Fraunhofer ILT

Fraunhofer Institute for Laser Technology ILT

Thursday May 5, 2022 | 16:30 – 19:30 h

Laser Technology Live Presentations at:

- **Fraunhofer ILT**
- **Industry Building DPP**
- **Research Center DPP**

Shuttle Transfer on May 5, 2022

Eurogress – Research Center DPP
16:05 h

Eurogress – Fraunhofer ILT
16:05 h, 16:10 h, 16:15 h, 17:00 h and 17:05 h

Research Center DPP – Eurogress
19:35 h

Fraunhofer ILT – Eurogress
19:35 h, 19:40 h, 20:20 h, 20:25 h and 20:30 h

Fraunhofer ILT – Research Center DPP
16:30 h – 20:00 h (frequently)

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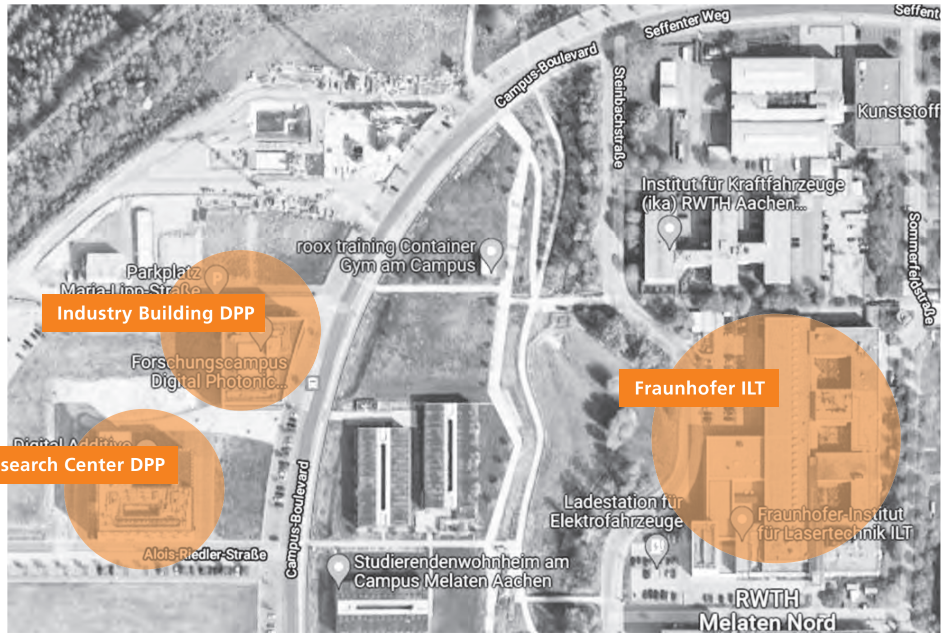
Presentations – Laser Technology Live



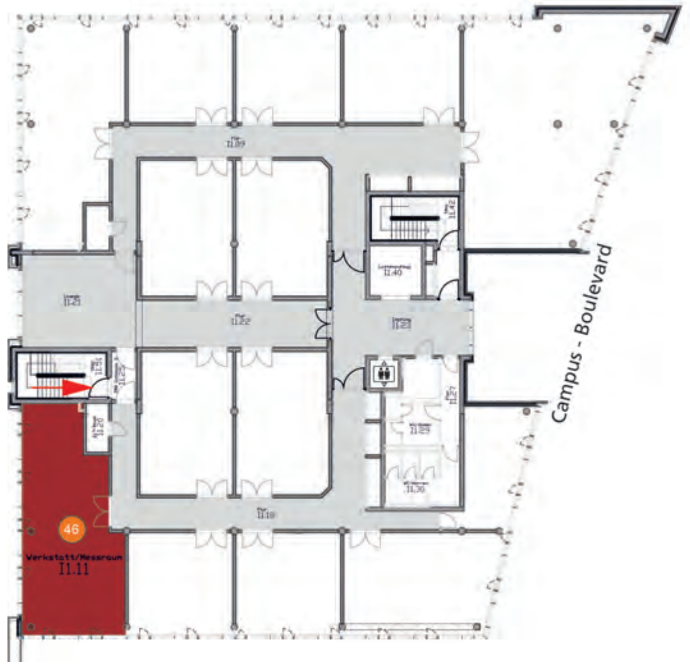
- Central Information, Special Exhibit
- Additive Manufacturing
- Surface Technology
- Laser Measurement Technology
- Competence Fields
- Chamber of Industry and Commerce Aachen (IHK Aachen)
- Cutting
- Joining
- Drilling
- Digitalization
- System Technology
- EUV + Plasma Technology
- Laser and Laser Optics
- Battery Lab
- Micro- and Nanostructuring
- Hydrogen Lab
- Optical Systems
- Quantum Technology
- Medical Technology

BOOTH PLAN

Industry Building DPP

GROUND FLOOR

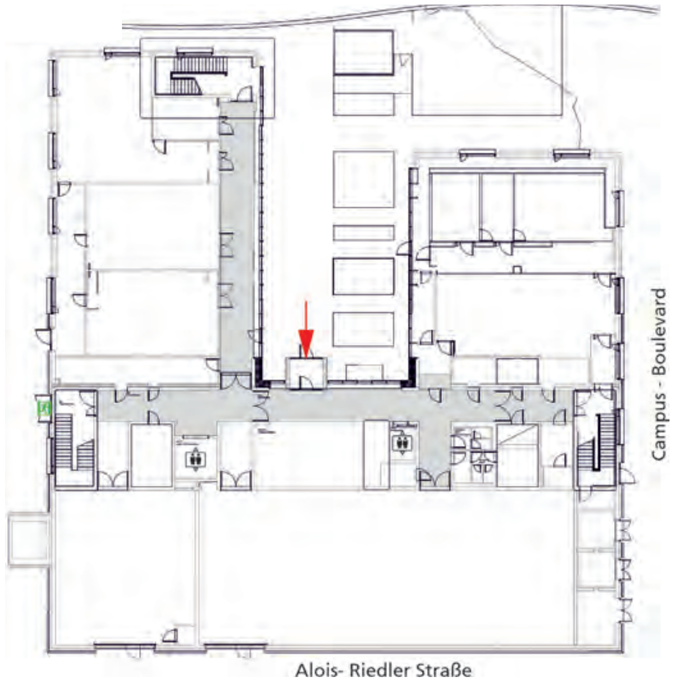
1ST FLOOR



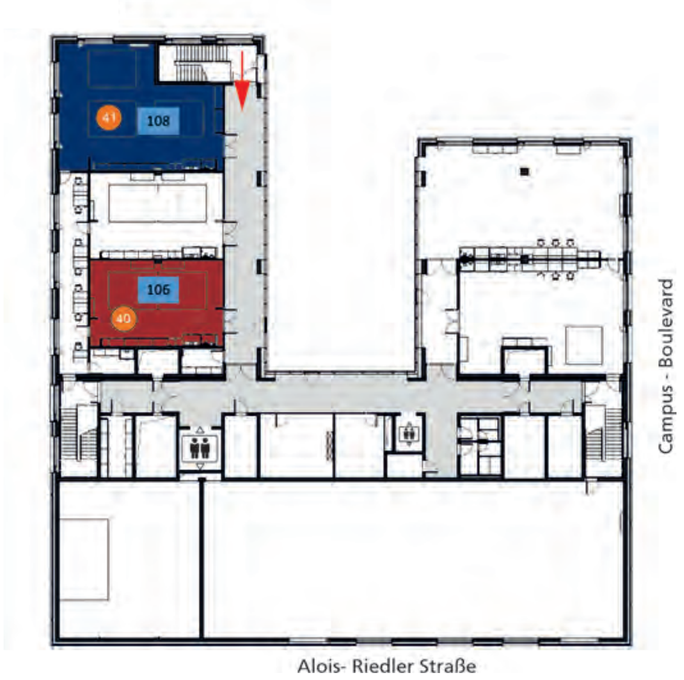
BOOTH PLAN

Research Center DPP

GROUND FLOOR

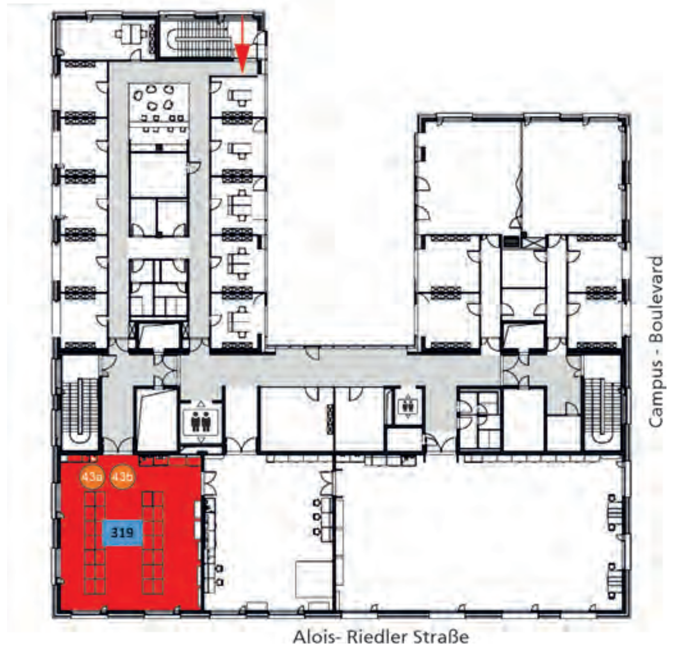


1ST FLOOR



2ND FLOOR

3RD FLOOR



BOOTH PLAN

Fraunhofer ILT

BASEMENT

GROUND FLOOR

- Central Information, Special Exhibit
- Additive Manufacturing
- Surface Technology
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- Medical Technology

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CENTRAL INFORMATION

BOOTH 1

Entrance

Fraunhofer Institute for Laser Technology ILT

With over 480 employees, more than 19,500 m² net floor space and more than 40 spin-offs, the Fraunhofer Institute for Laser Technology ILT is one of the world's most important contract research and development institutes in the fields of laser development and laser applications. Our core competencies include the development of new laser beam sources and components, laser measurement and testing technology, and laser manufacturing technology. This includes cutting, ablation, drilling, welding and soldering as well as surface finishing, micro manufacturing and additive manufacturing, among others. The areas of application for laser beam sources and processes include production and metrology, energy and mobility, medical and environmental technology, and quantum technology. Together with excellent partners from German and international research and industry, we develop, for example, satellite-based measurement systems for climate research or frequency converters for a fiber-based quantum internet. Cross-sectionally, Fraunhofer ILT addresses issues of digitalization in photonics and production technology, process monitoring and control, simulation and modeling, AI in laser technology, and the entire field of system technology.

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CENTRAL INFORMATION

BOOTH 2

Entrance

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 outstanding innovation in the field of laser technology and to shine a spotlight on their authors.
In 2021, 180 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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BOOTH 3

CENTRAL INFORMATION

Entrance

ELI e.V. – 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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BOOTH 4

SPECIAL EXHIBIT

Entrance

95 kWh of Energy: The High-Voltage Battery System of the Audi e-tron

The powerful lithium-ion battery in the Audi e-tron provides for a range of up to 453 kilometers in the WLTP driving cycle. The battery operates with a nominal voltage of 396 volts and stores 95 kWh of energy (gross). The battery system in the Audi e-tron is located beneath the cabin and is 2.28 meters long, 1.63 meters wide and 34 centimeters high. It comprises a total of 36 cell modules in square aluminum housings, each of which is roughly the size of a shoe box. They are arranged on two levels, known as “floors” – a longer lower floor and a shorter upper one. The cell modules in the Audi e-tron can reproducibly discharge and charge electricity over a broad temperature and charge status window. They can be densely packed to achieve a very high output and energy density in the volume available. Each module is equipped with twelve pouch cells having a flexible outer skin of aluminum-coated polymer. Audi also uses both technically equivalent prismatic cells in its modular concept. An indirect cooling system distinct from the cell space ensures the high-performance operation of the battery over the long term.

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ADDITIVE MANUFACTURING / SYSTEM TECHNOLOGY

BOOTH 5

E100.A09

System Technology with Coaxial Wire Feed for Additive Manufacturing

By utilizing a wire as feed material, major disadvantages of currently used powder-based Laser Material Deposition (LMD) processes can be eliminated. Contamination of the process cell with metal powder, significant material losses during the process and insufficient powder quality are just some of the problems which are solved by this approach. A continuous circular laser beam is one of the distinguishing features of this laser cladding head. The laser beam and the wire are arranged coaxially to one another. Through this design, the welding process is independent of the feed direction. Together with a very high degree of material utilization it leads to an efficient and precise buildup of two- and three-dimensional geometries. The reduced mass of the head through advanced design makes highly dynamic cladding processes feasible. The new processing head is suitable for a combination of laser and arc. By combining the two energy sources, processes with higher deposition rates can be realized.

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ADDITIVE MANUFACTURING / SYSTEM TECHNOLOGY

BOOTH 6

E100.A11.2

EHLA 3D – Alternative Technology for Near-Net-Shape Additive Manufacturing and Free Form Coating

EHLA is a modified variant of the powder-based Laser Material Deposition (LMD) technology and is known as a highly productive coating process for rotational symmetric components. Due to its process characteristics, hard-to-weld materials can be processed. Also, EHLA combines high-deposition rates and thin layer deposition, which is a prerequisite for productive near-net-shape Additive Manufacturing (AM).
Typical EHLA processes operate with a feed rate of > 50 m/min by rotation of the rotational symmetric part. To utilize the EHLA principle for AM and free form coating a machine concept needed to be developed, which can operate with high and dynamic feed rates in the horizontal x-y-plane. As a result, the pE3D machine with a tripod kinematic concept was developed and manufactured by Ponticon GmbH in collaboration with Fraunhofer ILT. The pE3D takes the EHLA process to the third dimension, hence EHLA3D, and can operate with up to 200 m/min feed rate and 5g acceleration.

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E100.A12

Laser Metal Deposition Processing Head with Online 3D Distance Monitoring for Additive Manufacturing

The working distance is an essential parameter of the Laser Metal Deposition (LMD) process which must be kept at a constant level for successful application. Especially in Additive Manufacturing (AM) working distance monitoring is important when building large-scale components by LMD as these can take multiple hours to complete. If the distance changes over time the process efficiency will decrease, and this can lead to a process breakdown. The development approach is to integrate an enhanced interferometric distance measurement system into a commercial LMD powder processing head. By guiding a circular measuring trace around the processing area, the sensor can detect the working distance as well as topological information. By continuously collecting data when moving the processing head a 3D-scan of the surface can be recorded online. This technology is beneficial for AM as well as LMD repair applications as the system allows the scanning of unknown surfaces prior to LMD processing.

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E100.A13

Adaptive Process Control for Laser Powder Bed Fusion

With state of the art Laser Powder Bed Fusion (LPBF) the processing strategy is determined independently of the part geometry or the user's requirements. The results are deviations in the part, defects in the microstructure and only minor intervention options for the user. The adaptive process control strategy allows the LPBF process parameters to be automatically adapted to the geometry. This means, for example, that less energy is applied to filigree component areas in order to keep the melt pool dimensions under control or users can individually adjust the component properties by selectively influencing the quality of the parts surface. The adjustment of LPBF process parameters is possible in the µm range if required. Not only the geometry specific LPBF process parameters are developed at Fraunhofer ILT, but also the associated software for data preparation and control of the laser and optical system. As a result, users can be provided with a powerful solution for the LPBF manufacturing of the future.

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E100.A13

Process Monitoring for Quality Control in Laser Powder Bed Fusion

The properties of components produced by Laser Powder Bed Fusion (LPBF) are unknown during manufacturing. In particular, internal defects as well as the actual part geometry can only be determined after the built by performing additional external quality control steps. At the same time, the cyclic character of the LPBF process could be leveraged for layer-by-layer process monitoring. Existing approaches for this are focused on the observation of thermal emissions. At Fraunhofer ILT, a line-sensor based process monitoring system was developed, which uses the in-process movement of the powder application unit to record highly resolving images of the resolidified parts layer-by-layer and line-by-line. The obtained images are combined with thermal information and application-specific image processing algorithms are applied to identify process deviations and possible defects from the image data.

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E100.C12.2

Integration of Printed Strain Gauges into Milling Head Using LPBF and Thin Film Processing

Additive manufacturing technologies allow for new approaches for integrating sensors into high-value parts, answering Industry 4.0's demand for smart parts. The presented demonstrator displays an LPBF manufactured milling head with 3 cutting edges. Each cutting-edge mount features an integrated strain gauge and a thermometer, allowing for health and tool wear monitoring, as well as R&D applications in milling technology. While the thermometers are off-the-shelf thermocouples, the strain gauges are printed into the part using Thin Film Processing. That allows to individually design the strain gauges measurement grids. The demonstrator features 6 strain gauges to measure radial and tangential forces. Measurement data can be transmitted wirelessly.

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BOOTH 10b

ADDITIVE MANUFACTURING

E100.C12.2

Sustainability Assessment of the Laser Powder Bed Fusion Process

Additive manufacturing (AM) techniques like Laser Powder Bed Fusion (LPBF) offer advantages like high material efficiency and production of parts with integrated functionalities. Since product sustainability over the manufacturing value chain becomes more important over the last few years, these factors play quite significant roles in order to reduce greenhouse-gas emissions compared to conventional manufacturing techniques. Nevertheless, the production process is dependent on many influencing factors like the used machine setup, the material type and the build layout. In an effort to quantify and reduce these emissions, Fraunhofer ILT investigates the effect of influencing factors on the sustainability of the LPBF process and the built parts.

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BOOTH 11

ADDITIVE MANUFACTURING / SYSTEM TECHNOLOGY

E100.C13

Large Scale Multi-Scanner Laser Powder Bed Fusion through a Movable Processing Head

Conventional systems for Laser Powder Bed Fusion (LPBF) are limited in their size. When increasing the usable build-volume, the challenge is to realize a homogeneous shielding gas flow over the entire powder bed. In addition, an increase in productivity is necessary to be able to use such systems economically. To meet these challenges, Fraunhofer ILT has developed a novel LPBF machine concept (build-volume: 1000 x 800 x 350 mm³) for the manufacturing of large components as part of its lighthouse project futureAM. The machine concept includes a processing head which is movable over the large powder bed via linear axes. The processing head features a local shielding gas system, thus creating process conditions which are easy to control. The latest development stage includes a processing head with five compact galvanometer units arranged in a row to cover a footprint of 180 x 470 mm² with high scan field overlap. Five fiber lasers with a maximum output of 400 W serve as beam sources.

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LASER

BOOTH 12a

E112

Brightness Scaling and Increased Reliability of High-Power Laser Diodes

High-power edge emitting lasers and VCSELs are used in a multitude of applications from fiber and disc laser pumping to direct materials processing and automotive LiDAR. The Fraunhofer ILT Software SEMSIS (semiconductor laser simulation software) allows a multiphysics simulation of these lasers considering their electrical, optical, thermal and mechanical properties. For edge emitters, the software can be used to describe the lateral beam quality of multimodal broad area lasers as well as catastrophic optical damage (COD), a sudden degradation mode limiting their reliability and output power. The optical feedback in external cavity laser diodes (ECDL) can be considered to predict both the spectral locking range and the reduced COD level due to misalignments of the optical components.
All models can act as a digital prototype of a laser diode to optimize the semiconductor heterostructure and external resonator configuration to achieve higher beam quality, reliability and output power.

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OPTICAL SYSTEMS

BOOTH 12b

E112

Development of a Beam Shaping System for Growing Gallium Oxide Single Crystals

The laser diode floating zone (LDFZ) method is a crucible-free technique for growing single crystals of high purity. In the LDFZ process, the generally polycrystalline starting material is radially irradiated with diode lasers and melted in a defined area. For this purpose, Fraunhofer ILT has developed and set up an optical system. As a beam source, a fiber-coupled high-power diode laser is used. To generate a process-adapted intensity distribution, the radiation emerging from the fiber is homogenized and split up into five partial beams of equal power, which are guided in a radial direction onto the Ga_2O_3 target. Furthermore, a switch box was developed for surveilling the temperatures at the optical components and the flow rates inside the cooling circuits, and for controlling the interlock of the laser. Currently, the system is located at AIST in Tsukuba, Japan, and will be used for the growth of Ga_2O_3 single crystals with a 2-inch diameter.

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BOOTH 13a

LASER

E118

Key Optical Components for Rugged Laser Systems

Many laser applications require a reliable long-term operation of the laser source in a harsh environment. This means that the laser has to withstand temperature cycles and mechanical vibrations and shocks. This is especially true for industrial but also space environments.
With the goal to build a spaceborne LIDAR instrument that has to operate maintenance free for more than three years a set of key optical components has been developed. To ensure long-term stability, especially when exposed to UV radiation, the key requirement is to avoid any organic material like adhesives or plastics. The soldering technique which is established for the mounting of laser diodes and laser crystals to heat sinks has been adapted for the mounting of mirrors, lenses, and nonlinear crystals for faraday isolators, Pockels cells and frequency converters. Several thermal cycling tests between -30 °C and +50 °C as well as random vibration tests of 14 grms have been performed to validate the required robustness.

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BOOTH 13b

SPECIAL EXHIBIT / LASER

E118 / Hallway

MERLIN – Building a Laser for Space Environment

In the frame of the Franco-German climate mission MERLIN, which is dedicated to measuring the space-resolved methane concentration in earth's atmosphere from a satellite, Fraunhofer ILT is building the laser source for the instrument.
The laser itself consists of a frequency-stabilized oscillator, a highly efficient Innoslab amplifier and a subsequent frequency-stabilized optical parametrical oscillator (OPO). The output is a narrow-bandwidth pulse at one of methane's absorption lines, allowing for optical measurement of the methane concentration.
A major challenge is the necessary robustness of the laser source with respect to environmental conditions in space. These comprise a non-operational temperature range of -25 °C to 50 °C, vibrational and shock loads. To fulfill these requirements, Fraunhofer ILT has developed a soldering technique for the mounting of optics. That allows for a "set and forget" approach, resulting in unmatched stability of optical mounts with respect to their initial alignment.

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QUANTUM TECHNOLOGY

BOOTH 14

E119

Production of N-vacancies for Quantum Sensors and Q-bits Using Soft X-ray Radiation

Nitrogen-vacancies in diamond are attractive for Q-bits in quantum computers or applications in new sensors with improved sensitivity. Partly, such sensors have been demonstrated successfully. Today, the generation of such N-vacancies in diamond is based on the irradiation of N-doped samples with electron or ion beams. The proposed set-up is used for demonstration of such generation using soft x-ray radiation, which is encouraged by the reported success using electrons with energies in the range of a few 100 eV, which is the corresponding photon energy of soft x-ray and extreme ultraviolet radiation. In a first experiment the creation of such electronic systems could be demonstrated using radiation with a wavelength of around 4.9 nm or 250 eV. Future activities are aimed at a better understanding of the process with finding optimized radiation doses. Another aspect is to prepare such technology for the production with higher throughput, where a photon-based technology seems to be superior to electron or ion beam method.

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LASER

BOOTH 15

E103.1

Ultra-High Stability Fiber Lasers for Quantum and Gravitational Measurements

For specific applications in the fields of quantum technology and gravitational wave detection, very specific tailored light sources are needed. Here, special requirements are for example ultra-high stability, a very low linewidth and high output power.
This results e.g. in laser systems with linewidths smaller than 10 kHz with noise lower than 0.01 percent at a frequency of 100 Hz.
To address various applications the wavelength must be adapted. For this, we build fiber lasers based on Neodymium (922 nm), Ytterbium (1064 nm), Thulium (1950 nm) and Holmium (2090 nm) doped fibers.
Based on the current technology readiness level, the different tasks are the development of an EM-Model in cooperation with a project partner for a LISA pre-study and investigations on the stability of Ho-doped fiber lasers and realization of an elegant breadboard within the Einstein telescope related project E-TEST. Another task is the proof of concept of Nd-doped fiber lasers for frequency conversion to address quantum experiments.

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BOOTH 16

QUANTUM TECHNOLOGY

E110

SLE Lab for USP Laser-Based Manufacturing Processes in Quantum Technology

Due to its high precision and flexibility, the selective laser-induced etching (SLE) process is identified as a key technology for quantum technology hardware manufacturing like ion traps for quantum computing and photonic integrated circuits for quantum communication. The quantum components are based on transparent materials for photon transmission and reduced thermal expansion coefficient. Due to complex 3D geometries with µm feature sizes or even undercuts, a precise and flexible manufacturing process is mandatory. Thus, the SLE process is a promising approach for quantum hardware manufacturing.
A tailormade microscanner in combination with a USP laser system, which enables the modification of microstructures in transparent materials, are the key components for this manufacturing approach at Fraunhofer ILT. Arbitrary contours are written into the volume of a transparent bulk sample. A subsequent chemical etching process removes the illuminated volume only and exposes the complex 3D component.

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BOOTH 17

SURFACE TECHNOLOGY

E107

Selective Laser Crystallization of Thick Amorphous Silicon Wafers for MEMS Production

MEMS sensors (micro-electro-mechanical systems) form the core of today's inertial sensors, such as accelerometers in mobile devices or automobiles. To meet the ongoing trend towards increased performance with simultaneous miniaturization, Fraunhofer ILT is developing a laser-based process to produce sensor structures monolithically on top of the integrated circuits, a process that can replace conventional wire- and solder-based processes. For this new process, process temperatures < 420 °C need to be maintained in the area of the integrated electrical circuits.
Selective laser crystallization of the CVD deposited, 10 µm thick amorphous silicon layers achieves the reduction of the initial layer resistances by more than four orders of magnitude down to < 0.05 Ω*cm (50 Ω/sq at 10 µm layer thickness) while preserving the functionality of the integrated circuits below thanks to the local selectivity and high heating and cooling rates achievable by laser processes.

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LASER MEASUREMENT TECHNOLOGY

BOOTH 18a

E037

LIBS as Enabling Method for Inverse Production Pushes Material Recovery from End-of-Life Electronics

Inverse production strives for a selective dismantling of industrial mass products at their end-of-life (EOL) to generate highly enriched fractions of valuable materials for subsequent tailored recovery procedures. Since in many cases there is only fragmentary or even no information available about the chemical composition of such EOL-products and their components, there is a need for a fast, inline, multi-element, stand-off analyzing methodology, that can be integrated into an inverse production line. We combine laser ablation and laser-induced breakdown spectroscopy (LIBS) to identify valuable materials inside electronic components and to allocate this analytical information to the location of the measuring object on the printed circuit boards of the EOL-product. The fused data set of physical – gained via 2D, 3D geometry measurements – and chemical data allows for a selective laser desoldering and sorting of such electronic components.

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SURFACE TECHNOLOGY / ADDITIVE MANUFACTURING

BOOTH 18b

E034

Coherent UV-Center of Excellence

Building up on the successful year-long collaboration between Coherent and Fraunhofer ILT new UV Center of Excellence is established in the laboratories of the institute. The combination of state-of-the-art industrial Coherent lasers with extensive applications portfolio of Fraunhofer ILT creates unique opportunities for both partners and allows for a significant decrease of the time-to-market for new ideas and applications.
The Center concentrates on applications of excimer and solid-state lasers in the ultraviolet range. Short wavelength allows not only for sub-µm resolution in classical laser processing application, but also results in efficient absorption in wide range of materials, enabling high-quality low-damage processing. In combination with high average power Coherent lasers this allows not only the fundamental studies of physical processes but also investigations of scalability towards high-volume industrial production.

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BOOTH 19

EUV AND PLASMA TECHNOLOGY

E044.1

EUV Application Laboratory – Fundamental and Industrial Research at Extreme Ultraviolet Wavelengths

In the extreme ultraviolet (EUV) Application Laboratory, various highly promising applications in the field of lithography, metrology and irradiation are being explored and evaluated. The realized EUV interference lithography utilizes the achromatic Talbot effect to create intensity modulations for sub-30 nm patterning over large areas. The unique laboratory-based multi-angle EUV spectrometer allows determining the thickness and chemical composition of thin films as well as nanoscale geometries with sub-nm precision. The EUV high-intensity setup is used for accelerated lifetime testing of industrially relevant samples. By combining these experimental approaches challenging tasks like the development and optimization of photoresists or contamination and degradation studies of EUV optics are performed. All setups are built in-house, using efficient and compact radiation sources based on the technology developed at Fraunhofer ILT.

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BOOTH 20

OPTICAL SYSTEMS

E044.2

Digital Laser Beam Shaping with Subsequent Amplification

In dynamic laser-beam shaping for laser materials processing, there often is a trade-off between the required laser power and the required number of degrees of freedom. Dynamic beam-shaping elements such as Liquid Crystal on Silicon (LCoS) have been limited to laser powers less than 200 W so far. To circumvent this trade-off, a laser beam can first be shaped at low laser powers and then amplified to the target power. However, nonlinear effects in optical amplifiers usually lead to a significant change of the intensity distribution in the amplifier and the target plane.
We here present an approach to account for these nonlinear effects, thus enabling the industry to use modern, highly dynamic beam shaping elements for applications whose required laser power are far above the damage thresholds of these beam-shaping elements. The developed approach and software tools can be applied to almost any amplifier geometry and optical system.

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SURFACE TECHNOLOGY / ADDITIVE MANUFACTURING

BOOTH 21

E100.A04

Circular Economy: Laser-Based Process Chain for Repair of Metallic Components

Components are exposed to wear and corrosion and often fail due to local surface damage. The replacement of failed components is resource intensive and recycling of metallic components involves energy intensive smelting processes. Besides, the growing demand for scrace raw materials leads to significantly increased CO_2 emissions in the manufacturing process.
At Fraunhofer ILT, an automated hybrid process chain for the sustainable repair of metallic components is being developed. The merging of additive and subtractive manufacturing processes makes it possible to overcome previous limits in the machining of precision components. By combining the processes of rotational turning and extreme high-speed laser cladding (EHLA), a hybrid machine is created that additively manufactures components as well as pre-machining and post-machining them in a single setup.
The shift to a sustainable circular economy enabled by this process chain results in decreased raw material supply demand, reduced carbon footprint and higher competitiveness of industrial end-users.

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DRILLING

BOOTH 22

E160.3

Highly Productive Precision Drilling Processes

Highly productive laser drilling processes usually employ an on-the-fly single-pulse drilling process. Typical applications can be found in the manufacturing of filters. The achievable high drilling rate has great potential for many fields of applications. However, new applications impose new challenges with respect to the drilling process. Thicker materials or large hole diameters might be necessary which demand a series of pulses instead of a single pulse. The increased volume of ablated material can also affect surrounding holes or decrease the surface quality. Those issues have been addressed during the last years by developing new on-the-fly drilling processes with pulse bursts and investigations about the occurring surface deposits due to the drilling process. Also, from a system technology point of view, new high power laser systems and a precise position-based trigger system helped to create advanced drilling processes for new applications.

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BOOTH 23

OPTICAL SYSTEMS

E204

Computational Methods for Advanced Laser Beam Shaping

Adapted beam shaping is increasingly drawing attention in many laser applications. This especially holds for laser materials processing where it becomes more and more obvious that the relevant laser parameters significantly influence the processing outcome. In the computational optics group at Technology of Optical Systems (TOS), several advanced beam shaping approaches are investigated and evaluated for various laser applications. This for example includes the computation of adapted intensity distributions in laser thermal treatment by the solution of an inverse heat conduction problem and their realization through freeform optics with many degrees of freedom. Using this approach, experiments show a significant increase in process efficiency and quality compared to state-of-the-art beam shaping approaches. Another presented beam-shaping strategy with high-potential exploits diffractive optical elements which enables a very flexible and robust beam shaping.

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BOOTH 24a

BATTERY LAB

E300

Battery Lab for Laser-Based Manufacturing Processes in Battery Production

Dedicated to research into laser processes in battery production, the Battery Lab is equipped with numerous different systems for the laser-based manufacturing of lithium-ion and solid-state rechargeable batteries. These include roll-to-roll battery electrode coating systems used to dry and structure electrodes using lasers. Laser-based drying has the potential to reduce time and energy consumption. Subsequently, the electrodes can be structured to improve various performance characteristics of lithium-ion cells such as their energy storage capacity, charging rate, and available power.
Battery cells are connected to form modules, which are in turn combined to create battery packs. The required electrical contacts are provided by laser welded copper and aluminum conductors. The resulting direct metal bonds have a lower electrical resistance than screw connections and the laser joining process can be automated and the weld seam quality can be monitored by means of built-in sensors.

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SYSTEM TECHNOLOGY

BOOTH 24b

E300

High-Rate Structuring through Parallel Multibeam Processing for Lithium-Ion Battery Production

The use of ultrashort (< 10 ps) pulsed laser radiation (USP) enables the precise generation of microstructures for a wide range of materials. However, a current lack of productivity decisively impedes USP laser structuring in large-scale industrial use. A key technology to increase productivity is to split the laser beam into multiple sub-beams. The system demonstrated is the worldwide first to combine a high-power USP laser source with multiscanner beam-splitting optics in a roll-to-roll system. This approach allows continuous material processing of 250 mm band width with USP laser radiation with a structure size of 20–80 µm, which is used especially for structuring active material in lithium-ion battery production. The laser radiation of a 160W laser is divided into 4 sub-beams, which are directed to 4 scanner systems. Each scanner moves a beam array consisting of 6 beamlets for parallel processing. This system bridges the gap between laboratory research and industrial application.

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DIGITALIZATION / ADDITIVE MANUFACTURING

BOOTH 25

E302

Digitalization in the Laser-Based Production: Process Control for the Laser Material Deposition

Laser Material Deposition (LMD) is used in the fields of additive manufacturing, repair and coating of components. Within all these fields the near net shape manufacturing of high-quality parts is a crucial condition. Due to the dynamic process movement as well as the interaction of the powder gas stream and melt pool, process control in LMD remains challenging.
Fraunhofer ILT presents a new layer-based control system for the LMD with a bride applicability for the industry. The automated recording of the actual geometry from the current layer is compared to the target geometry, which leads to the definition of local process parameters for the consecutive layer. This not only means a leap towards process automation, but furthermore a crucial milestone to achieve process control in LMD.

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BOOTH 26 JOINING

E304

Hybrid Joining of Plastics and Metals

Lightweight construction is a central issue in automotive and aerospace industry due to the need to reduce CO_2 emissions. One way to achieve weight reduction is to use different materials adapted to functions and local loads. New paths for weight optimization are especially enabled by the combination of (fiber reinforced) plastics and metals. These hybrid components combine their unique characteristics and thus can lead to advantageous constructions parts properties. As a result, light and at the same time rigid components are realized. The need for suitable joining techniques without using additional materials like adhesives and primers is a central challenge. An approach to overcome the problems of state-of-the-art technologies is using single mode fiber laser radiation to generate microstructures with undercut grooves in the metal surface. In a thermal joining process, molten polymer is pressed into these structures and forms after setting a joint based on mechanical interlocking.

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BOOTH 27 JOINING

E310

Automated Experiment Execution and Data Acquisition at the German Electron Synchrotron in Hamburg

Laser-based processes are important for manufacturing high-precision parts in fuel cell and battery technologies due to precisely adjustable energy input. The use of synchrotron radiation allows the in situ investigation of laser beam processes with high temporal and spatial resolution to gain precise insight into the fundamental phenomena. A mobile setup for investigations of laser-based manufacturing processes at the German Electron Synchrotron in Hamburg will serve as a platform for experiments in 2022 and 2023. This platform allows the modular change between laser beam sources of different type and wavelength (fiber, disc, ring mode, USP laser) and optical systems (scanner-based and fixed optics) to carry out laser beam welding, cutting and drilling experiments. Synchronized process control with optical and acustic sensors is used to develop algorithms for process evaluation. For efficient execution of the experiments, sample handling and data acquisition will be fully automated.

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SURFACE TECHNOLOGY / THIN FILM PROCESSING BOOTH 28

E313

Sensing Components Manufactured with Laser-Based Additive Processes

Intelligent components that provide data on their production status and condition are a central component of current developments in "Industry 4.0". By combining thin-film processing (TFP) with additive manufacturing, research can pave the way to the production of so-called "smart parts".
Fraunhofer ILT develops process chains for integrating additively manufactured sensors (strain gauges) into additively manufactured components. Additive manufacturing of the component using Laser Powder Bed Fusion (LPBF) is interrupted for the integration of the sensor, which is additively manufactured with TFP technology. Here, the different materials and structures are printed directly onto the component layer by layer and then functionalized (sintered, melted, hardened, etc.) using laser radiation. For the production of strain gauges, the insulation layer, the measuring grid and the encapsulation are applied one after the other.

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ADDITIVE MANUFACTURING / MEDICAL TECHNOLOGY BOOTH 29

E321

Growing Autologous Implantable Tissue with Geometry Freedom thanks to 3D Printing

In reconstructive surgery, flap plastics are used to reconstruct larger defects. If no autologous material is available, this technique reaches its limits. One approach to compensate for this problem is the cultivation of patient-specific and transplantable tissue flaps, the so-called AV loop technique. Here, perfused tissue flaps can be grown from the patient's own cells in implantable plastic chambers. For a defect-specific reconstruction, individualized plastic chambers are to be produced by means of 3D printing and thus customized flap plastics are to be generated. At Fraunhofer ILT, the additive manufacturing of these plastic chambers, which are to be flexible and biocompatible, is developed. Combinations of photo resins and lithography-based 3D printers have been tested for this purpose and verified by in vitro cell tests. Multiple design iterations, the 3D printing of these chambers and post-processing are shown and explained.

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BOOTH 30

DIGITALIZATION

E100.B07

Multimodal Imaging and Deep Learning for Real Time Quality Control in Laser Welding

Concerning real time quality diagnosis, Fraunhofer ILT shows a multimodal imaging and machine learning-based process monitoring system. The system has been integrated into processing optics and applied to a laser beam welding process showing an automotive production scenario. The cognitive architecture is based on Convolutional Neural Networks optimized for fast inference and high prediction performance. The approach is used to distinguish nine different quality states based on multimodal image data observing the weld plume, keyhole and weld pool and its surroundings. With the help of metallographically analyzed weld samples, the system learns to display different quality categories based on the incoming images, thus clearly identifying various process defects. In parallel, the neural network extracts relevant properties of the keyhole and weld pool in real time, enabling adaptive control of the welding process.

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BOOTH 31a

CUTTING / HYDROGEN & BATTERY LAB

E100.B06

High-Speed Cutting for Laser Blanking, Bipolar Plates and Battery Electrodes

Automotive blanks, bipolar plates for fuel cells or electrodes for battery production – for all these parts, cutting or punching is an essential step in the related process chains. Replacing mechanical processes by high-speed laser cutting is attractive because of its tool-less programmability and resulting flexibility, leading to savings in material consumption, tooling expenses and floor space. Moreover, laser cutting overcomes limits of mechanical cutting tools when high-strength steels, coated or multilayer materials, or soft materials are to be cut with high quality and repeatability. Employing a cutting process that uses a cutting head with sophisticated optics and nozzle design enables much higher quality than using a scanner for remote cutting. However, the achievable cycle time is limited by the dynamics of the motion system – the high-speed laser process itself is not limiting anymore. Fortunately, innovative drive and control technologies now reduce processing times to a level competitive with punching, with the additional advantages of tool-less processing and high-quality capabilities.
Fraunhofer ILT presents two unique, highly dynamic cutting systems utilized in projects for product development and feasibility studies.

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CUTTING / JOINING / DIGITALIZATION

BOOTH 31b

E100.B06

AI-Assisted Process Control for Laser Cutting and Welding

The economic and ecological efficiency of laser material processing systems will benefit from a further enhanced degree of automation. Combining the unique temporal and spatial programmability and controllability of laser tools with new machine learning (ML) methods makes laser cutting and welding processes more efficient and robust by using artificial intelligence (AI) for open and closed loop control. The joint project DIPOOL is funded by the German Federal Ministry of Education and Research and scientifically coordinated by Fraunhofer ILT. First of all, in order to obtain coherent data quality, the project provides solutions to improve the significance of pure process signals monitored by optical sensors. Thereby, efficient machine learning algorithms result in reliable predictions and system decisions. By a unique concept, "minimally invasive" laser modulation patterns (MILM) are applied to the cutting or welding process. The process continuously responds to this with characteristic, condition-dependent signals. The availability of such revealing response signals and their fusion with further sensor data of the machine allow a highly efficient training of ML algorithms and reliable conclusions and decisions of the resulting inference engine.

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SPECIAL EXHIBIT / DRILLING

BOOTH 32a

Entrance / Hallway

SimConDrill – Laser Drilled Filter Module to Separate Microplastics from Wastewater

The Federal Ministry of Education and Research is currently funding the project "Innovative filter modules for the separation of microplastics from wastewater", in short "SimConDrill". The aim of the project is the development of an innovative filter module for the removal of microplastics in wastewater. In order to realize this goal, the technological development for the production of such a filter is in the foreground. The patented cyclone filter of the company Klass Filter GmbH serves as starting point. For hole diameters smaller than 10 µm using metal foils with a thickness of more than 200 µm, high demands are placed on the laser drilling process. The drilling process is to be simulated with a software developed at Fraunhofer ILT, so that the drilling process can be designed considering the laser parameters laser power, pulse duration or beam radius. To ensure the smooth manufacture of the filters, the drilling process will be monitored by an optical method.

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BOOTH 32b

LASER

E317

CAPS User Facility – Multi-kW Ultrafast Lasers for Future Applications

The Fraunhofer Cluster of Excellence Advanced Photon Sources CAPS pushes the average power of ultrafast lasers and connected system technology beyond the current limits. Two user facilities at Aachen and Jena provide the opportunity to develop and evaluate new applications based on the very latest laser technology.
At Fraunhofer ILT Innoslab- and Thin-Disk Lasers with up to 10 kW average power and pulses of 1 ps down to 30 fs duration are developed and made available successively. The current status and future perspectives can be seen and discussed.

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BOOTH 32c

LASER

E317

CAPS User Facility – Partner Projects and Applications

The Fraunhofer Cluster of Excellence Advanced Photon Sources CAPS connects USP lasers with promising application areas from research and industry via partner projects. A user facility at Aachen provides the opportunity to develop and evaluate new applications based on the very latest USP laser technology.
Various partner projects are already in the application phase at Fraunhofer ILT user facilities. In every project, high-power USP lasers are needed to make precision processing faster and nevertheless of high quality. Topics addressed by the content of the partner projects include hydrogen, battery, quantum and health applications.

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LASER

BOOTH 33

E316

Lasers and Frequency Converters with Customized Wavelengths from UV to MIR

Converting laser radiation to new application-specific wavelengths increases the possibilities of using modern solid-state, fiber and diode lasers in industry and research. By tailoring the combination of fundamental laser source and frequency converter, the Fraunhofer ILT develops efficient and cost-optimized beam sources for a wide variety of applications. The output parameters of our customized lasers and frequency converters can provide laser wavelengths from UV to MIR, output power from the Milliwatt-level up to multi-hundred Watts and all time-regimes from CW operation to ultrafast pulses. Exhibits include compact packages of efficient frequency converters as well as exemplary oven designs for nonlinear crystals and tunable laser crystals. Highlights are firstly, an OPG-based converter box providing high-power short pulses with addressable wavelengths in the IR and secondly, a robust OPO unit with soldered optics and crystals for satellite-based LIDAR measurement of methane.

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SYSTEM TECHNOLOGY

BOOTH 34a

E100.C03

Characterization of Powder Nozzles

In powder-based Laser Material Deposition (LMD) or Direct Energy Deposition (DED), the supply of filler material into the melt pool plays a crucial role. It influences the dimensional accuracy and the quality of the applied layers as well as the cost-effectiveness of the process. Both, the adjustment and wear state of the powder feed nozzles used and the parameters of the powder feed – such as particle size of the powder, powder mass flow, and conveying or shielding gas streams – determine the formation of the powder gas jet. To ensure high process quality, there is a need to characterize and document this tool. At Laser Technology Live a system, based on industrial standards, will be demonstrated, that makes it possible to carry out a measurement automatically and fully characterize a powder gas jet formed by a coaxial nozzle. The standardization and automation of the measurement procedure is the prerequisite for users to compare characteristic features of the powder feed.

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E100.C03

Flexible Inert Gas Shielding Device for Laser Material Deposition

The processing of reactive materials by Laser Material Deposition (LMD) requires a low oxygen content in the surrounding atmosphere. Shielding through the powder or wire feeding nozzle does protect the melt pool but not the hot surrounding material of the substrate and the built-up volume. To tackle this challenge, a cost-effective and resource-saving solution was developed to produce a local inert gas atmosphere. The key solution is a flexible fabric, which is inflated like a balloon by inert gas. The fabric is gas-tight, heat resistant and resistant to laser beam reflections. The mobility and flexibility of the fabric ensure maximum degrees of freedom at low oxygen levels (< 50 ppm). The volume of the shielding gas device can be adapted to the component size and allows rapid inflation.

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E100.C02

Use of Acoustic Resonances in Laser Beam Cutting – the Cutting Whistle

An acoustically tuned cutting nozzle – the so-called "cutting whistle"– was developed as an innovative approach to improve the cut flank quality by acoustic amplification of high-frequency melt waves on the cut front. This is based on recent findings on acoustic resonances of the gas column in the cutting kerf and its positive effect on the cut flank quality. The cutting whistle is designed on the principle of a cavity-induced supersonic flow. The cavity built at the nozzle exit side enables the generation of high-frequency waves whose resonant frequency is controlled as a function of cavity length. Schlieren optics and an optical microphone are used not only to validate the resonance in the nozzle, but also to investigate its effect in the interaction zone. A kerf model made of quartz glass is used for this purpose. Furthermore, the performance of the cutting whistle is evaluated on real cuts relative to a standard conical nozzle.

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E100.C02

Multi-Functional Laser Processing with a Digital Twin

The flexibility of the laser beam enables the integration of different manufacturing processes in one single tool. A multi-functional processing head developed by Fraunhofer ILT comprises a set of movable optical elements allowing the adjustment of beam parameters for laser beam cutting, welding, and deposition welding. For the additive technique, a wire supply is provided. Process control is possible through a coupling module for sensors and cameras. The unit operates in a robotic work cell. The entire cell, its components and communication are simulated in a digital twin which was used for planning and virtual commissioning of the complete system in a software-in-the-loop approach. Coupling the simulation with its physical counterpart, called hardware-in-the-loop, enables flexible direct cell control, flexible reconfiguration, training, and much more to satisfy global competition requirements.

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E100.A02

Online Monitoring of the Ultrashort Pulses Laser Microstructuring

Online monitoring is essential to increase the stability of the processing as well as accelerate its development. The particular challenge for the lasers with ultrashort pulses (USP lasers) micromachining lies in the high requirements on both spatial and temporal accuracy. Moreover, it is important that the measurement does not affect the processing.
These challenges are tackled by collecting the secondary process emissions via laterally integrated detectors. To achieve the spatial resolution, the actual processing position is recorded completely synchronously to the emissions intensities. For this purpose, an FPGA-based data acquisition system was developed. Furthermore, it performs the data analyses in parallel to the machining and can localize the defects as they appear on the workpiece surface.

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BOOTH 36b

DIGITALIZATION

E100.A02

Micro Service Network for Laser Micro Structuring with Industrial Robots

Commercial 3D-Micromachining systems are typically based on rigid and heavy cartesian systems. To achieve the accuracy required for 3D laser micro structuring with a commercial 6-axis robot, a sensor-based position detection and control system based on a micro service network is being developed at Fraunhofer ILT. The individual services perform the following tasks: Measurement of the 3D and 2D position of the robot relative to the workpiece, compensation of the position offsets by adjusting the laser scan vectors with a CAM postprocessor, external control of the robot position with a real-time PLC and control of the processing laser as well as the scanner.
The project partners "Module Works" and "AixPath" are developing the CAM post-processor to calculate the scan vectors and the robot positions to compensate for the measured position offsets.
The micro service network allows easy implementation of a fully automated process chain in a central server component with the benefit of a high flexibility to improve and exchange single services or add additional new services.

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BOOTH 37

JOINING

U102

Roll-to-Roll Laser Processing for Flexible Solar Cells

Silicon-based solar cells are currently unsurpassed in terms of efficiency. As an alternative, flexible solar cells can generate electricity wherever silicon modules cannot be installed due to their rigid shape, such as on wind turbine columns and on curved facades. This becomes economically interesting from an efficiency of ten percent. In the EffiLayers project, the Fraunhofer Institute for Laser Technology ILT is working on transferring the ten percent from the laboratory to continuous roll-to-roll production for solar films. The preliminary studies in the laboratory and the necessary plant conversions were completed at the beginning of 2022. Using the existing process know-how for roll-to-roll processing and laser technology processes, thin functional layers are applied to transparent films, the layer thickness will be determined in-line, cells will be separated using laser scribing and transparent protective films will be applied using laser welding.

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SYSTEM TECHNOLOGY / SURFACE TECHNOLOGY

BOOTH 38a

U120.1

Laser Polishing of Glasses and Polymers

The current state of the development of laser processes for polishing and form correction polishing of optics made from glass and polymers will be presented. These processes are currently under development and focus on the fabrication of highly individualized, non-spherical optics, since conventional manufacturing methods tend to be comparatively slow and expensive in this field. Laser polishing by melting can reduce the surface roughness significantly down to Sa < 1nm. In addition, micro ablation can be used to remove the last remaining redundant material to enhance the form accuracy and remove waviness. Therefore, an ultra-precision laser ablation process, the Laser Beam Figuring (LBF), is under development. Ablation depths down to 5 nm are possible with a spatial resolution of < 100 µm.

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SURFACE TECHNOLOGY

BOOTH 38b

U120.1

Laser Polishing of Metals

The latest results on laser polishing of metals will be shown:
- Machine tool for laser polishing of 3D parts
- CAM-NC data chain for easy programming of the polishing of complex shaped 3D parts
- Laser deburring
- Additive manufactured SLM parts polished with lasers
- 2-gloss-effects on tools
- Further laser polished samples (e.g. Titanium, Inconel 718, Aluminum, Tool steel 1.2343, GGG40, …)

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BOOTH 39 — HYDROGEN LAB

IBDPP E.02

Hydrogen Lab – Laser Processes for Hydrogen Technology

Green hydrogen produced by renewable electricity through water electrolysis is the energy carrier of the future. Potential areas of application include mobility and domestic energy supply based on fuel cells. In addition to further technological developments, a broad market penetration requires above all a significant cost reduction and a significant speed-up in production along the value chains of electrolysers, fuel cells and their components. Highly productive laser processes play a decisive role in scaling up the associated manufacturing processes.
In our brand new Hydrogen Lab you can expect modern laser-based equipment for coating, micro-structuring, cutting and joining of bipolar plates, as well as leak tightness and fuel cell test benches and numerous exhibits of the individual process steps for the production of a bipolar plate. As a highlight, we produce hydrogen live on laser-structured electrodes.

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BOOTH 40 — LASER

RCDPP 106

Optical Frequency Comb in the Vacuum Ultraviolet for 229-Thorium Nuclear Excitation

229-Thorium is the only element with a nuclear transition in the optical range, which is suitable for the operation of a nuclear clock. Such a clock can potentially reach a higher precision than atomic clocks. We are setting up a tunable frequency comb in the vacuum ultraviolet (VUV), which will be used to optically excite this transition for the first time. The VUV wavelength around 150 nm will be reached via high-harmonic generation (HHG) of a high-power infrared comb at 1050 nm. The system includes a nonlinear pulse compression and an enhancement resonator with 10 kW circulating power to reach the VUV power (1 nW per comb mode) required to drive the transition. A frequency comb in the VUV or EUV enables further applications in spectroscopy. Moreover, spatially coherent sources in the VUV to XUV, which can be realized by HHG, offer numerous applications in science and industry, e.g. photoemission spectroscopy, microscopy, lithography and metrology.

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QUANTUM TECHNOLOGY — BOOTH 41

RCDPP 108

VISION Quantum Networks

Emerging applications like distributed quantum computing and secure communication require qubits to perform long-range communication. Current qubits communicate on wavelengths not compatible with the established global fiber network used for high-speed internet connections. To establish this compatibility, quantum frequency conversion (QFC) uses nonlinear optics to convert the wavelength of single photons to fiber-compatible wavelengths Fraunhofer ILT and RWTH LLT are developing such devices in cooperation with excellent partners. In ML4Q, a demonstrator of a waveguide-based converter was set up with an internal efficiency of > 80 percent. At QuTech, we set a low noise record for the conversion of single photons from NV-centers in diamond using a novel converter concept. Strengthening this cooperation, we aim to establish an NV-center node in Aachen. In the HIFI project, funded by BMBF, we now aim to develop QFC with improved TRL together with German partners from Science and Industry.

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SURFACE TECHNOLOGY / DRILLING / MICRO- & NANOSTRUCTURING — BOOTH 42a

RCDPP 206

Scanner-Based Sub-µm USP Laser Structuring

A sophisticated UV microscanner has been developed at Fraunhofer ILT for the flexible generation of micro- and nanoscale structures and holes in different materials. The shorter wavelength of 343 nm is not only advantageous due to the higher absorption, especially in polymers, but also allows a significant reduction of the laser focus diameter. Focus diameters with a size down to 0.5 µm can be realized. The high-precision workstation is complemented by a linear axis system and a chromatic-confocal height sensor, both with < 0.3 µm accuracy.
With the aid of the UV microscanner, holes down to 0.8 µm in size can be reproducibly drilled with a tolerance of less than 10 percent. Even a high hole density in thermally sensitive material can be realized without any thermal material distortion. Nanostructures e.g. for surface functionalization can be manufactured with arbitrary designs in contrast to interference-based structuring methods that generate structure features in the same size regime.

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BOOTH 42b

MEDICAL TECHNOLOGY

RCDPP 220

Fundamentals of Laser-Based Biofabrication

With an aging population, the need for patient-specific treatments of age-related diseases is also increasing. Biofabrication, i.e. the automated production of functional biological tissues and products, is the key technology to address the medical challenges of the 21st century. Using laser-based biofabrication, the Chair of Laser Technology LLT at RWTH Aachen University, in close collaboration with Fraunhofer ILT, investigates digital photonic production techniques for biotechnology and medical technology at the Research Campus Digital Photonic Production (RCDPP). In the interdisciplinary laboratory at the RCDPP, research is focused on the synergy of materials development and lithography-based manufacturing technologies for subsequent cell seeding and maturation to generate 3D biohybrid constructs. Prospective applications are regenerative therapy approaches, as well as 3D tissue models that function as test systems for drug development and aid in tailoring treatment options to the individual patient.

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BOOTH 43a

DIGITALIZATION

RCDPP 319

New Laser Robotics Lab at the Chair for Laser Technology

Robot-based laser materials processing suffers from low stiffness of the robot resulting in insufficient path accuracy for many applications. At the same time progress in laser processing heads, robotics, sensors and new (AI-based) robot control systems allow for new kinematic concepts for force-free laser material processing. Within the framework of the Research Center of Digital Photonic Production (RCDPP), a new Laser Robotics Lab was established at the Chair for Laser Technology (LLT). The new lab is focused on new kinematic concepts, sensors, path planning and control strategies for robotics in laser material processing. Two new approaches in mobile robotics and trajectory planning are presented to showcase the new field of research.

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DIGITALIZATION

BOOTH 43b

RCDPP 319

Worldwide Laser Lab

The vision of the RWTH Aachen Cluster of Excellence "Internet of Production" (IoP) is to enable a new level of crossdomain collaboration by providing semantically adequate and context-aware data from production, development and usage in real-time, on an adequate level of granularity.
For this purpose, 25 institutes from RWTH Aachen University are working together at RWTH Aachen Campus. Within the "Worldwide Lab", a new joint digital infrastructure, the partners interconnect tailored process models and aggregated process data from different process chains.
Researchers from the Chair for Laser Technology are deeply involved in the development of according to IT-architecture as well as the development of digital connected laser machines. We demonstrate these activities with a prototypical laser scanning machine. With the help of a modular software architecture, we can load different processing apps to the machine for different requirements (processing strategies, data aggregation logic, …).

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ADDITIVE MANUFACTURING

BOOTH 44a

IBDPP E.01.2

Cooperation FH Aachen – Fraunhofer ILT (Aachen Center for 3D Printing)

The Aachen Center for 3D Printing, a collaborating Additive Manufacturing group formed by Fraunhofer ILT and Aachen University of Applied Sciences (FH Aachen), has been founded to offer primarily small and middle-sized companies access to AM technologies. In 2017 the research group started the project SLM XL with the aim to develop the Laser Powder Bed Fusion (LPBF) process to manufacture large components (> 250 x 250 x 250 mm^3) according to the quality requirements. The research focus contains the entire LPBF process chain for large components (data preparation, LPBF process and post-processing of the components). The research group was part of the public-funded project LEIMOT. In this project the LPBF technology will be used to develop the next generation of automotive engines. The functional optimized engine will be presented at this booth.

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BOOTH 44b

ADDITIVE MANUFACTURING

IBDPP E.01.2

Polymer Additive Manufacturing at Cooperation FH Aachen – Fraunhofer ILT

With over 10 years of experience in the field of additive manufacturing of plastic components using various additive manufacturing processes such as laser sintering (LS), fused layer modelling (FLM), stereolithography (SL) and 3D printing (3DP), Fraunhofer Institute for Laser Technology ILT and the University of Applied Sciences (FH) Aachen are among the leading research institutions in this field. The cooperative research group between Fraunhofer ILT and the FH Aachen actively shapes the further development of additive technologies for polymers along the entire physical and digital process chain – from the material to the laser technology to the finished component. In addition to numerous machines for the various manufacturing processes, it has extensive analytics for characterization the material and component properties of additively manufactured components made of polymers.

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BOOTH 45a

SYSTEM TECHNOLOGY

IBDPP E.02

System Integration for Cascaded Multibeam Optical Devices

The increase of productivity for applications using ultrashort pulsed lasers is strongly related to the scanning technology involved in the machining concept. During the initial phase of this project, a research platform was built consisting of a galvanometer scanner combined with a two-axis stage and an ultra-short pulsed laser, controlled and synchronized by an embedded software. However, the system was designed to allow flexible integration of additional optical systems due to a large optical table available in the machine setup. Using this advantage, the currently installed setup demonstrates how acousto-optic modulators can be integrated to enhance the production process.
As part of the Digital Photonic Production Research Campus, Busch, Edgewave, Scanlab and the RWTH Aachen University – Chair for Laser Technology LLT – develop new solutions and demonstrate how different optical technologies can be combined and controlled synchronously to gain better performance and productivity.

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ADDITIVE MANUFACTURING

BOOTH 45b

IBDPP E.02

HoPro3D – 3D Printing of Microfluidic Components with High Accuracy

3D printing is already being used to produce functional parts from polymers. Due to current events, the demand for short development times for microfluidic components is of particular interest. However, accuracies in the µm range are expected. Optical area exposure processes by UV photopolymerization achieve resolutions of about 25 µm. An increase in resolution to about 1or 2 µm is achieved by multiphoton polymerization (MPP), but this reduces the build-up rate by several orders of magnitude. The combination of area exposure with high build rates (approx. 1200 mm³/h) and fabrication by MPP for geometry fidelity allows short build times with the highest precision. Examples are the production of micro screens, mixed structures and cell traps. The combination process enables significant time savings, reduces lengthy iteration steps in development and thus represents an alternative with high economic potential.

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LASER

BOOTH 46

IBDPP 1.11

VCSEL Modules for Large Area Heat Treatment: Softening, Joining, Welding, Sealing of Various Materials

TRUMPF Photonic Components, technology leader in VCSEL and photodiode solutions for consumer electronics, datacom, automotive and industrial markets. At the Digital Photonic Production (DPP) Research Campus in Aachen, TRUMPF is focusing on VCSEL-based high power heating systems. The compact laser modules offering scalable and flexible solutions for industrial thermal processes. VCSEL-based micro laser arrays are delivering directed large-area beams of near infrared power that can be applied in many industrial heating applications from e-mobility to electronics industries.
The unique solution offers homogenous heat treatment of large target areas, achieving high process speeds, due to the high irradiance of over 100 W/cm². Furthermore, high precision and flexibility is given by the independently controllable emission zones.
In the live demonstration TRUMPF is showing local softening of high strength steel. With the VCSEL heating modules high tensile steel parts can be selectively softened quick and easy.

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