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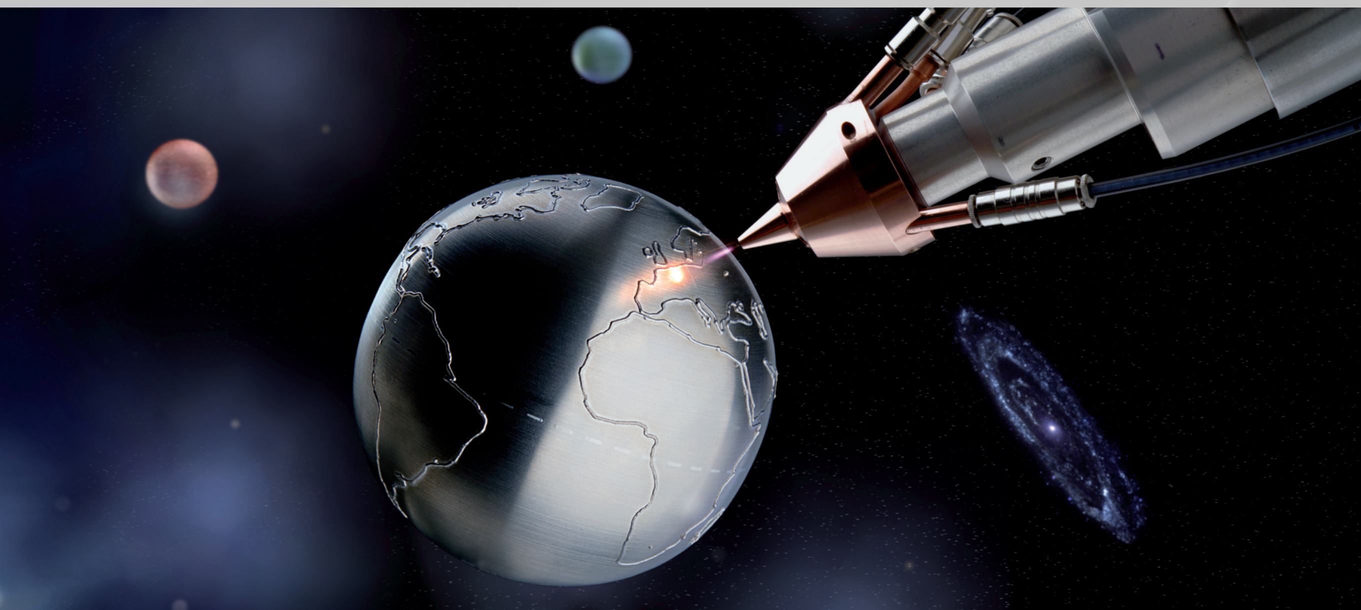
LASER TECHNOLOGY LIVE

AKL'10 PRESENTATIONS

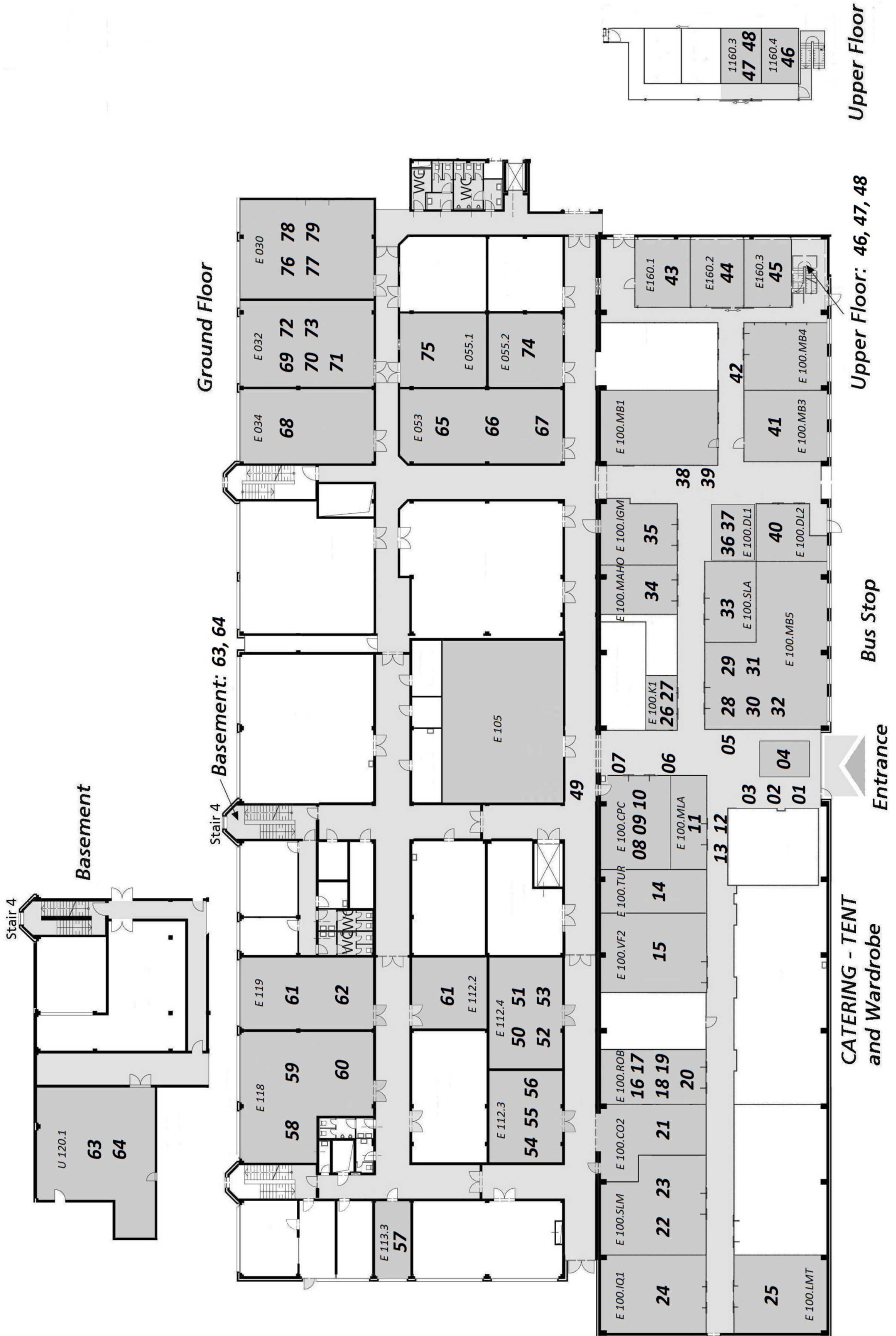


- WEDNESDAY, MAY 5, 2010
  14:30 - 16:30
- FRIDAY, MAY 7, 2010
  14:30 - 17:30

AT FRAUNHOFER ILT
AND APPLICATION CENTER

Fraunhofer
ILT

CONTENT - LASER TECHNOLOGY LIVE



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BOOTH 16

E 100.ROB

Combi-processing Forgives Tolerances

Laser cutting and welding with one tool - combi-processing - leads to more flexibility in short process chains with less equipment and reduced clamping, positioning and handling operations. Since the tool center point (TCP) of the combi-head is identical for both processes, the accuracy in locating the subsequent process relative to the previous process track is significantly increased.
By measuring the workpiece position and geometry with the capacitive distance sensor - possible during cutting operations, a dynamical coordinate correction of the path for subsequent welding and cutting processes can be accomplished. In this way, parts with huge tolerances such as deep-drawn parts, bent components or profiles or unprecisely clamped parts can nevertheless be produced with high accuracy of important geometrical features.
As an example, U-profiles are cut to length, simultaneously gauged and flange plates are joined to the profile by a stake-weld. The path of the weld seam and subsequent cutting operations are positioned according to the measured profile geometry.

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CUTTING

BOOTH 17

E 100.ROB

High Speed Cutting and Welding

Fiber-coupled 1µ lasers achieve cutting speeds in thin sheet metal far above those possible with CO_2 lasers. 1mm thick sheets can be cut with speeds in the range of 100m/min. Highly dynamical machines allow to apply these speeds also in contour cutting. The achievable productivity and quality is better than in remote cutting, considering typical automotive sheet applications. So laser cutting partly substitutes mechanical blanking, that suffers from difficulties in cutting high strength steel grades. Similarly, 2D welding applications profit from high-speed laser processing.
Fraunhofer ILT is building a laboratory machine for enhanced process development and diagnostics of high speed applications. The machine has an accelaration of 4g for processing speeds of up to 300m/min at excellent accuracy. To allow visual access from various perspectives, the processing head remains in a fixed position while the workpiece is moved in X and Y direction on double gantry axes. Thus diagnostics equipment as high speed cameras and detectors can be installed stationary without dynamic load.

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RWTH AACHEN HOUSE
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BOOTH 36

E 100.DL1

High-end Laser Cutting Machine

The latest state-of-the-art in CO_2 laser cutting is visible in the TruLaser 5030 machine from Trumpf. With a single cutting head strategy and a 6kW CO_2 laser source the machine can cut thin and thick materials without changing the cutting head. The machine is installed at Fraunhofer ILT as a business-case within the Cluster of Excellence "Integrative Production Technology for High-Wage Countries" of the RWTH Aachen University. As a first step to the introduction of cognition into laser cutting machines, Fraunhofer ILT develops a self-optimizing laser cutting process automatically adapting the focal position. The control concept is based on optical real-time process diagnostics and a machine-integrated metamodel. In this context Fraunhofer ILT presents the TruLaser 5030 additionally equipped with a coaxial process camera, a real-time LabVIEW controller and an implementation of a first metamodel for analyzing the process condition and defining the target parameters.

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RWTH AACHEN UNIVERSITY HOUSE OF PRODUCTION

BOOTH 18

CUTTING

E 100.ROB

Laser Processing Heads for Cutting and Welding

Laserfact GmbH develops, produces and delivers beam tools for flexible manufacturing with lasers. The aim of Laserfact is the provision of laser processing heads which perform extremely reliably, efficiently and flexibly in industrial laser applications. By using sophisticated optics and nozzle design combined with solid engineering the products of Laserfact achieve optimum performance with striking simplicity in construction, operation and application. Laserfact supplies beam tools for laser cutting and laser welding with CO_2 lasers and solid-state lasers. A speciality of Laserfact are combi-heads for flexible laser cutting and laser welding of sheet metal components without changing heads. A combi-head allows software-controlled process change on demand and with it significant cost savings regarding investment and operation. Among other Laserfact products a new version of the laser combi-head, being specially developed for coaxial mounting on robots and gantries with integrated beam guiding, is presented within a 3D laser gantry of Reis Robotics.

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CUTTING

BOOTH 46

1160.4

Remote Laser Cutting of Metal Sheets with Highly Brilliant Beam Sources

Fine cutting with remote laser processing is particularly interesting as a means to save costs in the production of prototypes and small series, because it offers much greater flexibility and freedom with regard to component geometry than conventional methods such as milling or punching.
Fraunhofer ILT forces the development of remote technologies by showcasing a remote fine cutting system as an example for the successful implementation of its modular process configuration. A suitable optical system with a matching laser beam source is integrated in a machine housing and, if necessary, fitted with additional sensors or a clamping device. The system can be used for inscribing, plastic welding, microstructuring, remote laser cutting or metal welding. In this case a 1kW single mode fiber laser and a mirror scanner, the unit can machine components in the millimeter range at cycle times of less than 100ms. Cuts of 20µm are achieved with suitable optical systems, so that precision parts, such stator sheets for electric motors, can be processed rapidly and accurately.

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JOINING

BOOTH 16

E 100.ROB

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BOOTH 69

JOINING

E 032

Different Process Approaches of Laser Beam Microwelding

In recent years different process approaches and new laser types with high brightness have been developed for the field of laser beam microwelding. The use of SHADOW® with pulsed lasers and the adoption of disc and fiber lasers have rendered intermittent seam welding obsolete. The SHADOW® technology combines the use of pulsed lasers with high speed welding resulting in a low heat input. The heat input can be reduced further by narrowing the weld seam width which can be achieved by the application of disc and fiber lasers with low M^2. In case of lap joints, which are exposed to high mechanical strain, a small laser welded seam may not be able to provide sufficient area to withstand the resulting stress. Theses welds are carried out with a fiber laser using different spatial power modulation techniques. To the linear feed motion an oscillating motion (e.g. a circular path) is added. This significantly improves controllability of the weld depth and the supporting joint area.

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BOOTH 34

JOINING

E 100.MAHO

Fiber Coupled Laser-arc Hybrid Welding in Heavy Section Applications

Fiber coupling technology simplifies the implementation and operation of industrial laser-arc hybrid welding systems significantly. With the availability of double-digit kW powers, disk and fiber lasers have just been introduced e.g. in ship building for highly productive and distortion minimized welding of large steel panels. Compared to CO_2 lasers hitherto established in this field, the shorter wavelength of fiber coupled lasers changes the dynamics of keyhole formation and laser-arc interaction. This leads to changes in process behavior and parameter rules. A simple take-over of CO_2 laser hybrid welding parameters is not sufficient, if a robust process for single-pass heavy section welding is required. Fraunhofer ILT is engaged in various hybrid welding projects in order to improve the process understanding and to enhance the stable application range with the new types of laser sources.

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BOOTH 17

E 100.ROB

High Speed Cutting and Welding

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JOINING

BOOTH 20

E 100.ROB

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BOOTH 04

ENTRANCE

Mercedes E-Class BR212: Joining Technologies

Body in White of the new Mercedes Benz E-Class, BR212, demonstrating the application of different joining technologies in volume production, e.g. laser brazing, laser welding and remote laser welding.

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BOOTH 06

HALLWAY IN FRONT OF E 100.CPC

Multi-Point Contour Control

Advancing laser sources enable manufacturers to weld seams of high quality and at high process velocities. These processes require high degrees of precision and their parameters have to be kept in close limits. The welding velocity is the most important parameter among laser power which has to be held constantly in order to achieve a stable quality of the manufactured products. Only a stable energy input per unit length may ensure a steady quality of the welded seam.
Multi-Point Contour Control enables the user to measure the real velocity, its direction and the resulting contour directly at the Tool Center Point. The Computer Vision System may also indicate the rotation of the welding head and defocused areas.
By comparing the desired contour and welding velocity with the measured data, inaccurate programming can be detected. The awareness of the actual contour helps to adapt the machine’s settings and empowers the manufacturer to increase the quality of welded seams.

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JOINING

BOOTH 70

E 032

Vision Assisted Laser Beam Welding of Electrical Components

Assembly and joining of micro electrical devices implies high positioning accuracy what normally places great demands on handling and clamping of the parts. In order to provide a flexible production technology for such parts the effort for clamping and handling devices must be reduced. Therefore an adaptable production system for different joining tasks is presented. The production system is based on a vision assisted laser welding tool. A CMOS camera is used for work piece observation through a galvanometric scanner. This enables position recognition within a working area of 25mm² with an accuracy < 10µm and real-time process supervision. The processing head is integrated in a conveyor system to enable combination with other processes. For demonstration of the system capabilities leadframes are welded to DCB substrates which are used for assembly of high power electronic devices. The welds are carried out with a fiber laser using different spatial power modulation techniques. Compared to spot welds the controllability of the weld depth is significantly improved.

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SURFACE TREATMENT

BOOTH 35

E 100.IGM

High Speed Laser Metal Depositon HSLMD

In the field of laser metal deposition (LMD) the focus diameter of the powder gas stream of a coaxial powder nozzle is not only important for the powder efficiency but also for cladding with high velocity in a range above 50 metres per minute. Consequently a high powder density is necessary to achieve the desired result. Therefore a new coaxial powder nozzle with a powder gas stream of less than 400µm is developed. At the gantry machine in E100.IGM you can see a coaxial powder nozzle for high speed laser metal depoition in full swing.

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E 100.TUR

Innovation Cluster TurPro

The Fraunhofer ILT works jointly with the Fraunhofer Institute for Production Technology IPT in the Innovation-Cluster »TurPro – Integrative Production Technology for Energy-Efficient Turbo-Engines« at effective and efficient manufacturing and repair concepts for innovative materials. Aim of the work is to develop an integrative process chain for manufacturing and repair processes of turbo-engine components. Part of the ILT is the repair and generation of stationary and flying turbo-engine components by laser cladding. Goals are the laser cladding of difficult and non-weldable superalloys and high-alloy steels, an increasing of the build-up rate for the generation of BLISKs by laser cladding and the development of a continuous process chain for the repair and generating process. For this purpose a demonstration cell, a Trumpf TLC 1005 5-axis laser cladding machine, has been installed. The demonstration shows the build-up of a damaged high-alloy steel turbine blade area by laser cladding, after the material of the damaged area was removed by milling.

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BOOTH 33

SURFACE TREATMENT

E 100.SLA

Laser Metal Deposition with Variable Track Width

During laser metal deposition laser spot sizes have to be changed in order to adapt the process to the component to be treated. Usually, for changing the laser spot size the working distance has to be changed. This means that the Tool Centre Point of the working machine has to be adapted, as well as the powder feeding nozzle distance. A more faster and efficient solution is demonstrated here by the usage of a zoom optic. The lens position can be changed via CNC control and therefore the beam size is varied at the working position. Changes of the beam size during the process are also possible. This enables the cladding of components where a variable spot size is required. In the demonstration a turbine blade tip geometry will be deposited by changing the width of the deposit from 0.6mm to about 2.5mm during the process.

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SURFACE TREATMENT

BOOTH 41

E 100.MB3

Local Heat Treatment of Hot-stamped Ultra-high-strength Steel Parts

Ultra-high-strength steels are widely used in the automotive industry. They allow a reduction of weight and improve crash-behaviour but they do have a reduced formability compared to deep drawing steels. A state of the art process for ultra-high-strength steel parts is hot-stamping of boron alloyed steels, producing fully martensitic microstructures in the final part. Although hot-stamped parts offer fair ultimate strain, higher ultimate strain may be required in critical zones to improve crash behaviour. A way to increase ultimate strain in a desired zone is local softening by laser heat treatment. Non-treated areas retain their strength. The process is temperature controlled, using a fibre-coupled high-power diode laser with a maximum laser power of 10kW and an optics with a rectangular and even intensity distribution.

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SURFACE TREATMENT

BOOTH 11

E 100.MLA

Micro Cladding with Dimensions below 100µm

Due to the miniaturization of products and the need for an economical and ecological use of natural resources, there is an increasing market demand for processes which allow the repair and the selective functionalization of micro parts. Applications can be found in many areas e.g. medical engineering, tool making and electrical industry. By laser cladding using fine powder small volumes below 100µm thickness can be deposited with a high precision. A key factor for the process is the constant powder feeding of powders with a particle size below 20µm.

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BOOTH 15

E 100.VF2

Multi-graded Layers by Laser Cladding for Wear and Corrosion Protection

Laser cladding offers the possibility to combine the advantages of different materials by building up graded material layer by layer. Opposed properties like ductility of the bulk volume in combination with high wear resistance at the surface can be achieved. Multi-layer laser cladding is a technology to produce metal based graded materials. The graded materials are formed in-situ layer by layer with a continuous change of composition of the powder formed additive materials in each layer. Coatings of several layers or bulk volumes can be produced in this way. E.g. wear resistance and fatigue strength require contra dictionary properties like high hardness and ductility which can be achieved by graded material. Potential applications for these materials are die-casting tools and injection moulds which are exposed to conditions like wear, corrosion and thermal cycling.

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BOOTH 63

U120.1

Polishing with Laser Radiation

Polishing with laser radiation is a new method for the automated polishing of 3D surfaces. A thin surface layser is molten and the material flows from the peaks to the valleys. The process is under development for the polishing of tool steels, titanium alloys and glass. The main characteristics are

- High level of automation
- Short machining time especially in comparison to manual polishing
- No pollutive impacts from grinding and polishing wastes and chemicals
- Polishing of grained and micro-structured surfaces without damaging the structures
- Generation of a user-definable and localized surface roughness
- Small micro roughness as the surface solidifies out of the liquid phase

The machine technology as well as examples of laser polished parts from tool and mould making, medical engineering as well as optics will be shown. Progress has been especially achieved for the polishing of 3D surfaces.

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SURFACE TREATMENT

BOOTH 40

E 100.DL2

Powder Feeding Head for Inside Cladding

One key component for laser cladding is the powder feeding head which provides the powder and the shielding gas for the process. The main demands in industry are flexibility, robustness and high powder efficiency. The Fraunhofer ILT has developed various powder feeding heads for several industrial applications. This includes discrete and coaxial powder feed nozzles, a zoom optic which allows a flexible change of track width (together with Reis Lasertechnik) and processing heads with integrated optic and powder feeding for cladding of inner surfaces (together with Pallas Oberflächentechnik). The design allows the cladding of inner surfaces starting from either 25mm or 50mm diameter upwards. In this demonstration the inside cladding of tubes will be shown.

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SURFACE TREATMENT

BOOTH 64

U120.1

Structuring of Design Surfaces by Laser Remelting

The surface of a part or product strongly influences its properties and functions, like abrasion resistance, haptics as well as the visual impression. Therefore, many plastic parts have structured surfaces such as leather textures on car dashboards. Usually these structures are manufactured in the injection mould by photochemical etching which is a time consuming and expensive process. A totally new approach to structuring metallic surfaces with laser radiation is structuring by remelting. In this process no material is removed but reallocated while molten. The innovation of structuring by remelting is the totally new active principle (remelting) in comparison to the conventional structuring by photochemical etching or the structuring by laser ablation (removal). The advantages of structuring by laser remelting are up to 10 times shorter processing times compared to laser ablation, the avoidance of post processing steps and the possibility of totally new surface appearances with multiple gloss levels.

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E 160.3

Drilling with Laser Radiation

Laser drilling enables the machining of different materials like steel, high-strength materials, multi layer systems, ceramics and plastics with high reproducibility and productivity. It offers an alternative manufacturing method to mechanical drilling, electric discharge machining (EDM), electro chemical machining as well as electron beam drilling.
Laser drilling is applicable for many manufacturing demands in industry due to the small achievable hole diameters, the high flexibility (e. g. different diameters and inclination angles) and the large attainable aspect ratios. A short cycle time and low production costs can be realized by the short drilling duration and "on the fly" machining. Especially for the manufacturing of cooling holes in turbo engines parts drilling with laser radiation allows to machine multilayer systems (e. g. substrate, bond coat and thermal barrier coating) at acute inclination angles.

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BOOTH 44

DRILLING

E 160.2

Helical Drilling Optics

For many high grade applications, i.g. in the fields of power and drive engineering, for automotive and microfluidic applications, filter technology or the production of textile fibres, high-precision drillings with large aspect ratios and exceedingly good surface quality are required. For these applications precise and round holes with diameters in the range from 40 up to 300µm with defined taper are needed.
Using short- or ultrashort pulse lasers to fabricate these holes by percussion drilling has the disadvantage that the laser beam quality has to be very high as the profile of the beam is mapped onto the cross section of the hole. By using the helical drilling technique, where the beam is rotated in itself, this problem is overcome and precise round holes can be drilled. Also, the taper of the holes can be adjusted.
The helical drilling optics is implemented in a precise positioning system. Therefore it is possible to drill any hole patterns with different programmable diameter and taper at a positioning tolerance of < 10µm.

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DRILLING

BOOTH 26

E 100.K1

High Rate Percussion Drilling of Silicon Wafers for EWT Solar Cells

The research and development in the field of solar cells for terrestrial applications is focusing on lowering production costs. The conventional way of interconnecting cells by soldering highly conductive tabs to the front and rear of neighbouring cells is however nearing the limit of what is possible in terms of cell efficiency. A different approach to contacting the cells is placing both negative and positive terminal to their rear surface. One back contact cell concept is called emitter wrap-through. Here, several thousands of through-holes are drilled through the wafer. In a subsequent step the emitter is diffused through these holes to form the contact regions on the rear side. Up to 1 hole per mm² is needed to achieve suitable series resistance values, resulting in up to 25,000 holes per wafer. The system shown in this demonstration uses a Rofin Stardisc, emitting at 1030nm, which is capable of drilling vias with 4 to 6 pulses of a pulse energy in the range of 4mJ and a pulse length of µs. The drilling speed is in the range of 2500 vias per second.

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DRILLING

BOOTH 47

1160.3

Transparent Metal - High Speed Laser Micro Drilling

Filters, nozzles and membranes are a key component for many products not only in medicine- and bio-technology but also in the fields of mechanical and automotive engineering. These applications require holes with diameters smaller than 30µm and drilling rates of more than 1000 holes per second which cannot be met by conventional drilling methods.
Due to an adapted laser drilling method with a scanning system a special machining strategy for high speed laser micro drilling of metal foils was developed. The arrangement of the holes and the drilling strategy of the single holes can be adapted very fast by a CAD-CAM coupling and therefore easily adapted to the customer demands.
It has been shown that micro holes can be drilled in up to 100µm thick metal foils with diameters of 30µm down to less than 5µm by drilling rates of up to several 1000 holes per second.

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E 030

Absorber-free Laser Beam Welding of Transparent Thermoplastics

While laser welding of polymers is used in many industrial applications, an infrared absorber is usually required for laser transmission welding. However, absorber-free laser beam welding can be utilized in a large number of applications primarily in medical device technology or in high-tech products.
Successful welding without an IR absorber is primarily attributed to the availability of new laser sources at specialized wavelengths. Analysis of the absorption spectra of polymer compounds shows particular wavelength ranges at which sufficient IR absorption occurs to enable welding. To generate a heat source in the joining area, the intensity distribution and the wavelength of the laser must be aligned to the absorption characteristics of the polymer compound. The usage of special optics with high numerical aperture keeps the laser intensity on top of the material and below the melting threshold. Only in the welding area does the intensity reach the necessary value to determine the welding of the transparent components.

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E 030

Compact Turn Key System for Microwelding of Plastics and Electrical Contacts

Direct diode lasers are now available with sufficient brightness and power to effectively perform microwelding and plastic bonding. The short wavelength in the range of 800nm to 1,000nm is much better absorbed by highly reflective metals, such as copper or gold. This enables efficient pulsed welding of electrical contacts.
A compact turn key system with a 100W diode laser and scanner will be presented. The footprint of the table top system is 25cm by 25cm to include the laser safe enclosure. Sample welding of plastics and thin metals will be performed. The system operates on 220V and does not require any water cooling.

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BOOTH 71

E 032

Glass Soldering by Laser Radiation

In industrial manufacturing glass solders are mainly applied in electro technology and electronics especially for the closure of electrode feedthrough and housing. The durability and the mechanical load of a glass solder joint depends on the mechanical stresses. Because of the problems with mechanical stresses the most joining processes require a temperature-time-profile which causes a thermal impact for the whole componentry. Often the required temperature sequence damages sensible components inside the housing by diffusion processes. Thus a soldering technology which works with reduced temperature input and a local heating is needed.
Glass soldering by laser radiation is an alternative to reduce the thermal input because of the localised energy absorption. The absorption of the laser radiation by the glass solder is an essential condition for a successful soldering process. This requirement is also performed by leadfree solders recently. By absorption the laser radiation the necessary temperature for a constant heating, melting and crack free soldering is achieved.

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MICRO TECHNOLOGY

BOOTH 57

E 113.3

High Speed Micro Structuring by In-volume Selective Laser Etching

High speed 3D micro structuring of transparent materials is possible by in-volume selective laser etching (ISLE). Using high repetition rate lasers like fs fiber lasers and high power slab amplifiers productive 3D modification is possible with sub micrometer precision. The modified material is selectively removed by wet chemical etching. Micro channels, 3D micro parts and shaped micro holes in glass and sapphire are demonstrated. High power fs-laser radiation (100W) is used to demonstrate the scaling of the ISLE process.

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Laser Soldering for Flexible Interconnection of Self-Bonding Copper Wires

Currently, the interconnection of self-bonding copper wires is soldered manually for electronic products due to a lack of automation facilities. The quality of the solder connection strongly depends upon the person conducting it. This method is not only time consuming, but also harbors a danger: the section of wire to be connected can tear when very thin self-bonding wires, e.g. < 100µm, are used, or a sound electrical interconnection cannot be established. To increase the process speed and reproducibility, an automated laser soldering process has been developed that not only enhances the manufacturing flexibility, but also offers great potential for further miniaturization. With this process, the enamel removal and the interconnection take place in one single process step. By using cost-effective diode laser systems this soldering process is even economically worthwhile compared to competing selective soldering processes.

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Laser Transmission Bonding

In the fabrication of hybrid micro-devices and systems consisting of different single components silicon is usually used as a base material. Conventionally these components are joined by bonding methods such as Silicon Direct Bonding and Anodic Bonding. The disadvantages of these joining methods are causing a high thermal stress and using the entire bond surface. As an alternative to these conventional areal bonding methods laser transmission bonding offers an unique opportunity to realize continuous selective bonding through a localized application. The exact energy deposition minimizes the heat affected zone and the thermal load of sensitive components can be reduced. Furthermore a locally selective joining is enabled. In addition to bonding dissimilar material combinations like silicon-glass, laser transmission bonding can also be applied to join similar material combinations like silicon-silicon and glass-glass. Thereby the laser energy is absorbed by a metallic interlayer in the joining zone.

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BOOTH 27

E 100.K1

Microstructuring with Excimer Lasers

Microstructuring with excimer lasers is particularly interesting for patterning organic materials like plastics or bio tissues. Due to the short wavelengths in the deep UV-range and the extremly high absorption of most organic materials, a very clean ablation is realized with excimer lasers. At optimized parameters thermal effects can be neglected. Excimer lasers have a high beam diameter and a tophead profile. Therefore, they are often used in mask projection setups, enabling to micropattern a relatively large area. By using masks with respectively small apertures, the setup can be used to drill holes with diameters of less than 5µm. The ablation depth per pulse can be easily adjusted by varying the fluence. Ablation depths of 100nm per pulse can be realized, allowing a very acurate patterning.
Patterning with excimer lasers is a rather slow process, due to small repetition rates of often only 200Hz. The excimer laser used here stands out with its high repetition rate of 2kHz.

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MICRO TECHNOLOGY

BOOTH 43

E 160.1

Tool Generation and Modification by Ablation with Ps-lasers

Complex replication tools for injection moulding or hot embossing are produced by generating the ablation geometry in a 3D-CAD-model and slicing the material with sclices of less than 1µm thickness. Especially with picosecond lasers, the accuracies of the laser ablation can be dramatically increased. Due to the very high pulse powers, the material is ablated only by vaporization and there is almost no residual melting layer on the surface. With this technology the slicing thickness can be reduced to several 100nm and therefore highly accurate moulding tools can be produced.

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UNIVERSITY OF PRODUCTION

BOOTH 78

E 030

TWIST® - New Process and SystemTechnlogy for the Laser Welding of Bio-medical Products

The development of new laser sources with almost ideal beam quality e.g. fiber lasers and disc lasers is bringing new opportunities for the laser welding of polymers. The latest research results show that using a recently developed welding method called TWIST® – Transmission Welding by an Incremental Scanning Technique and taking advantage of the high focusability of these laser sources, high quality weld seams at high processing speed can be achieved. Beside the process related benefits, the TWIST® approach enables the development of a new generation of compact and cost effective laser systems for the welding of polymers. Due to very high beam quality, the necessary optical equipment like scanner and focusing device can be miniaturized while keeping the ability to achive spot sizes down to several 10µm. Therefore, the new TWIST® process and the corresponding welding station developed provide higher process flexibility and precision for various bio-medical products such as Microfluidics.

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MODELING AND SIMULATION

BOOTH 49

HALLWAY IN FRONT OF E 105

Computational Photonics Engineering

When dealing with laser radiation in the field of material processing, laser measurement applications or in developing laser sources one is always faced with the problem of beam guiding and shaping. For the proper design of optical components and systems the use of numerical tools is most often inevitable. In some cases it is sufficient to treat the laser radiation in the geometrical limit taking laser beams as light rays. But often the coherence and small transverse dimensions of the laser beams make it necessary to consider the wave nature of laser radiation. Basically this means to solve Maxwell equations in some approximate form. The most widely used approximation is the paraxial approximation that leads to the solution of the Fresnel integral or equivalently the SVE-approximation of the Helmholtz equation. For wide angle beam propagation as is for example the case with high NA focusing other numerical methods have to be employed.

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BOOTH 38

HALLWAY IN FRONT OF E 100.MB1

Interactive 3D-Process Simulation for Laser Cutting

Laser cutting is an industrially established production technology. Nevertheless there is a great influence of dynamical processes on production quality regarding high cutting speeds assuring efficient facility utilization as well as for low cutting speeds, which are used to cut contures accurately.
For finding suitable control directives experimental diagnosis is found to be crucial. Physical modeling is therefore always based on experimental evidence.
Quality features such as surface roughness or adherent dross are caused by the dynamics of the process. The various process states and characteristic phenomena (e.g. evaporation, drop formation, gas flow) are visualized in a process simulation and have been experimentally validated.
The process simulation reproduces experimental details, observed by the diagnostic system and makes it possible to retrieve possible strategies to avoid defects like adherent dross.

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MODELING AND SIMULATION

BOOTH 42

HALLWAY IN FRONT OF E 100.MB4

Modeling and Simulation of Laser Keyhole Welding

Laser welding is a well established production technology, which in the industrial application is rated by productivity and product quality. Nevertheless there seems to be still a certain potential for a design optimization based on physical modeling and numerical simulation. The extension of suitable process domains by a modified process control is therefore based on a fundamental understanding of the physical processes occurring in laser welding applications.
An interactive process simulation for laser welding applications based on an approximative model has been developed, which resolves the form of the welding capillary and gives the dimensions of the weld pool in axial and azimuthal direction. Whereas commercial tools for laser welding model a fictitious heat source according to experimental data like metallographic cross-sections, the process simulation gets the weld pool dimensions from the underlying physical processes like the diffusion of heat and the fresnel absorption on the capillary surface. It has been validated against experimental data.

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E 100.MB5

S&F System Technology - Commissionings and Laser Machines

The enterprise S&F Systemtechnik GmbH is a spin-off from the Fraunhofer ILT, being founded in 2001. Programming of system kernels is the key competence. As a result of rising requirements of our industrial customers we now perform tasks in the domain of modernizing (Retrofit) and developing solutions for IPC, NC and PLC based automation systems. Furthermore, we offer components and complete machines for laser materials processing. Productivity, usability and flexibility come to the fore. The enterprise introduces at AKL'10 its business areas "Commissioning", "Retrofit" and "Machines for innovative laser processing". Examples, references and work samples of several carried out projects are presented. It is planned to show the following exhibits:

• an arbitrary robot performing automation jobs
• a laser machine for laser cladding
• automation components an services
• our network and partners

Furthermore a presentation will give additional impressions concerning fields of work, know-how and expertise.

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BOOTH 19

SENSOR TECHNOLOGY

E 100.ROB

Demonstration of Active Laser Safety System Laser-Spy for Brilliant High Power Laser Sources

This experiment is designed to point out the inherent safety risks for machinery and operators when using brilliant high power laser sources and the solution to minimise these risks. The active Laser-Spy sensor monitors the inside of a light tight double walled housing element and shuts down laser operation upon intrusion of radiation into this housing element prior to breach of the outer wall. The demonstration set-up includes an additional sensor system to measure the time it takes the laser to penetrate the inner wall in comparison to the actual Laser-Spy reaction time.

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E 100.CPC

Laserbrazing

The setup of coaxially integrated quality control system for laser brazing is exposed. Two cameras are observing the process in different spectral regions. The first camera collects the reflected light of an external illumination while a second camera records the near-infrared spectral region. Hence, a real image and a distribution of the thermal radiation are generated. With the combined analysis of these two images it is possible to measure process parameters like brazing velocity, brazing time and process geometry. Moreover seam imperfections like pores, surface quality and the wetting behaviour of the joint can be detected while their emergence. As an additional time and money consuming off-line inspections is avoided by this system it is a useful application for industry where demands on seam quality are very high, e. g. in the automotive sector. The presented system provides the opportunity to control the quality of the seam during the brazing process. Results and film material of a brazing process are shown in a presentation.

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SENSOR TECHNOLOGY

BOOTH 09

E 100.CPC

Measurement of the Powder Density Distribution for Powder Feed Nozzles

The Laser Metal Deposition has established as a technology for functionalization of surfaces, repair and modification of components as well as generation of new parts. The most important field of application is the manufacturing of tools and combustion engines, stationary gas turbines and aero engines. At the laser cladding process a filler material in form of a powder is melted using the laser beam and fused with the base material. Therefore the powder feeding into the melt pool is an important influencing variable for the result of the process. The powder efficiency, the oxidation by the ambient atmosphere and the roughness of the cladded layer are influenced by this parameter. For this reason there is a need for a characterization of the powder-gas-flow to assure the quality of the processing result. As a solution a measurement method has been developed that allows to scan the powder density distribution of the entire powder-gas-flow.

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BOOTH 07

E 100.CPC

Monitoring the Melt Pool Geometry at Laser Cladding

Laser cladding is used almost exclusively on complex geometries, durable and high-valued components, e.g. for stationary gas turbines and aero engines. These parts have to fulfill high safety standards and very high quality and documentation requirements. Understandably, process documentation, monitoring and control methods play an important role here. The CPC system (Coaxial Process Control) developed at the Fraunhofer ILT/LLT is adapted to the cladding process combined with a process illumination by High-Power LEDs. The aim is to extract quality-relevant process information in-situ whilst laser processing by monitoring the melt pool geometry as a robust process parameter. This information should interrupt defective processes in time to initiate corrective processing strategies, and fulfilling the relevant quality assurance documentation requirements (DIN ISO 9000 ff., VDA 6.1), e.g. for safety-relevant components.

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SENSOR TECHNOLOGY

BOOTH 29

E 100.MB5

Process Monitoring and Control during Hybrid Laser-arc Welding

In current manufacturing, conventional arc welding processes, such as MIG/MAG and submerged arc welding, are mainly used to produce joints of metal sheets over a wide range of materials and wall thicknesses. Yet the manufacturers are facing problems like a low productivity and reliance on the skill of operators to change process parameters to maintain weld quality, particularly during changeovers, i.e., when material and/or wall thickness is changed. Hybrid laser-arc welding offers many advantages compared with conventional arc or laser welding. Producing deep penetration welds comparable with laser welds, and at the same time having an improved tolerance to joint fit-up when compared with laser welding. The coupling of the two processes - laser and electric arc welding – leads to an increased number of parameters and degrees of freedom, respectively. In the presented work a camera based coaxial monitoring system is employed to achieve controlled conditions for laser MIG/MAG hybrid welding processes.

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SENSOR TECHNOLOGY

BOOTH 37

E 100.DL1

Process Observation in CO_2 Laser Beam Cutting

Trumpf Trulas 5030 is one of the fastest Flat-Bed Laser Beam Cutting Machines currently available. As part of the Cluster of Excellence at RWTH Aachen University, ICD D2.1 "Technology Enablers for embedding Cognition and Self-Optimisation into Production Systems", this machine was equipped with an optical sensor system that allows live observation of the process. A high-speed camera system coaxially coupled with the processing beam monitors the 2 millimetre interaction zone while the machine moves the processing unit at 200 metres per minute accelerating with 2g.
Current works focus on strategies to analyse the acquired data in process to enable Self-Optimisation of the machine. Together with the Fraunhofer ILT and NLD, a system is developed that implements cognitive functions by means of a Controller Component and a Meta-Modelled Knowledge Base which willl lead to the Cognitive Laser Beam Cutting Machine.

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SENSOR TECHNOLOGY

BOOTH 10

E 100.CPC

TCP-Seam Tracking

The first industrial system for simultanoues TCP- and seam tracking is shown.
During longitudinal seam welding of pipes in industrial manufacturing plants, lacks of fusion often lead to production downtimes and returns. Lack of fusion in the weld seam that has not been identified can lead to a failure of the seam in further processing.
The reason for the defect is a lateral shifting of the groove in relation to the laser beam, which can be caused by the pipe twisting, the joining edges being out of alignment, poor initial setting of the plant or of the seam-tracking sensor, and shifting of the laser beam owing, for example, to thermal influence. While the first two effects can be controlled and corrected using conventional seam-tracking sensors and proper tracking, thermal effects result in a shifting of the beam within the beam guiding system. The principle suggests that this can be neither identified nor corrected by conventional seam tracking. So the aim is to ascertain the beam's position relative to the seam, in order to have the seam tracking correspond of the TCP.

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BOOTH 54

E 112.3

Automated White Light Mach-Zehnder Interferometry and Microscopy

With Mach-Zehnder interferometry and microscopy we have created a new approach for the analysis of transparent materials and cells. The technology combination of transmitted light microscope and interferometer allows for the determination of layer thickness with an accuracy of one nanometer. Moreover, it allows for the mapping of refraction index distributions with a spatial resolution at the diffraction limit. The exceptionally high standards for production accuracy are realized through the use of micro actuators and piezo positioning elements. What is more, motor-driven components allow for automated adjustments and measuring.

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BOOTH 25

LASER MEASUREMENT TECHNOLOGY

E 100.LMT

Laser-based Material Sorting

Fast laser identification of materials is applied to sort different materials. Individual pieces of material are transported on a conveyor belt at a speed of 3m/s and online analysed by a laser beam. Within a few microseconds the laser carries out a multi-element analysis of the material. According to the result of the laser-spectroscopic analysis, the pieces are ejected into the appropriate fraction.
This technique can be used in various industrial applications. In the recycling industry a more detailed classification becomes increasingly important with increasing recycling rates. To produce a variety of alloys using a high fraction of recycled material, it is necessary not only to separate different metals, but also to fractionate different alloys of the same metal from the waste stream. Scrap aluminum is sorted as well as other light metals or high and low alloyed steel.
This online measurement technology can also be applied to characterize and sort streams of raw material, e.g. minerals and ores, and for mix-up inspection in a production line.

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BOOTH 61

E 119 / E 112.2

Extreme Ultraviolet Radiation: A Versatile Tool for Nanotechnology

Extreme ultraviolet and soft x-ray radiation (XUV, 1-50nm, or EUV, at around 13.5nm) enables a variety of new optical, analytical and imaging procedures. The distinct features of XUV light such as the short wavelength allow resolutions in the range of a few nanometers in printing or imaging. Its strong interaction with matter permits high elemental contrast and photochemical sensitivity. Taking into account the recent progress in the development of sources and optics, XUV applications in the semiconductor industry, thin-film technology, life- and material sciences are envisioned. Examples are the determination of element composition, layer thickness and surface roughness from grazing incidence reflectivity or defect characterization from scattered light measurements using EUV dark field microscopy. Relevant applications are, e.g., mapping of mask blanks for EUV lithography, which requires the ability to scan large surfaces for the presence of small printable defects as rapid as possible or the examination of ultra-thin gate oxides or interlayers.

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EUV- AND PLASMA TECHNOLOGY

BOOTH 62

E 119

Nanopatterning with EUV Interference Lithography

Interference lithography (IL) with extreme ultraviolet (EUV) radiation is one of the most promising candidate technologies for resist patterns in the sub-20nm range. The distinct features of EUV light such as the short wavelength, allowing for resolutions within the range of a few nanometers in printing (down to $\pi/4$), and its strong interaction with matter, which permits photochemical sensitivity, make it a promising candidate for future nanostructuring systems.
Utilizing the experience of Fraunhofer ILT with plasma sources of high intensity EUV radiation, the nanopatterning setup for EUV Interference Lithography was built in RWTH Aachen University (RWTH-TOS). The setup is operating with 2" substrates, with a single illumination field size around 100µm*100µm. The method is substrate-independent, allowing for great flexibility of the technique. Typical exposure time is between 5 and 10min. Dense patterns with sub-50nm resolution have been experimentally demonstrated.

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E 053

An Automated Setup for Measuring Laser-induced Damage Thresholds

The Laser-induced damage thresholds (LIDT) of optical components are major design issues for the laser engineer as they limit efficiency and lifetime of many laser systems. Not only does the LIDT of an optical component depend on the laser parameters such as pulse duration, wavelength, beam profile, etc.; it is also closely linked to the production process and thus difficult to estimate.
This setup allows testing of optical components with respect to LIDT and qualification of batches of them for usage in volatile laser systems. It is conform with ISO 11254-2 and can be adapted to a large variety of laser parameters. A monitoring system detects damage of a test spot online and stops its irradiation. In this way, contamination of the test sample is prevented and more test spots can be placed on the test sample. Environmental conditions can be defined (vacuum with $p < 1e\text{-}5$mbar or vented with process gas).

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BOOTH 50

LASER AND LASER OPTICS

E 112.4

Assembly Technology

A large number of laser applications would be more competitive if the price of the laser modules would be lower significantly. Cost reductions can be realized by applying fully automated mounting/assembly techniques. For this, the design concept of diode laser modules was changed and improved to make alignment and joining of optical components easier. To realize this a manufacturing system prototype was designed and constructed. This prototype features high flexibility in connection with highly precise alignment. To show the potential of the system a compact green laser module for projection application has been assembled. All components have been positioned and joint accurately and efficiently. UV-curing adhesive with a linear shrinkage smaller than 0.1% has been used to join the components.

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Automated Assembly of MicroLasers

Presented is a miniaturized solid state laser for marking applications, featuring novel assembly strategies to reduce size, cost and assembly effort. Design and setup have been laid out with future automation of the assembly in mind. Using a high precision robot the optical components of the laser system are directly placed on a planar substrate providing accurate positioning and alignment within a few microns. No adjustable mounts for mirrors and lenses are necessary, greatly simplifying the setup.

Consisting of a Neodymium doped crystal, pumped with a fiber coupled diode laser, a q-switch for pulse generation and a beam expander the entire assembly is confined in a 100ml space and delivers 4W of continuous output power at 1.064μm with an efficiency greater than 40%. Pulse lengths of 10-20ns and repetition rates of up to 150kHz have been obtained with an acousto-optic modulator. In addition, a custom designed electro-optic modulator with integrated high voltage switch has been realized.

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RWTH AACHEN UNIVERSITY HOUSE OF PRODUCTION

bDPSSL: A Compact Design for a Laser Directly Emitting Green Light

The development of compact, low-cost RGB laser beam sources for use in projection applications has the potential to open a large mass market. The proposed solution involves implementing the green component of the RGB module by means of a special optically pumped laser crystal. An off-the-shelf, blue-emitting laser diode is used as the pump source, and a praseodymium-doped YLF-crystal as the active laser medium. This concept to generate green laser light with 523nm is based on a conversion process that guarantees high efficiency and low temperature dependency.
A laboratory setup was realized, using an extremely short resonator with a length of 10mm, with which it was possible to produce a cw output of 136mW from a pump input of 410mW and thereby an electro optical efficiency of 6.5%. The measured beam quality of the laser is M2 < 1.05.
Furthermore a prototype with a customized micro optics, an overall length of 23mm and comparable performance to the laboratory setup was realized.

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BOOTH 59

E 118

Beam Shaping and Frequency Stabilization of High Power Diode Lasers

Diode laser modules are used as pump sources for different devices, such as fiber lasers, for signal amplification in telecommunication and can also be used in direct material processing, such as plastic welding. The main advantages of diode laser modules are their high wall-plug efficiency, their small size and their cost efficiency. Various fiber coupled and free space diode laser modules suited for space and terrestrial applications are presented.
High-power diode lasers, which are spectrally stabilized by using diffractive optics, enable power scaling concepts in the field of high brightness laser modules. Therefore direct material processing and the increase of the pumping efficiency of solid state lasers – particularly fiber lasers – can be realized by the implementation of this technique. A characterization setup for volume gratings developed at Fraunhofer ILT is exhibited.

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BOOTH 30

LASER AND LASER OPTICS

E 100.MB5

Gain-switched Diode-pumped Fiber Lasers

Volume markets in micro materials processing such as laser marking, ablation and drilling require cost-efficient, pulsed beam sources with fundamental mode beam quality. Pulsed fiber lasers perfectly match these demands due to their high efficiency, simple construction and excellent beam quality.
Gain-switched fiber lasers offer a new approach, promising considerable cost saving. The fiber laser is built as an all-fiber oscillator and the pulse is generated by temporal modulation of the pump diodes. So the repetition rate reaches from about 1MHz down to single-shot operation.
In order to show the feasibility of the concept, a single mode ytterbium-doped fiber was pumped with a pump energy of 30µJ within 200ns. Pulse energies in the range of 8µJ, pulse widths of 1.4µs and repetition rates of 50kHz were achieved.
With an enhanced fiber coupled pump module with up to 300W in 105µm the pulses were shortened to 250ns and the efficiency was increased up to 45% at an output pulse energy of 30µJ.

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BOOTH 66

E 053

Innoslab Based Amplifier Platform: A Compact 230W Amplifier for Ps Lasers

High-end micromachining with picosecond lasers became an established process during the recent years. Power scaling led to industrial lasers, generating average power levels well above 50W. Such lasers are routinely used in applications like machining turbine blades, micro moulds, and semiconductors. They allow to micro-structure any material, also materials, which are very difficult to process by mechanical means. These lasers offered a new quality in laser micro-machining by cold ablation, a cold removal of very thin material layers, nearly without any thermal side-effects like burrs and micro-cracks. We present further power scaling, achieved by combining a state-of-the-art industrial LUMERA picosecond laser with Fraunhofer ILT INNOSLAB amplifier technology. Pulses with 10ps-duration and a wavelength of 1064nm were generated from a LUMERA RAPID laser and than further amplified in one compact INNOSLAB amplifier stage well above 230W with an M^2<1.5. Experimental results for 0.5, 1 and 10.7MHz repetion rate will be presented.

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LASER AND LASER OPTICS

BOOTH 39

HALLWAY NEXT TO E 100.MB1

Intelligent Drivers for Diode-Lasers

The Beratron GmbH specializes in pulsating current sources for applications using high-power diode-laser technology. Beratron current sources are best suited for pulse operation for single diodes, bars and arrays.
Our products are available in a 19 inch rack format and range across different power classes. The sources are available with different output voltage levels. The load-voltage is automatically adjusted by the device. They are equipped with several safety-loops and can be controlled via EIA-232, USB and CAN-Bus.
Some applications are R&D, material processing and SSL pumping.
In cooperation with the Fraunhofer Institute for Laser Technology ILT, Beratron offers Burn–In stations especially designed for development purposes. They can be operated in CW, Pulse or On/Off mode. A pulse current up to 500 Ampere is available.

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E 100.MB5

Laser Processing Heads for High Power Lasers

The research into laser-based applications and new fields of applications creates a demand for specialized optics and laser processing heads for high power lasers. At the Fraunhofer ILT and the chair TOS innovative optic concepts and laser processing heads for high power lasers have been developed. Examples are: a high speed railway cleaning head, a transformation optics for de-coating metal parts by high-power laser, a coaxial laser brazing head that features a coaxial ring-shaped laser beam distribution in combination with coaxial wire feeding and coaxial process control that allow the deployment of the brazing head without constant reorientation (a development together with Precitec KG) and an application optics for laser assisted incremental sheet forming, which features a rotating laser beam.

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E 100.IQ

Micro SLM (Selective Laser Melting)

IQ evolution is specialised in Mikro-SLM and cooling technologies, a rapid manufacturing procedure of three dimensional complex products made of metal powder

- Our products are micro cooler for high-power laser diodes, cooler for power electronics or LED as well as other complex 3D-structures
- Our micro coolers are leading f.e. to a significant increase in the lifetime of the laser bars compared to the current copper based cooling echnology (the new materials used here are not exposed to corrosion and erosion)
- We have special know-how in the Selective Laser Melting process and machines as well as in using special materials, pure materials and custom made material compounds
- We are able to produce micro structures from 50µm up

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BOOTH 52

E 112.4

Oven for Nonlinear Optical Crystals

Nonlinear Optical Crystals as Lithium Triborate (LBO), which has proven its suitability for many industrial concepts of frequency conversion, require an accurate temperature control to provide reliable and constant output power and beam properties. The shown oven does not only allow to keep the temperature constant within a range of 0.02K, but also ensures that the crystal is heated homogeneously to achieve the maximum conversion efficiency. At the same time the mechanical stress is minimized by use of a spring mount for clamping the crystal with controllable force.
Especially for high power applications the suppression of stray light is an important issue. For that reason the oven is equipped with a coolable copper aperture. The oven has proved its functionality in several lasers exceeding 190W of green output power.

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LASER AND LASER OPTICS

BOOTH 67

E 053

Qualification of Opto-mechanical Components for Applications in Harsh Environment

Laser resonators and complex sequential amplifier and frequency converting setups require a high mechanical stability of the optical components. For example typical tilt stability requirements of oscillator mirrors are in the range of a few µrad. For scientific applications the environmental laboratory conditions are quite stable regarding temperature, humidity, pressure, etc. and usually offer low vibrational loads.
But many laser applications in the industrial or scientific field demand stable laser operation in unstable environment. This is especially the case in airborne LIDAR-lasers where high frequency, pointing and energy stabilities have to be ensured at different environmental conditions and with inevitable vibrational noise and mechanical transport shocks. For the development and qualification of appropriate optomechanical components we make climate, vibration and shock tests on component level. To avoid resonant response to vibrational excitation of components and more complex setups theoretical and experimental modal analysis is performed.

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SHG Modules for Laser Radiation with Low Peak Power

Periodically poled nonlinear optical materials can provide high conversion efficiency even at low intensities of the fundamental input radiation, e.g. from continuous wave diode lasers and pulsed fiber lasers. This is a result of the exceptional high nonlinearity of these crystals. In contrast to alternative technologies no optical resonator is required to enhance the field. As a consequence simple system architectures with a minimum of optical components can be developed based on this concept. As alignment tolerances are significantly relieved compared to resonator concepts, innovative mounting and packaging technologies can be applied, aiming for significantly reduced costs, improved compactness and performance.
Examples show a frequency doubled DBR tapered diode laser module with an output power of 500mW and a SHG module for a pulsed fiber laser with 1W average power and 25kW pulse power.

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BOOTH 32
LASER AND LASER OPTICS
E 100.MB5

Station for Inverse Glass Drilling of Fiber Preforms

State of the art manufacturing of preforms for polarization maintaining fibers is to fabricate the holes for the stress rods by ultrasonic drilling. This limits the maximum length of the preform and the aspect ratio. Fraunhofer ILT is developing a laser drilling process to exceed this limit.

At this process the laser beam is focused at the bottom side of the preform. The laser beam is deflected by a scanner. This and a translation stage in the z-axis define the ablation volume. With this process holes with a diameter of 500µm and a depth of 80mm, and 130µm slots in a 6mm substrate have been achieved.
Thus far a q-switched and frequency doubled Nd:YAG laser has been used. Present experiments aim to achieve a better aspect ratio. For the future experiments with picosecond lasers are scheduled.

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BOOTH 60

E 118

Tailoring of Freeform Optical Surfaces for Highly Customized Illumination Applications

LEDs are becoming a light source of great importance, allowing very flexible beam shaping due to their limited spatial extent. Here, the techniques of classical optics design can no longer be applied as demands on target intensity distributions and optical efficiency are particularly high. It is thus required that new concepts be developed for the design of efficient and flexible optics.
Instead of classical lens geometries, general refracting or reflecting surfaces (freeform surfaces) are used in the optical design. Their shape is established using complex mathematical algorithms which are developed at Fraunhofer ILT.
LED systems for the uniform illumination of square and rectangular areas were designed. Additionally, the flexibility of this approach was demonstrated by creating arbitrary irradiance distributions in the target plane.

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LASER AND LASER OPTICS

BOOTH 55

E 112.3

Time Resolved Observation of Formation of Laser-induced Nanostructures

"Sub 100nm"-structures offer vast potential benefits in photonics, biotechnology, tribological surface design and plasmonic applications. However the dynamics of their generation are not well understood. Research in this field requires high temporal and spatial resolution. A combination of a fs-laser and an EUV-microscope system provides a toolchain for controlled and reproducible production of nanostructures. Focused fs-laser radiation causes a local modification resulting in nanostructures of high precision and reproducibility. The unique interaction processes induced by fs-laser radiation open up new markets in laser material processing and are therefore a subject of current research. Microscopy using EUV-light is capable of detecting structures on a scale down to several tens of nanometers. An EUV-microscope, consisting of a plasma-source, collector, sample handling, zoneplate and detector, has been constructed to achieve a high spatial and temporal resolution. By using a gated MCP as a detector we expect temporal and spatial resolutions < 1ns and < 100nm.

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E 112.3

Nano and Micro Structuring with High Speed Scanner

A high-speed scanner with small focus (<1µm) is used with a 1.5W fs fiber laser to process dielectrics. With this set up the fabrication of waveguides, in-volume marking and surface nano-structuring for different applications becomes productive.
Moreover the high speed modification of sapphire and fused silica and subsequent etching are used to fabricate 3D micro components of e.g. micro mechanical devices, miocro optics and micro fluidic devices.

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BOOTH 05

NANO-PROCESSING

ENTRANCE

Production Technology for Transparent, Conductive Nano Layers (PROTCF)

Nano-particulate dispersions have proven to be a powerful source for producing functional layers. Their application onto glass substrates by e.g. ink-jet processes is particularly challenging as the necessary thermal treatment of the dried films often requires temperatures that exceed the temperature stability of the substrate. With high processing speeds the laser beam offers the possibility to overcome these drawbacks; the thermal load of the substrate is minimized.
Indium tin oxide (ITO) for example is used as a transparent anode material for display and lighting devices, e.g. OLEDs. As the price of indium continues to increase it is crucial to decrease its loss in conventional masked sputtering processes or avoid cost-intesive vacuum sputter and lithography processes for structured coatings. This is achieved by printing the desired design at once and treating it with laser radiation to decrease the printed sheet resistance from several hundreds of kiloohms to less than 100 ohms per square.

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BOOTH 48

1160.3

Three-beam Laser Interference Technique to Generate Micro- and Nanostructures

In laser-interference technique the laser beam is split by two beam splitters into three coherent beams and recombined under a specific angle. By changing this angle of incidence it´s possible to generate different periodicities.
The three interfering beams are controlled by several mirrors to overlap on a three-dimensional adjustable stage for structuring the substrate. Three polarizers and half-wave plates are placed in the beam paths to control the polarization and the intensity of the interfering beams.
By changing the polarization of the interfering beams it is possible to get different intensity distributions. By means of these different intensity distributions we are able to produce micro cavities, micro bumps, rectangular bumps or grating lines on the surface of polymer materials without any further changes of the setup.
By means of a three beam laser-interference technique, it is possible to generate more than 100.000 of holes with a single burst. The number of required pulses depends on the type of material, absorption coefficient and the pulse energy.

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RWTH AACHEN UNIVERSITY HOUSE OF PRODUCTION

ADDITIVE MANUFACTURING

BOOTH 22

E 100.SLM

Additive Manufacturing of Parts Made of Copper Alloys Using High Laser Power

Selective Laser Melting (SLM) is a powder-based additive manufacturing technique for the manufacture of metal parts. Amongst other areas, SLM is used in industry to manufacture tooling moulds from tool steel with conformal cooling channels. These tooling moulds minimise cycle times and enhance the quality of plastic parts. Due to the high thermal conductivity of copper, tool inserts made of copper alloys are often used to conduct the heat out of the tool. The most efficient way of cooling would be an insert made of copper combined with conformal cooling channels.
Until now however, copper alloys could not be processed by SLM with properties required for tooling or any other application. Although the melting point of copper alloys is lower compared to steels, copper alloys require a significantly higher laser power for the laser melting process. This is due to the low absorption of laser radiation and the high thermal conductivity of copper. At Fraunhofer ILT a SLM machine with a laser of 1kW maximum output power has been set up to process copper alloys to dense parts.

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BOOTH 23

E 100.SLM

Rapid Manufacturing of Aluminium Parts for Serial Production via Selective Laser Melting (SLM)

The additive manufacturing technology Selective Laser Melting (SLM) is used for direct fabrication of metal-based functional components. SLM is currently being qualified for aluminium alloys, for example AlSi10Mg, which is a common die-cast aluminium alloy. For serial-identical functional prototypes, individual parts, and small series, SLM permits an economic alternative for mould and die production like die-casting. The application of these components made using SLM demands that the mechanical properties attain similar values as conventionally built parts.

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RWTH AACHEN UNIVERSITY HOUSE OF PRODUCTION

BOOTH 21

ADDITIVE MANUFACTURING

E 100.CO2

Rapid Manufacturing of Bioresorbable Bone Substitute Implants

Rapid Manufacturing of individual bone substitude implants via Selective Laser Melting (SLM) is developed for common metal materials in implantology (Titanium (-alloys) or Cobalt-Chrome-alloys). These implants are permanent implants which have to be removed in a second operation or will stay in the human body. The clinically preferred strategy is the regenerative therapy. This means that the self healing process of the body is used for healing of large bone defects. A new approach follows this strategy. The SLM process is adapted for bioresorbable materials (Biopolymer, Bioceramic) to build individual implants which will dissolve in the body and be replaced by new bone. The additive manufacturing makes it possible to realize an interconnected porous structure in the implant which is necessary for a vascularisation of the implant and a complete substitution by new bone. Using Selective Laser Melting a new technique for manufacturing of individual bioresorbable implants with interconnected porous structure will be possible.

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BOOTH 73

E 032

Scanner-based Soldering of Solar Cells by Simultaneous Energy Input

Laser processes offer a large potential to meet the market driven demands for new solar cell concepts, a significant increase in efficiency and highly productive processes for solar cell and module manufacturing.
Due to the decreasing thickness of silicon solar cells below 200µm contactless joining processes for module production are required. A suitable technique for the electrical contacting of solar cells is laser-beam soldering, due to the low and locally restricted energy input involved. By selecting suitable solders, the joining temperature can be reduced to a minimum, and thanks to the non-contact process, the solar cells are not subjected to mechanical stress, unlike with conventionally used bowtype electrodes.
To optimize energy input a processing optics consisting of two galvanometric scanners and one diode laser has been realized and is presented. The radiation of the single laser source is divided into two beam paths. By means of this front- and backside of the solar cell can be soldered at the same time thus leading to less energy consumption.

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LIFE SCIENCE

BOOTH 75

E 055.1

Laser Induced Forward Transfer

Complex structures can be printed using the innovative laser-printing technique LIFT (laser-induced forward transfer). This enables to deposit a bioactive film (cells, proteins, etc.) from a target with an absorber layer to be transferred to a substrate through targeted laser ablation (figure below). The transfer takes place via a laseractive absorber layer, which evaporates when irradiated with laser light. The resulting pressure wave transports the bioactive film across short distances onto a substrate.

Using a fast optical scanner it is possible to generate array patterns between 20µm and 300µm in size with up to 1000 spots/s. Any grid patterns can be processed using this technique. It was also demonstrated that vital cells can be specifically transferred.

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BOOTH 68

E 034

Multiphoton Polymerisation

Multiphoton polymerization (MPP) is a high resolution stereolithographical process, which can be used to generate complex three-dimensional structures in the sub micrometer range. Usable materials cover a broad variety of photosensitive polymers, such as acrylic resins or biomolecules. Based on the physical principles of MPP, special processes and their technological implementation for applications in the field of tissue engineering will be realized.

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BOOTH 74

LIFE SCIENCE

E 055.2

Temperature-controlled Coagulation

An increasingly acute problem in medical care is to deal with chronic wounds. The preferred treatment is placing a tight dressing on the entire area of the wound and to fix the dressing by putting staples into the skin. A new laser-based concept avoids these injuries by fixing the dressing by protein glue. The glue is applied in liquid form and can then be cross-linked with laser radiation. For the cross-linking to take place without damage to the tissue the temperature has to be in range between 55 - 70°C for a few seconds. Because of the many variables in the wound situation the desired temperature cannot be set reliably just by inputting the laser parameters.

To circumvent these difficulties a new type of applicator with integrated temperature sensing is applied for bonding. When the sensor signal is fed into the feedback loop of the laser's power control that enables reliable coagulation of the glue in changing conditions. Thus the laser can cure the protein glue without overheating or damaging tissue.

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BOOTH 12

NEXT TO ENTRANCE

Cluster of Excellence »Integrative Production Technology for High-Wage Countries«

In the Cluster of Excellence »Integrative Production Technology for High-Wage Countries«, process engineers and materials scientists based in Aachen are developing new concepts and technologies offering a sustainable approach to industrial manufacturing. A total of 18 chairs and institutes of RWTH Aachen, together with the Fraunhofer Institutes for Laser Technology ILT and for Production Technology IPT, are working on this project, which in the first instance will run until the end of 2011. Funding of approx. 40 million euros has been granted to this Cluster of Excellence, an initiative that unites the largest number of research groups in Europe devoted to the objective of preserving manufacturing activities in high-wage countries. Within the Cluster of Excellence the following nine research groups are working in the field of laser technology and optics.

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RWTH AACHEN UNIVERSITY HOUSE OF PRODUCTION

EXCELLENCE NETWORKS

BOOTH 13

NEXT TO ENTRANCE

RWTH Aachen Campus

In the upcoming years, RWTH Aachen University will create one of the largest campus areas and one of the nationally and internationally most reknown knowledge and science centres on an area of 2.5 square kilometers. The RWTH Aachen Campus will bundle knowledge, research, development and life in a new quality dimension. Sophisticated architecture and various facilities offer work and living quality on the highest level. Enterprises will have the possibility to settle on the Campus: for rent or in own buildings, in any size, from a 3-persons-office and limited projects up to longterm engagements with several hundred employees. As an outstanding feature, enterprises may enrol in the training and education programmes of RWTH Aachen University. Research and Development will be organised in thematic clusters, representing the most important future-relevant topics. Up to 12 thematic clusters are planed and one of the starting clusters will be the Photonics cluster.

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Chamber of Industry and Commerce Aachen (IHK Aachen)

The Aachen Chamber acts as a critical partner in political and administrative issues, as an independent practicing lawyer in the market and as a customer-oriented service provider for companies. As a decisive promoter of the Aachen economic region, it is concerned with improving commercial framework conditions and building up the competitive competence of the local economy.
A further important function lies in the performance of duties such as holding examinations, calling in experts, monitoring cartel law and issuing foreign trade documents.
Finally, the chamber offers its members concrete company-based services such as information about new legislation and developments, advice about starting up and safeguarding companies, arranging cooperation, foreign trade information, innovation and technology transfer as well as further training and seminar events.

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Industrie und Handelskammer Aachen IHK

Fraunhofer Institute for Laser Technolgy ILT / Press Counter

With about 300 employees and more than 11.000 m^2 of usable floor space the Fraunhofer ILT is world-wide one of the leading development and contract research institutes of its specific field. In the technological area »lasers and optics« development activities are concentrated on innovative diode and solid state lasers for industrial use as well as design and assembly of optical components and systems. The technological area »laser material processing« offers solutions in cutting, ablation, drilling, welding, soldering, surface treatment and micro processing. The activities cover a wide range of applications from macro processing via micro processing up to nano structuring. In the area »medical technology and biophotonics« innovative procedures for therapeutic laser treatments and processes for the production of medical technology products, particularly for microsurgery techniques, are developed. In the area »laser measurement technology« processes and systems for inspection of surfaces, for chemical analysis and for testing geometrical accuracies are developed.

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AKL e.V. - Aix Laser People

Arbeitskreis Lasertechnik AKL e.V. is a registered non-profit association formed in 1990 by a group of companies and private individuals aiming to pool their experience and conduct joint public-relations activities in order to spread the use of laser technology in industry and promote the sharing of scientific ideas. The »Innovation Award Laser Technology« aims to reward excellent achievements in applied research and oustanding innovation in the field of laser technology and to shine a spotlight on their authors.

In 2009, around 97 laser experts and enthusiasts were signed up as active members of the AKL network. The association's activities include disseminating information on innovations in laser technology, organizing conferences and seminars, compiling educational material dealing with laser technology, stimulating the interest of future young scientists, and providing advice to industry and research scientists on questions relating to laser technology.

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CENTRAL INFORMATION
ENTRANCE

ELI - European Laser Institute

Optical technology is taking an increasing hold on all domains of industry and science. Europe already possesses a strong position in this field by virtue of its numerous experts and excellent research and development facilities. Nevertheless, it has been realized that there is an urgent need to link the existing sources of know-how and expertise, and to enhance the performance of joint research activities.

Consequently, the European Laser Institute (ELI) has created an efficient platform bringing together the necessary competence and knowledge on optical technologies. By promoting technology transfer within Europe, ELI aims to enhance the international lead of European industry and research in the field of laser technology and photonics. By working in close collaboration with existing national and international organizations, the ELI network of industrial and academic research institutions helps to influence R&D policy on a national and European level.

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