



MACHINE TECHNOLOGY FOR LASER POWDER BED FUSION



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Fraunhofer Institute for Laser Technology ILT

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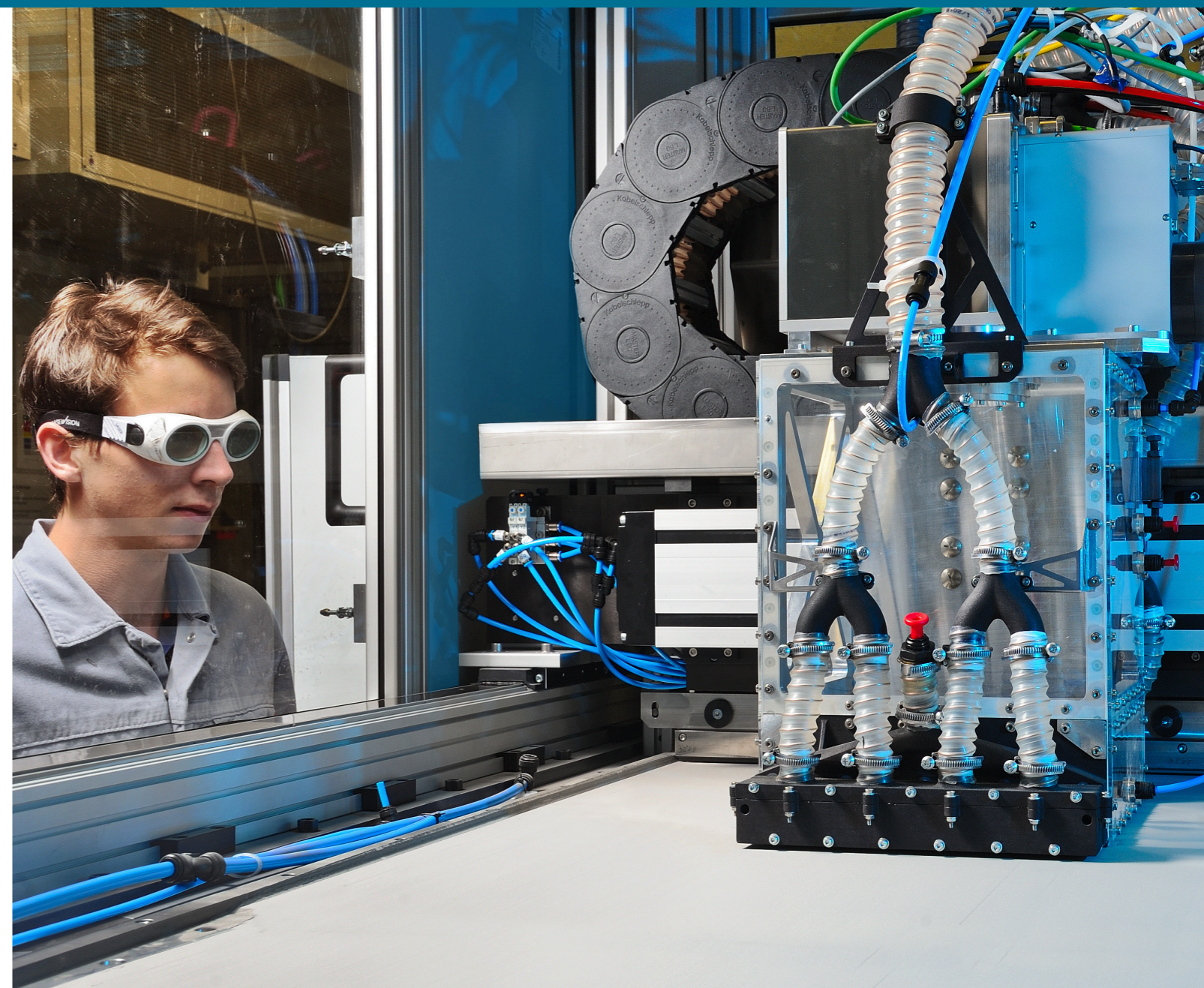
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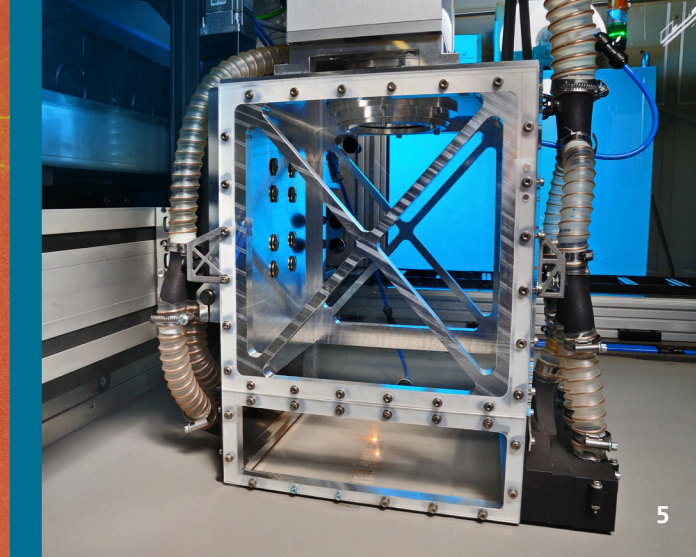
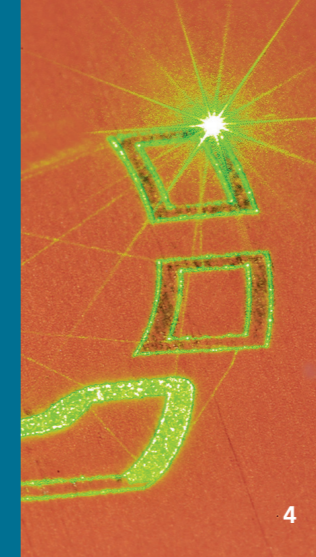
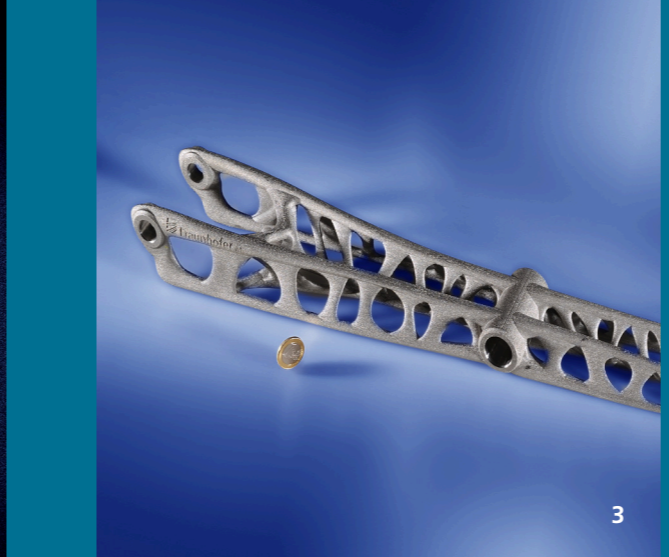
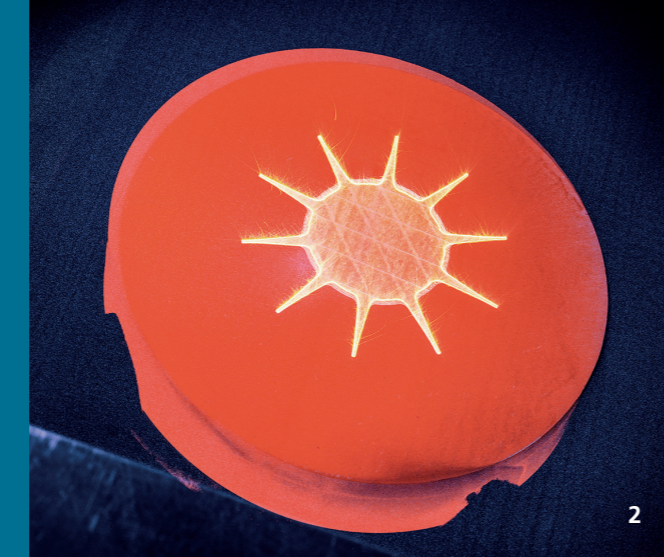
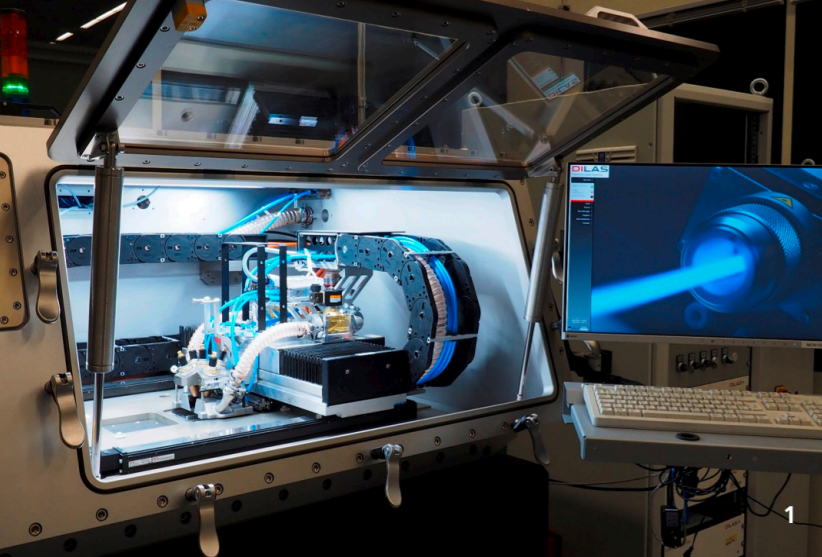
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Fraunhofer Institute for Laser Technology ILT

The Fraunhofer Institute for Laser Technology ILT is one of the most important development and contract research institutes in laser development and application worldwide. Its activities encompass a wide range of areas such as developing new laser beam sources and components, laser-based metrology, testing technology and industrial laser processes. This includes laser cutting, ablation, drilling, welding and soldering as well as surface treatment, micro processing and additive manufacturing. Furthermore, Fraunhofer ILT develops photonic components and beam sources for quantum technology.

Overall, Fraunhofer ILT is active in the fields of laser plant technology, digitalization, process monitoring and control, simulation and modeling, AI in laser technology and in the entire system technology. We offer feasibility studies, process qualification and laser integration in customized manufacturing lines. The institute focuses on research and development for industrial and societal challenges in the areas of health, safety, communication, production, mobility, energy and environment. Fraunhofer ILT is integrated into the Fraunhofer-Gesellschaft.





MACHINE TECHNOLOGY FOR LASER POWDER BED FUSION

The Fraunhofer Institute for Laser Technology ILT has been developing the additive manufacturing process Laser Powder Bed Fusion (LPBF) since the mid-1990s and, ever since, has been consistently advancing the entire LPBF process chain. The institute aims to qualify the process for use in industrial production and to integrate it into existing production processes. To accomplish this, the experts at Fraunhofer ILT work together with customers from industry and research on an interdisciplinary basis.

LPBF machine technology

Since LPBF builds up structure directly from CAD data layer by layer, it can produce highly complex components from metallic materials without using shaping tools, materials that cannot be produced using conventional manufacturing processes such as casting or machining. LPBF can be used to generate novel components with innovative functionalities because previous production-related restrictions are no longer relevant.

Almost all currently available LPBF machines have a movable build platform on which a powder layer is applied by a powder coating unit. The surface of this powder bed is then melted by laser in accordance with the component geometry to be produced. The laser beam required for this is deflected via a galvanometer scanner and focused with a flat field lens (F-theta optics) or a vario optical system. Metallic materials are processed in an inert gas atmosphere, with the gas circuit also performing the task of removing flue gases and process-related spatter.

The components used (beam source, optics, powder application unit and axis systems) influence various properties of the overall system, such as process speed, downtime, component quality and automation capability. The appropriate selection and combination of individual components for the corresponding application is, therefore, decisive for the economical use of Laser Powder Bed Fusion.

Main areas of research

Based on years of experience and competence, Fraunhofer ILT experts can support you individually from your initial idea, through feasibility studies and concept development, all the way to implementing and integrating the systems into your production environment. Not only is our extensive plant equipment, consisting of various commercial systems and highly flexible laboratory systems, at your disposal, but also our profound know-how in the field of laser beam source and optics development.

Since we cooperate closely with RWTH Aachen University and FH Aachen University of Applied Sciences, you benefit from the bundled competence of the Aachen location in the field of additive manufacturing. Fraunhofer ILT is therefore your competent partner in all areas of additive manufacturing using LPBF.

1 Machine with multi-diode laser system.

2 High temperature preheating system.

3 Large aerospace component manufactured with a specially designed LPBF machine.

Scalable machine concepts

An essential prerequisite for LPBF to be successfully industrialized is the scalability of the machine technology – in terms of build volume and productivity. For this purpose, Fraunhofer ILT is developing innovative machine concepts based on mobile processing heads with local shielding gas guidance, concepts that enable simple scaling of the build volume. Multi-beam source systems are used to increase productivity, whereby both classic galvanometer scanners and novel kinematics concepts are being investigated.

Laser beam sources and optical systems

The process and cost efficiency of the LPBF process can be increased by using adapted laser and optical systems. Fraunhofer ILT is testing new laser beam sources with short-wavelength light that promote efficient energy coupling, in particular for highly reflective materials such as pure copper. In addition, cost-effective diode laser systems are being qualified for use in LPBF and optical systems developed for adaptive beam shaping, both of which will enable higher build-up rates.

Robust preheating systems

Component distortion and cracking in LPBF can be prevented by suitable preheating. Fraunhofer ILT has preheating systems that reach temperatures of up to 1200 °C and enable sophisticated materials susceptible to cracking to be processed crack-free. In addition to conventional build platform heating, novel systems are being developed for direct preheating at the process level. This enables constant preheating conditions to be achieved regardless of the component size.

Process monitoring and data analysis

Reproducible process and component quality is essential for LPBF to enter series production. In order to guarantee this, adapted process monitoring systems are required. Fraunhofer ILT uses pyrometers and camera-based systems to analyze and monitor the LPBF process. It is also investigating platform technologies for integrating measurement data relevant to the process into cloud-based systems and suitable analysis methods.

Equipment

In addition to our many years of experience and profound know-how in the field of LPBF, you can also benefit from the extensive equipment at Fraunhofer ILT:

- Various laser beam sources (wavelengths, intensity distributions, multi-kW powers)
- Different optical systems (lenses, scanners, etc.),
- Flexible laboratory machines for testing new types of laser, optical or protective gas systems
- Measurement technology for the characterization of LPBF machines (laser, optics and shielding gas)
- LPBF preheating systems.

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4 LPBF process with green light.
5 Machine with mobile processing head.