser welding method that adds wire containing nickel now allows

these materials to be joined. The engineers conducted a feasibility study to test the new welding process with respect to durability and distortion in particular. Finally they decided to use this process on the components commonly known as the differential.

Screws are usually used to join the ring gear and differential housing. But the screws take up weight and space. So there was room for improvement. After all, reducing weight, especially for rotating parts, is an important task in the automotive industry. Less weight translates into significant reductions in fuel consumption and CO<sub>2</sub> emissions. "Eliminating the screws is not the only factor reducing costs and weight," explains Dr. Angerer. "There are additional weight and space benefits resulting from the laser-specific design – what you might call a double effect from laser welding. We were also able to improve the efficiency of the axle gear." When they eliminated the screws and the associated high flange with its ribbing, there was a reduction in resistance and turbulence in the transmission oil bath.

Advisers from the TRUMPF Application Center played an important role for BMW during the entire development phase. "Working closely



*(Left) A view on part of the laser welding center with three welding stations for mass production in Dingolfing, Germany.*

*(Center) In three years under the watchful eye of Dr. Tim Angerer, BMW developed a laser weld process of axle differential housing and ring gear for mass production.*



*(Right) Ring gear and housing are automatically pressed together before laser welding.*

“The benefits of a laser-specific design in terms of weight and space are far greater than what we would save by only eliminating the screws.”

together with TRUMPF’s Application Center, we welded the prototypes and defined the initial process parameters. And during the entire development phase we benefited from the laser professionals there, who were always ready to help us out. As a result, we enjoyed the fruits of an ongoing exchange of know-how,” says Dr. Angerer.

Developing the process presented a wide variety of challenges to the engineers in Munich and Dingolfing. Tests were conducted to optimize a range of parameters such as the composition and diameter of the filler wire, weld seam preparation, laser power, focus location and welding speed. The engineers repeatedly subjected the components to stress and quality testing. The welding joint proved to be especially durable. “Until now, we have no way of testing the upper stress limits of our weld seams,” says Dr. Angerer.

**Component production — made in Dingolfing** While the development process was taking place, BMW had already begun planning the plant layout. “Since there were ongoing changes in the process and design of components, we got an early start with the coordination of

process development and plant layout,” remembers Dr. Angerer. “By mid-2005, we were able to order a laser welding center with three automatic loading and unloading devices and three welding stations from TRUMPF. We then put them into operation at the Dingolfing plant in the spring of 2006.” The system allows rear and front gears to be welded in what is called a “chaotic system.” In addition, several steps were integrated such as the cleaning or quality control of the weld seams.

Dr. Angerer calculates that the ROI (return on investment) for development costs will be quickly realized. “We have also acquired expertise that we can use in other applications,” explains the project manager. “The extraordinarily intense collaboration with TRUMPF was worth it to us. It is only within an effective partnership between the user and system supplier that creative, high-tech and economical solutions can be reached.” ■

**Contact:**

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# „The Laser came just in time“

Dominique Ligeois from the French battery manufacturer, Saft, discovered the laser seven years ago. Now he explains how and why the investment has paid off.

*What do you do with lasers, Mr. Ligeois?*

More than seven years ago we bought six lasers with which we weld primarily battery covers and cases. Since this requires great precision, we worked with microplasma welding devices up to that point. But their production speed is relatively low.

*Is that the reason for the switch to laser technology?*

Not only. Plasma technology no longer met our criteria for production speed and quality. In addition, we needed to increase production. TRUMPF came at just the right time. In 1998, we bought the first 2 kW solid-state laser for our production plant in Bordeaux, France. The device, which is equipped with two welding heads, works with time-sharing of the laser power. We were able to weld two different parts on two different stations and optimize the capacity utilization of the laser source. Then seven years ago we started to equip the plant in Poitiers, France. Today two continuous-wave and four pulsed solid-state lasers from TRUMPF are in use in our production there. The laser power for welding lie between 350 watt and 1 kilowatt. Welded materials are

either stainless steel or aluminium. During the refinement of the new generation of lithium-ion aluminium batteries, Saft bought a new laser device with a PFO (Programmable Focusing Optics) from TRUMPF that works with very high power. With this technique, several small parts mounted on a carrier can be welded with enormous precision in one fixture. Another application uses a 1 kilowatt laser working with energy-sharing. It is connected to two welding heads, supplied with each 500 watt, that simultaneously weld two different parts using the same laser light source.

*Doesn't this increased welding power have a negative impact on quality?*

No, on the contrary. Laser technology allows the power to be matched to the materials being processed. In the case of stainless steel for example, 400 Watt are sufficient to obtain a proper weld seam. Welding aluminium, on the other hand, requires at least 1.6 kilowatt of laser power. And it's quite obvious that the laser power must be increased accordingly if you target at higher welding speeds. Laser technology allows us to obtain optimal results regarding weld depth as well as homogenous, perfect and gas tight weld seams. Holes and cracks are avoided by using shielding gas.

*How do you test the weld seam?*

By inspection. We evaluate the process by conducting pressure tests and by making cross sections to measure the weld depth. And of course we check the impermeability. Obviously that cannot be done with all parts. But that's also not necessary. If none of the systems components move, the parts are firmly fixed and the laser welding power is perfectly set, then all parts are the same. Problems are actually very rare in this regard. →

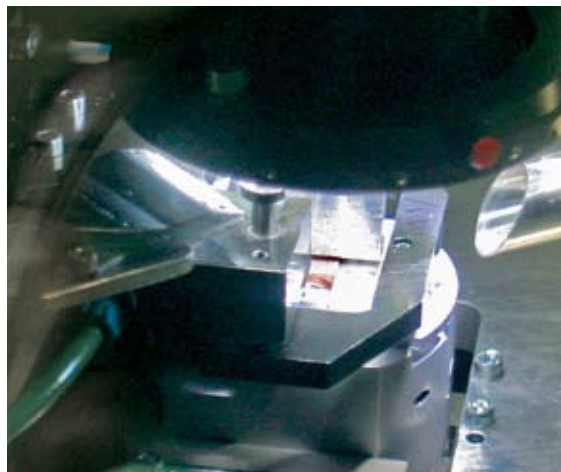


*The machine fleet of Dominique Ligeois, engineering director at Saft in Poitiers, includes a solid-state laser, that welds two different parts at the same time.*

“We then installed a system with programmable scanner optics and high laser power. As a result, we are able to weld several small parts firmly fixed to a single carrier with enormous precision.”



*Lithium cells in production: SAFT produces several million accumulators and batteries each year.*



*Laser technology is a sure thing for Dominique Ligeois. For example, the most recently installed PFO system (right).*

“The depreciation period of our investments is usually one and a half years. So we bank on increasing the production speed to cut costs while maintaining the number of employees.”

*What lifetime do you calculate with for laser and welding heads?*  
The lifespan is unlimited. It's only the lamps for pumping the laser that are exchange parts. We replace them about every 1,200 hours. Since there are no moving parts operating in the devices, there is also no wear or tear. What can happen is a defect in an electronic component.

*What is the legitimization for such a large investment in laser systems?*  
We produce several million parts each year, that is accumulators and batteries. The depreciation period of our investments is usually one and a half year, so we bank on increasing the production speed. This cuts costs while maintaining the number of employees. If you consider the investment cost of lasers then it becomes clear that this can't be the only important factor in our depreciation plan. The overall plan is what counts. Each year we invest about two to three million Euros in new production equipment and to cut-down costs.

*Is there still a need for improvement of the production cycle speed?*  
There is never an end to improvement. With respect to laser technology, using continuous-wave lasers instead of pulsed solid-state lasers allows us to increase the production cycle speed. But then, the rest of the assembly line would also have to speed up... Be that as it may, we will continue to adapt our equipment to market demands step-by-step. ■

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PORTABLE POWER

Saft is an international company specializing in the development and manufacture of high performance high-tech batteries for industry, shipping, aeronautics and the military. Saft is a global leader in the manufacture of nickel-cadmium batteries for industrial applications as well as primary lithium batteries for a wide range of applications. The corporate group is likewise a European market leader in top-level technologies for the defense and aeronautics industries. With around 3,800 employees — of those, 2,000 are working in France — Saft has locations in 18 countries around the world.



*Doing it right, sheet metal  
can turn mere sounds  
into special moments.  
Especially if you hit the  
pedal to the metal ...*



# Vrrrrroouu

Rolf Eisenmann is the virtuoso that makes a special instrument sing:

While the engine delivers the power muffler plays his music.

➤ No, “Eisenmann” isn’t a stage name. Though where he lives, in a smaller town located in the automotive region Stuttgart, Germany, Eisenmann translates to “ironman”. And the name does fit him well: When it comes to metal, the man knows his stuff, and for many of his customers he is a true artist. Rolf Eisenmann produces muffler systems. And within the community of sports car drivers his name roars like thunder. From the dull mumbling vroooooom to the angry rumbling rrrrooooooarr to the husky screeching leaaaaanngghh – the Eisenmann orchestra

“Our 3D laser unit is not only a quantum leap in production, but its mere existence garners the trust of major clients in the automotive industry.”

hits almost every note. A TV show recently called him a “composer of exhaust pipe sounds.” “A great job title,” says the 54 year old, even if it does fall a little short. Educated as a businessman and now a self-made entrepreneur, he is a man of many talents with a passion for problem-solving and amateur racing.

**Thrown off the track** Rolf Eisenmann’s remarkable career began with a serious motorcycle accident. In the late 1960s, the mechanic and successful Junior Cup driver crashed his Kreidler Florett so badly that

of other car brands started showing interest, the market was receptive, and business for exhaust systems began to pick up.

“But then,” says Eisenmann with a wink, “in faith only I made a radical decision.” The young entrepreneur decided overnight that he would no longer build his sports car mufflers using ordinary sheet metal but rather high-grade stainless steel. It was absolutely the right decision for the look and durability of the product, but a qualified disaster for production. His machinery didn’t match with the new material. The punching machine was too weak, the saw failed, and welding also didn’t

# uummmh



for a time he had to switch to a desk job. But he came back to realize his passion for technology and racing in subsequent years as the youngest automotive technician foreman in Baden-Württemberg. He managed a motorcycle department, and finally – at the age of 22 – he became an independent motorcycle dealer, developer, tester and consultant to various Italian manufacturers. “By 1986, motorcycle business had gone flat,” he says, leading Eisenmann to sell his company. He then used the time to reconsider his options: “I had a lot of time, and tested the waters in every direction. Meanwhile, I messed around a bit on my Porsche, and one of the things I did was build my own exhaust system.” The homemade exhaust pipe caught the attention of other Porsche drivers, subsequently giving rise to the first Eisenmann limited series. Drivers

work out as well. But Eisenmann stood by his difficult decision to use stainless steel, swapping out nearly every machine at great expense. So it was perfect timing when a call came from Porsche asking about a possible collaboration – which Eisenmann was receptive to – and an agreement was reached to exhibit a car equipped exclusively with Eisenmann mufflers at the 1995 Frankfurt International Motor Show IAA. And in fact on the very first day of the trade show, more than 100 dealers ordered the exclusive exhaust system. Not a bad start and the collaboration continues to be successful. Artificer Eisenmann made his masterpiece in 1996 by “tuning” the Porsche 996, the sports car makers first water-cooled model. Using a complex, electronic control unit, he gave the right sound to the sports car. His success caught the atten-



*From racer to sound artist.  
Rolf Eisenmann "tunes" sports  
and luxury cars with special  
designed muffler systems.*

tion of other auto makers and he received development contracts for different sports and luxury cars.

**The recipe for success?** Eisenmann's steel-blue eyes focus on his hands: "I call it our closed system: We do everything ourselves – from the initial idea, the drawing of the construction, tool construction and manufacturing, all the way to test charts, sales and distribution." Being a self-made man, he says that his closed system is the only way to remain flexible and fast enough to keep up with the ever-shrinking development times of the automotive industry. In fact, his first laser system entered the picture thanks to enormous industrial demands. "For a long time we tried to get by with stamping, grinding and cutting, but at some point we were ready for lasers. For the cutting of complicated contour lines in our formed parts we only considered a 3D laser system, even if you can't exactly pay for a five-axis unit out of petty cash." The investment seems to have paid off – just 18 months later he ordered the second laser system, another TRUMPF LASERCELL 1005. "The mere existence of 3D systems impresses the major OEMs, which is an enormous boost to the way they perceive us and the confidence they have in our abilities."

**Lots of drive** Rolf Eisenmann is not worried about the future. He has too much faith in himself and his more than 100 employees. In the future he wants to focus more fully on complex engineering and consulting tasks "even outside of my regular activities. After all, I also taught myself the theoretical principles behind acoustics, forming technology and material science." And he intends to place greater emphasis on patent protection for his many developments. "It used to be that I would develop something, and as soon as it was complete I was finished with it." More than one copycat has challenged him over the fruits of his labor. "But you shouldn't worry about missed opportunities. The one focussing on the past too much, has no room for new ideas." ■

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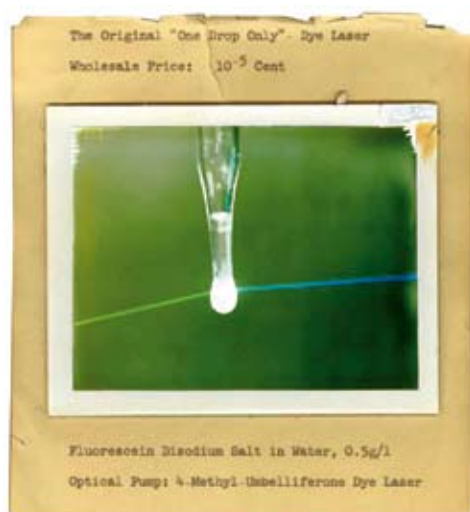
# The first edible laser

By Nobel Laureate Prof. Theodor W. Hänsch

In 1970, Arthur Schawlow and Theodor Hänsch invented the world's first edible laser. This is the story of how, as a young researcher in Schawlow's lab, Hänsch paired his own ingenuity with Schawlow's contagious sense of humor.

■ In early 1971, a short note on the laser action of dyes in gelatin was posted on a number of university and corporate bulletin boards. Highlighted in the body of the note were the words, "... this may well be the first edible laser material." Although to some readers it all may have seemed little more than a frivolous joke, I felt rather proud of my first joint publication with Arthur L. Schawlow of Stanford University, co-inventor of the laser, whose laboratory I had joined as a postdoctoral student and NATO fellow in April 1970. In hindsight, this short paper marked the start of the most exciting period of my 40 years of research in atomic, molecular and optical science.

I had first met Art Schawlow at a summer school in Scotland in 1969, and I was immediately captivated by his warmth and playfulness, his contagious sense of humor and his keen mind. We soon discovered that we shared a passion for clever gadgets. He was sufficiently intrigued by my proposal to let me purchase an AVCO nitrogen laser I had come across during a visit at Charles V. Shank and Herwig Kogelnik at Bell Labs in Holmdel, NJ. This nitrogen pump laser, which was delivered in July 1970, immediately proved an irresistible toy. It emitted superradiant ultraviolet flashes of about ten nanoseconds duration and one millijoules energy at repetition rates up to 100 hertz. Many different laser dyes could be efficiently pumped simply by focusing the rectangular ultraviolet beam with a cylindrical lens to a line inside a glass cell or near the surface of the liquid in a beaker. The dye laser gain was so large that, even without a laser resonator,



The original picture of the "one-drop-only" dye Laser, a precursor of the edible laser.



*Jelly as a  
laser medium?  
The playtime  
actually resulted  
in serious  
applications.*

a collimated beam of amplified spontaneous emission appeared. With a diffraction grating at one end of a simple cavity, the output color could be changed by turning a knob.

**Playing around in the lab** one evening, I focused the blue output beam of a simple dye laser into a drop of sodium fluorescein solution which was dangling from a glass pipette. I felt thrilled when this drop became a dye laser of its own, emitting an intense beam of green light. A cavity had obviously been formed by the reflecting surfaces of the drop. I could not resist taking a picture of this “one-drop-only laser” with a Polaroid camera and posting it at the laboratory door. When Art discovered the picture he studied it for a surprisingly long period, probably because he had spent countless hours explaining to patent lawyers at Bell Labs just what the essential elements of a laser were. After examining the photo for some time, he postulated that “anything will lase if you hit it hard enough!”

To prove his point, he suggested we try to obtain laser action from one of the colorful gelatin desserts popular with children. The next morning he arrived with a packet of 12 different flavors of Knox Jell-O. In our small dark room, we prepared two flavors according to the instructions by adding 16 ounces of hot water to the contents of one bag. We poured the liquid into clear plastic cups, where a colorful gel of normal food consistency formed after several hours. We then took these cups with their wobbly content to the

nitrogen laser and focused the pump light from the top to a narrow line. Although we could see strong fluorescence, we did not observe any laser action. In resignation, Art took the obstinate experiment to his office and savored it as a snack. This ritual was repeated every morning until we had tried all twelve flavors

without success. Not one to give up, Art pointed out that sodium fluorescein is almost non-toxic. So we mixed up some clear gelatin with a small amount of this dye, and we soon had a potent new laser material, although Art no longer insisted on eating it. The gelatin laser medium was rather soft for optical work, but could be cut with a knife into laser rods or other shapes. Later we explored the behavior of other laser dyes in gelatin. For rhodamine dyes we found a significant improvement in performance when we added some kitchen detergent (Pink Lotion Trend) to the mixture to prevent the dimerization of the dye molecules, even though the edibility of the laser medium was thus further compromised. Finally, we also observed dye laser action with some of the Kodak Wratten gelatin color filters

commonly used in many optical laboratories.

Inspired by this work, Kogelnik and Shank at Bell Labs soon realized the first distributed feedback laser with laser dyes in a holographic grating structure of dichromated gelatin, and we felt that our snack experiment at Stanford had actually led to some useful new technology. Distributed feedback has since

**“I refuse to feel guilty about simply enjoying some playtime in the lab.”**

gained much importance with its application to semiconductor lasers.

**Since the frivolous edible laser** experiments at Stanford, I refuse to feel guilty about simply enjoying some playtime in the lab. At the University of Munich, I have even set up my own small toy laboratory, which has done much over the years to help me satisfy my curiosity, invent useful new tricks and preserve the immense sense of joy I experience through my involvement in the world of optical science. ■

Extracted from: Edible Lasers and Other Delights  
of the 1970s, Theodor W. Hänsch, Optics & Photonics News,  
February 2005

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# Mr Laser Australia

Prof. Milan Brandt has put his stamp on laser research Down Under. If it has to do with future industrial applications,

■ An invisible, mythical map spreads across the fifth continent. Australian aborigines used paths called “song lines” to make their way in their expansive land. They used these song lines to find holy places or hidden sources of water.

For about 30 years now, a trail has led through Australia – not as straight as a laser seam but certainly created by the development of lasers. It is a trail that Milan Brandt has blazed while researching new laser applications. Brandt, 54, is something of an institution with respect to lasers Down Under. He has been working with this technology since the 1970s.

Brandt studied physics “because you can look for answers there, you can look for fundamental things.” When his adviser recommended that he study laser physics after his coursework was completed, he didn’t wait long: “There is a lot going on in that field.” While science was preoccupied at the time with the search for suitable materials for building lasers, the young physicist in Sydney developed one of the first white-light lasers. In the early-1980s, research on new lasers was flourishing and Brandt also recognized this fact as he developed a blue-green strontium laser at the Material Research Laboratory for the Australian Ministry of Defense in Melbourne. The national research organization CSIRO showed interest in Brandt, hiring him in 1986 to lead their industrial laser activities. While at CSIRO he established the first Industrial Laser Centre in Australia.

Scientists there were working on industrial applications, and Brandt was their messenger. He introduced companies and technical faculties to the advantages of industrial laser processing. “Many mechanical engineers had never before come into contact with lasers,” he says.

New methods and products were created from these projects together with industrial companies and other universities. One of these projects was a filter-screen used for sugar processing whose holes were made with lasers. “The one square-meter sieves consist of very thin stainless steel containing up to three million holes,” explains Brandt. “The holes must be as uniform as possible, 60 by 1,000 micrometers. Lasers are the ideal tool for this.” Since the 1990s, a start-up named ActionLaser has been marketing the sieves. The company currently has customers in about 20 countries and continues to grow.

**Laser Community** – Laser research – for industrial applications, no less – is only a niche within the world of Australian science. But this didn’t stop Brandt from gradually creating his own community while pursuing research with close ties to industry. “I can get people excited about something,” he says. When Swinburne University in Melbourne created a new task force in 1999 to research industrial applications for high-powered lasers, they brought the





nothing in Australia gets by the Yugoslavia-born scientist.



*He shaped the laser technology on the fifth continent: Milan Brandt*

restless scientist on board. Funding for the new task force at the Industrial Research Institute Swinburne (IRIS) was secured.

Since then, Brandt has developed the IRIS into the largest industrial laser research and development center in Australia. Since 2004, Brandt has also been the director of the IRIS. “I still love to work in the lab and I can operate all the systems there,” he says not without a certain pride. “I’m a hands-on guy.” This was evident in a recent industrial project. Along with his colleagues, Brandt developed a method for laser beam coating to repair power plants’ corroded turbine fans without having to dismantle them. As a result, power plant operators might be able to greatly reduce downtimes during scheduled maintenance. Millions of US-dollars could be saved. A spin-off company called Hardwear involving Swinburne University is now working on marketing the process internationally.

Brandt was born in Yugoslavia, which explains his first name. His last name is German because an ancestor on his father’s side emigrated from Germany to Yugoslavia. Brandt’s father,

a geophysicist, worked for many years on projects abroad, including five years in Uganda with his entire family in tow. “After the time in East Africa, my parents immigrated to Australia in 1971,” says Brandt, who was then 18. After high-school he studied physics at Macquarie University in Sydney and earned his doctorate. At Macquarie University he also met his future wife – a physicist like himself – who works today as a teacher. The two have three children ranging in age from 15 to 21.

Have other research communities tried to use their power to take funding away from the small group of laser researchers? “Never directly, but of course there have been and always will be competition with colleagues in other disciplines,” says Brandt. “The trick is to grow slowly and don’t go hiring people at an uncontrolled rate, because ultimately that isn’t financially feasible.”

Nonetheless, he tried to set up a large laser research center in Australia three times during the 1990s, but those attempts failed due to a lack of financing. Brandt has since put that idea to rest. “The time for monolithic laser research centers is gone. Today the need is for smaller units.” He says this without any regret or resentment. It is no doubt a good thing that he has taken to heart the Australian mindset of easy living. “Easy living means you don’t take things too seriously,” explains Brandt. “There are so many problems out there. If you get attached to them, you’ll become unhappy or even depressed.” He should know. He’s already worked hard on many problems in the world of lasers. ■

**Contact:** Industrial Research Center Swinburne (IRIS), Prof. Milan Brandt, Phone: +61 3 9214 8600, brandt@swin.edu.au, www.swin.edu.au/iris  
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“I’m a hands-on guy. I still love to work in the lab, and I can operate all the systems there.”



**LASER DOWN UNDER**

In Australia, the dominant industrial laser application is two- and three-dimensional laser cutting of metals and nonmetals. In addition, laser engraving and laser beam deposition welding are becoming increasingly important. Laser drilling and welding, on the other hand, are merely niche applications.

**THE IRIS**

Prof. Milan Brandt is director of the Industrial Research Institute Swinburne in Melbourne, Australia, which is the country’s leading facility for applied research and technology transfer. Its areas of research include biotechnology, intelligent production systems, lasers, micro and microwave technology, robotics and noncontact testing methods. Brandt is also the director of laser research.

[www.swin.edu.au/iris](http://www.swin.edu.au/iris)



“Given the situation, the laser was never invented?”

**5 QUESTIONS TO HERMAN REEDY**

*“Lasers have made so many contributions, it’s impossible for me to even consider!”*

*Which laser application seemed impossible ten years ago?*

High speed laser marking of commercial products. Highspeed galvanometer technology and software have resulted in laser marking systems that compete with ink jet marking. Who would have guessed CO<sub>2</sub> laser marking of eggs?

*What is your wish, that lasers should also be able to do?*

For CO<sub>2</sub> lasers to become part of a reliable and economical 13.5 nm light source for production EUV lithography.

*What change in laser technology is for you the most important one?*

It is critical that this valuable knowledge be passed on to the next generation. Laser technology and its manufacturing ap-

plications must become a part of the engineering curriculum in the United States universities.

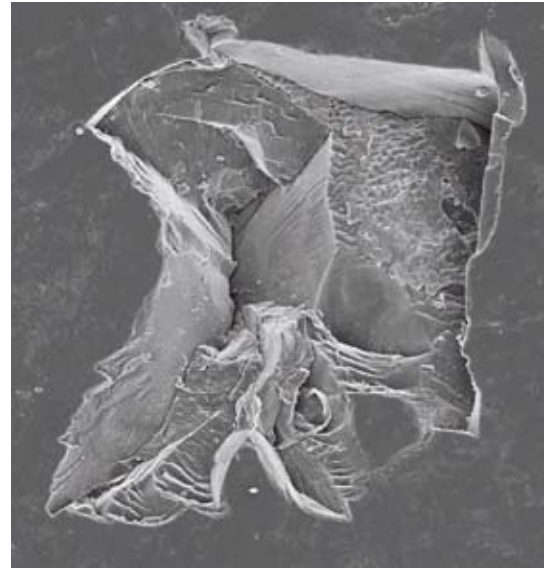
*Do you have any laser technology role models or “idols”?*

I admire the early laser pioneers, like Towns, Maiman, and Patel, and their contributions to the laser development. Also, European and Japanese machine tool manufacturers who recognized its potential. They had the vision to develop the CO<sub>2</sub> laser from a laboratory laser into a rugged industrial workhorse. This has radically changed the way the world manufactures products.

*Herman Reedy graduated in Electrical Engineering at the University of Pittsburgh and was employed by Carnegie Mellon University and Essex International Inc. For 30 years he has been serving II-VI Inc., since 2003 as the Executive Vice President IR Optics. Reedy’s extensive work with CO<sub>2</sub> laser and IR applications in industrial, medical and other fields earned him the Engineering Excellence Award of the Optical Society of America.*

**More questions to Herman Reedy:**  
hreed@ii-vi.com

*Nonslip surface: microscopic view of a single crater.*



## Getting a Grip

**Lasered microstructures ensure nonslip stone floors.**

They look beautiful – but look out when they get wet. The risk of slipping is real. Polished stone surfaces, frequently used in the entryways of public buildings or swimming pools as flooring, are a major hazard when they come into contact with water or dirt. Laser beams can help with this. The solution is a grid of microscopically small craters and pores on the material surface which prevents slipping and keeps the shine to the polished surface. Laser microstructuring allows up to 15,000 pores to be created per second that act like suction cups, increasing the friction between shoes and the floor. The Fraunhofer-Institut für Werkstoff- und Strahltechnik in Dresden, Germany, developed the process in several stages. Quite a challenge, according to engineer Dr. Jan Hauptmann: “High power

is demanded of the beam sources along with excellent focusability.” The success speaks for itself: Four units are currently being used industrially and another mobile one is being used for floors already in place. An important user of the method and supplier of nonslip products is the company Magna Naturstein GmbH in Saxony-Anhalt, Germany. Additional perspectives are being developed because laser micro-structuring is not limited to polished stone floors. It can also be used on glass and plastic surfaces. ■

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# The Original Laser

Laser pioneer Paul Seiler on pulsed solid-state lasers — then and now

■ May 16, 1960. The laser is born. Laser light is generated for the first time. The experiment set-up by Theodore H. Maiman was astonishingly simple: A short, thick ruby rod as an active medium. The end surfaces of the rod, polished coplanar and coated dielectrically, as the resonator. A coiled flash lamp was used for excitation. The first laser developed by Maiman was a pulsed solid-state laser. Its successors



have proven themselves particularly in production technology. Tens of thousands of them do their work around the world on a higher technical level but still based on the same principle. Market expert Dr. Arnold Mayer calculates the global market for these beam sources to be around 150 million euros for 2006.

Maiman's ruby laser could only be operated with minimal pulse repetitions. But the pulse power and energy were already quite considerable: A pulse penetrated through a packet of razor blades. This was no mere game. The number of penetrated razor blades was the relative unit of measurement for the pulse energy because there were no measurement devices at the time. A spectacular use of the ruby laser was in 1969 when the distance to the moon was measured. Neil Armstrong's Apollo 11 crew brought a retro-reflector to the moon for this very purpose.

The first industrial laser applications came about at roughly the same time. But before the laser could be used as a tool, Joseph E. Geusic had to invent the YAG crystal in 1964, which permitted a pulse repetition frequency that was several times that of the ruby. Consequently, the pulsed laser beam, focused on a few tenths of a millimeter, was suitable for small holes and

spot welding in precision engineering. The clock industry was a pioneer in its use.

While Swiss clock makers were intent on drilling the bearing jewels, Carl Haas in the Black Forest town of Schramberg was pursuing another application. The clock industry supplier was specialized in producing flat spiral springs for the oscillating system of mechanical clocks. The connection of the inner end of the spring is crucial to the accuracy. Laser-based spot welding seemed ideal for the company from Schramberg, and so they concentrated on building suitable lasers in 1971. At the time there was no place to buy them. Although automated laser welding of flat spiral springs was a complete success, it did not last for long. The quartz watch displaced its mechanical counterpart. But laser precision welding attracted other industries — especially medical technology and the manufacturers of automotive assemblies. In electronics pulsed lasers achieved a breakthrough in the 1970s with millions of weld spots per day on cathode ray tubes. Although they have been replaced by flat screens for the most part, similar tasks for automated precise and distortion-free joining of small punched and deep-drawn parts have now become a typical application of these lasers. Despite the trend towards diode-pumped beam sources, the flash-lamp-pumped pulsed solid-state lasers are very contemporary. Their use in the production of entertainment and vehicle electronics, medical

technology and precision engineering, as well as in tool and mold making guarantees that they will continue to grow steadily. ■

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*Paul Seiler devoted his work life to the industrial use of lasers.*





# Where is the laser?

**BEHIND THE DRILL HEAD:** While the drill digs deep, sensors in the bar report its progress. This is how the control unit maintains the programmed course of crude oil exploration. Originally, carbide “scale armor” protected the sensitive electronics and control mechanics. But hardfacing by powder deposition welding has now become standard. Lasers are used to deposit layers of various materials, each with its own function. The result is a seamless and nonporous protective coating that is not only easier to apply, but is also extremely corrosion-resistant and wear-proof. In addition, once a layered composition is deemed successful, it can be reproduced at any time.

Up to  
10,000,000,000,000  
Hz

*Terahertz sources operate between microwaves and light in this previously unattainable spectrum. They provide new options, for example, in drug tests or tumor detection: The Terahertz radiation "shines through" people or objects, like this diskette, differently from other radiation. They are generated using infrared lasers.*

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