

PROCESS CONTROL IN LASER MATERIALS PROCESSING



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DIN EN ISO 9001:2015
Reg.-No. 069572 QM15

Fraunhofer Institute for Laser Technology ILT

Director
Prof. Constantin Häfner

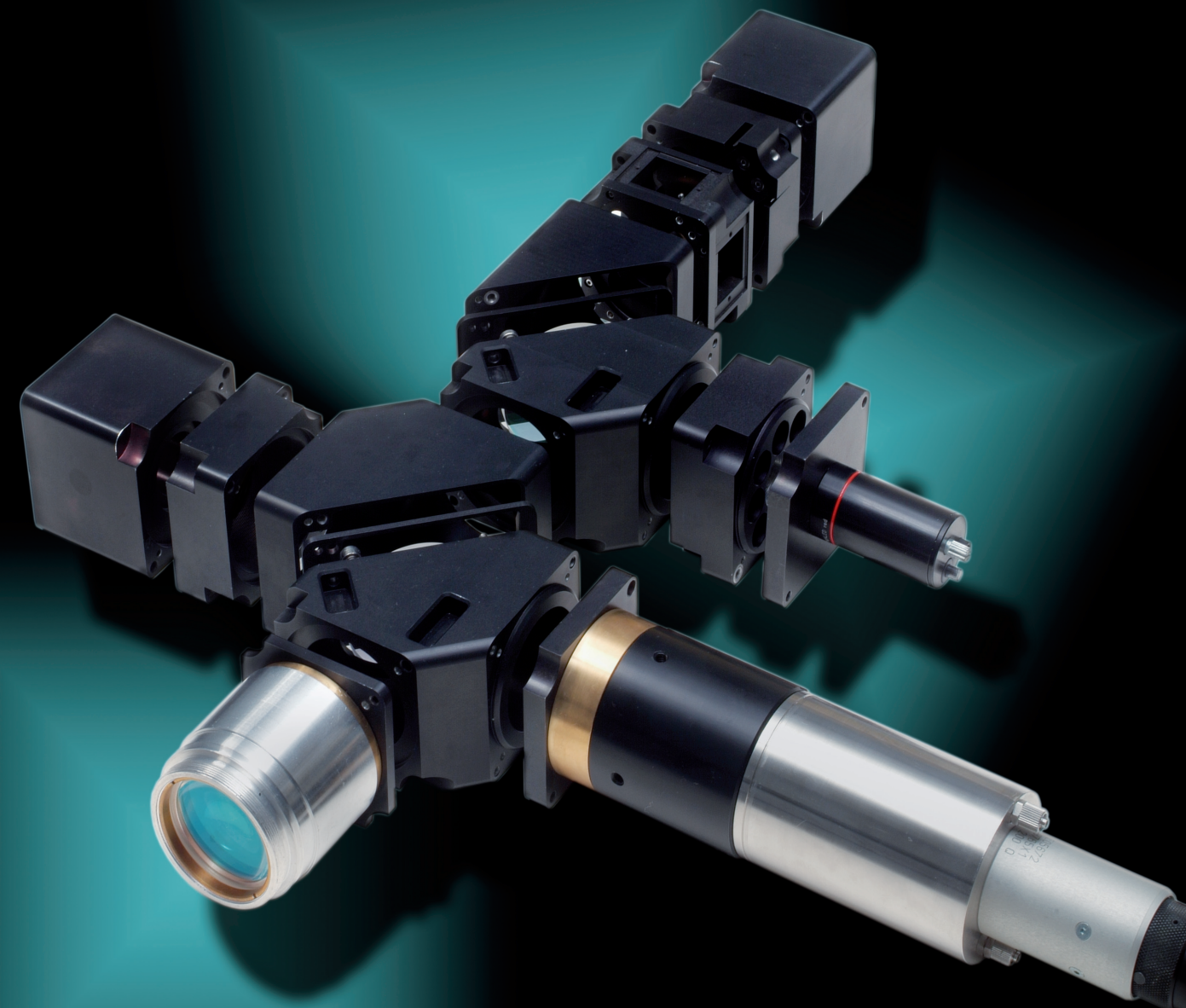
Steinbachstraße 15
52074 Aachen, Germany
Telephone +49 241 8906-0
Fax +49 241 8906-121

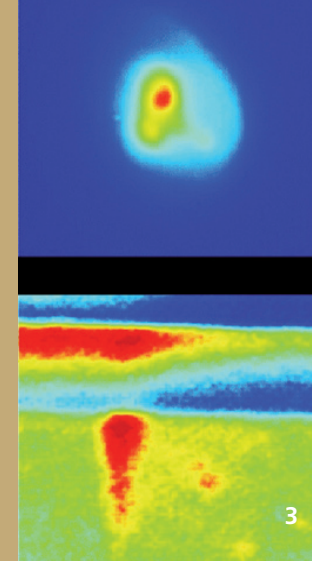
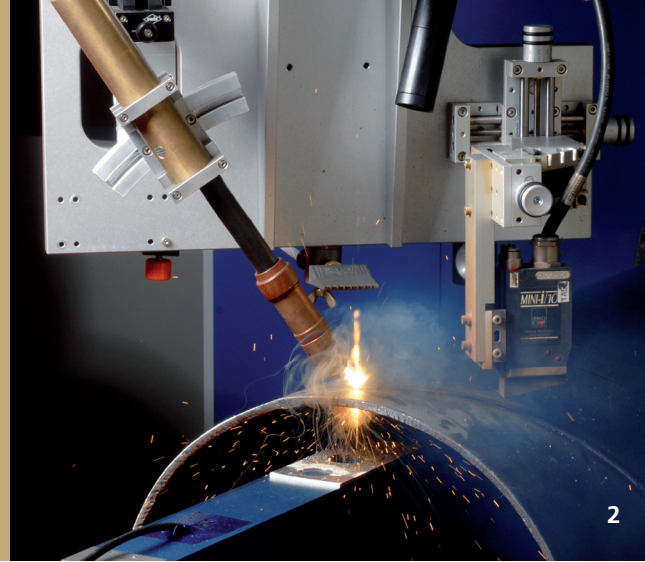
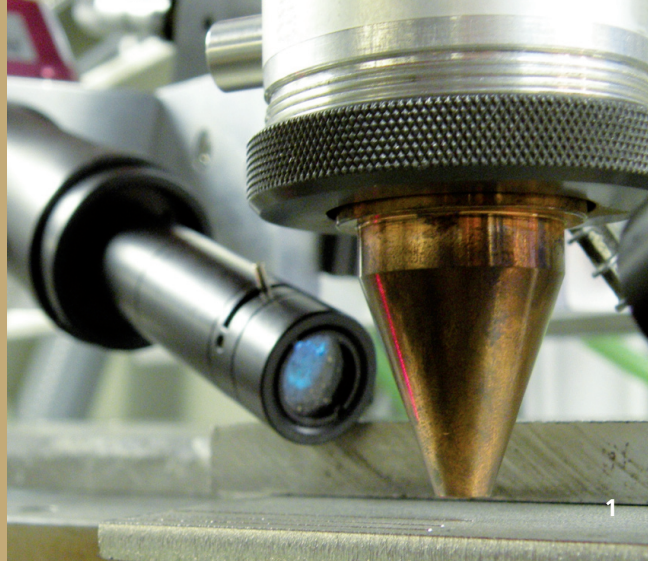
info@ilt.fraunhofer.de
www.ilt.fraunhofer.de

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.





PROCESS CONTROL IN LASER MATERIALS PROCESSING

The Process Control group at the Fraunhofer Institute for Laser Technology ILT develops and evaluates industrial process control systems. In addition to diagnostics and monitoring, the core portfolio includes the closed-loop control of laser processes. At the forefront of the engagement in research and development lies the improvement of product quality. The range of services to achieve this goal spans from process diagnostics through the development of innovative sensor systems to the complete integration of control systems on the customer's premises.

Process Control

The requirements for process control today no longer simply contain recording of process measurands, but monitoring the behaviour of the process by means of interim and trend information. Herein, derivation of indicators for the processing result makes process diagnostics an important element of understanding and optimizing laser processes.

Key Benefits

- Generation of new process knowledge by process visualization and process diagnostics
- Process monitoring for closed loop-control
- Quality assurance
- Documentation of laser processes by monitoring setting parameters, process measurands and product quality
- Detection and Reduction of the occurrence of insufficient product quality
- Robust process operation at the limits of stable process windows
- Efficient usage of laser manufacturing processes
- Facilitating highly dynamic laser processes with stringent requirements on mechanical precision
- Cost reduction for subsequent processes

Efficient and stable usage of process diagnostics in the industrial environment calls for an extensive understanding of the process as well as precise knowledge of the systems and machines in use. Development and integration of process diagnostic systems employ the extensive know-how and experience gained by ILT's experts in the fields of process development and modelling, system technology and beam source development.

Sensor Systems

Contactless measurement techniques such as pyrometry, thermography and spectroscopy in combination with triangulation and camera based observation preserve the technological advantages of laser processes. Signals that are acquired from such sensors are processed and analyzed by individual software that is derived from a collection of signal processing algorithms. Robust, online analysis of recorded data and the extension of Fraunhofer ILT's algorithm framework are central objectives of the research. In order to meet the full range of requirements in process diagnostics the extensive range of sensor systems is extended continuously.

Process Diagnostics

Process knowledge is being generated through the application of various diagnostic techniques. Tailored to the process and the current task, these techniques enable to discover relationships between setting parameters, process measurands and product quality. Such information identifies process measurands that can be used for process monitoring. In addition to direct measurands such as the feed rate, insights into the product quality are also gained through indirect measurands such as the weld pool geometry or heat distribution.

Process Monitoring

Increasing demand on quality and productivity in laser materials processing creates the necessity to apply process monitoring systems in industrial manufacturing. Visualization of the process zone enables operators to observe the process which contributes to productivity in multiple ways. Resource utilization for set-up of processes is reduced through the possibility to directly analyze the effect from changes in setting parameters. During production, the observation allows experienced operators to take corrective action which reduces the probability of rejects. The transition to online process monitoring finally replaces expensive downstream quality checks, enabling the manufacturing process to be documented in accordance with DIN EN ISO 9001 quality management systems.

Closed Loop Control

Manufacturing processes can be controlled when sufficient process understanding exists to reliably correlate the monitored values with product quality. ILT's Process Control Group develops customized closed loop control solutions which optimize existing manufacturing systems and enable entirely new processing strategies.

Facilities

- Digital high-speed cameras with frame rates up to 1,000,000 frames per second
- Photocathode image intensifier in the visible spectral range
- Digital IR and NIR high-speed cameras
- Pyrometers with measurement ranges from 100°C and a measurement rate of 10,000 measurements per second
- High-power LED illumination systems in the visible and in the NIR spectral range
- Laser beam sources for illumination at different wavelengths
- Coaxial Process Control System, customizable, modular optical system for integration of sensors into laser based manufacturing systems (CPC-System)
- Reference sources for calibration of measurement equipment
- Measurement equipment for laser beam characterization
- Software libraries for signal processing and task specific software development
- Laser manufacturing systems with various handlings, processing heads and a large variety of different laser sources

Contact

Dipl.-Ing. Peter Abels
Telephone +49 241 8906-428
peter.abels@ilt.fraunhofer.de

Cover: Coaxial Process Control System (CPC-System).

- 1 Lateral process visualization of laser beam cutting.
- 2 Process monitoring of laser hybrid arc welding.
- 3 X-ray image of the welding process in false colour representation.
- 4 Industrial laser brazing optics with process monitoring system.
- 5 High-power LED illumination source.