

THEMATIC RESEARCH FOCUS

Research area

- Laser welding
- Laser 2D/3D cutting
- Process diagnostic
- Visualizations of process gas flowing
- High power beam shaping

Excellence

- Diagnostics of laser welding process
- Visualization of gas flowing in laser welding and laser cutting process

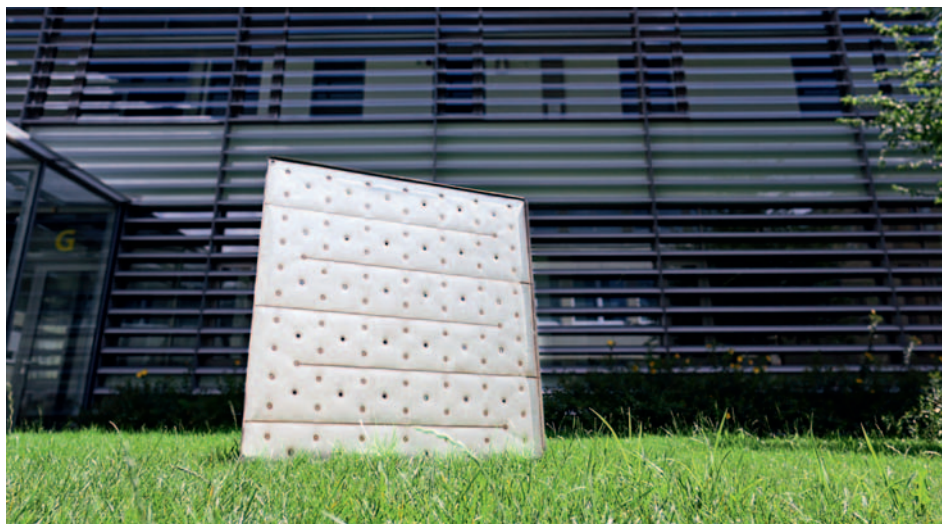
Mission

- Theoretical and experimental study of the laser welding process
- Control of the laser welding process
- Application of the laser welding technology for the manufacturing of heat exchangers and solar absorbers
- Thin optical coatings for high-power laser optics

UP-TO-DATE ACTIVITIES

Research orientation/focus

- Correlation of the penetration depth and the frequency characteristics of the light emissions produced during the welding process
- Numeric modeling of the laser welding process
- Analysis of the welding process dynamics by means of image processing
- Analysis of the laser weld microstructure by means of electron microscopy
- Development of optical components adjusting the intensity distribution and the focal geometry of the laser beam
- Theoretical and experimental study of laser induced damage threshold of thin film optical coatings



Laser welded solar collectors

**Institute of Scientific Instruments
of the CAS, v. v. i.**

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Main capabilities

Basic research

- Study of the welding process using a method based on frequency analysis of the light oscillations produced during the process
- Numeric modeling of the welding process depending on the welding parameters and the focal geometry of the laser beam

Applied research

- New type of a sensor monitoring the quality of the laser welding process
- System for continuous control and optimization of the laser beam geometry during the welding process
- Heat exchangers and solar absorbers with controlled circulation
- Laser induced damage threshold test station

Innovations

- Licence agreement about utilization of methods of monitoring laser welding process based on patent CZ303797

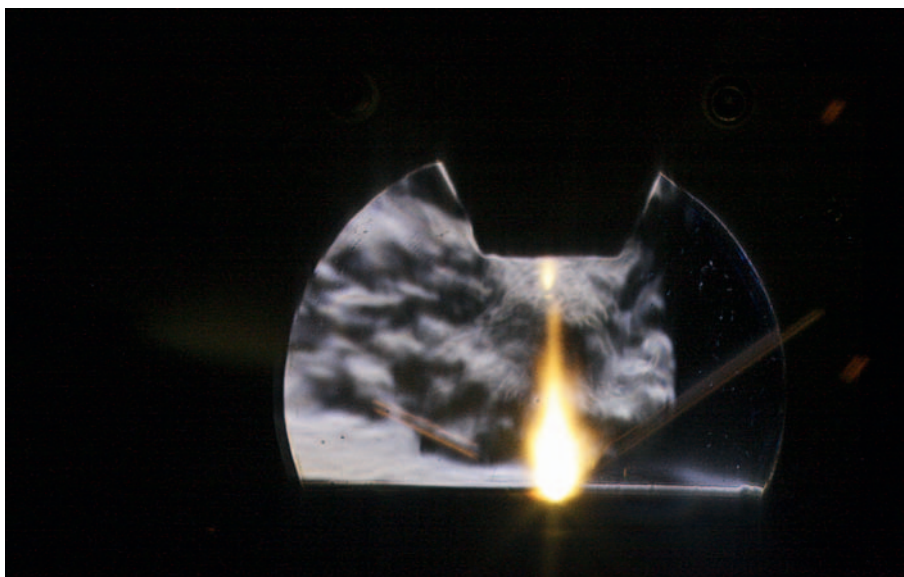
Sub-fields of group activities

- Engineering industry related to modern methods of material processing
- Renewable energy
- Materials science
- Optics for high-power lasers

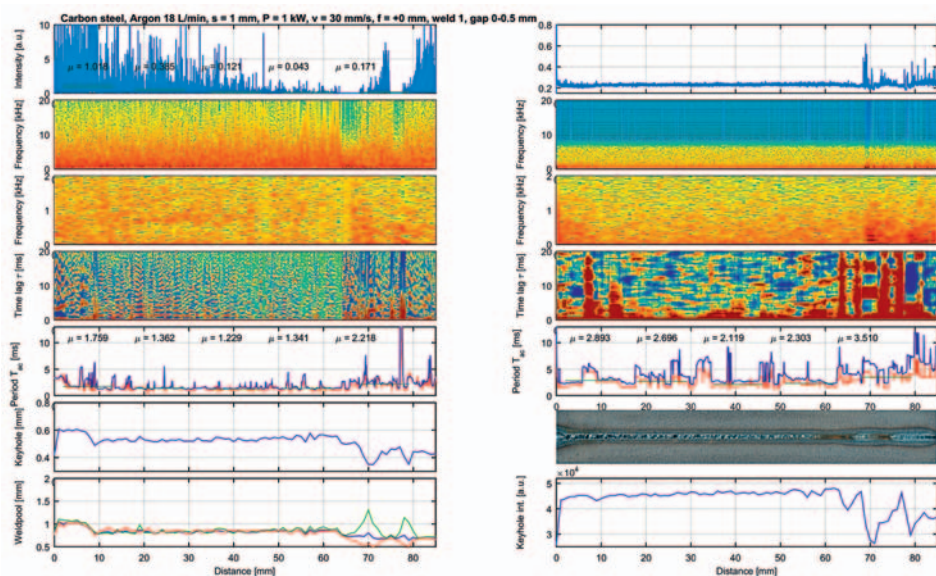
KEY RESEARCH EQUIPMENT

List of devices

- Laser YLS2000 (IPG photonics)
- Welding head YW30 (Precitec)
- Cutting head YRC100, (Precitec)
- Scanning welding head Fiber RHINO (ARGES)
- Robotic arm IRB2400 and 2-axis rotary positioner IRBP250 (ABB)
- Infrared Camera FLIR A310
- BeamWatch BW-NIR-2-55 (Ophir)
- PIAD Electron beam evaporation coating system SYRUSpro 710 (Leybold Optics)
- Electron beam evaporation coating system Balzers BAK550
- Spectrophotometer Varian CARY 5E



Displaying the flow of shielding gas and plasma plume in the schlieren field



An example of a complex evaluation of the radiation of plasma plume through the laser weld

ACHIEVEMENTS

■ We study the laser welding process using frequency and time analysis of plasma plume radiation and using the schlieren methods for visualizes the interaction between plasma and shielding gas.

- L. Mrňa, P. Horník: "Autocorrelation Function for Monitoring the Gap between The Steel Plates During Laser Welding" *Physics Procedia*. **83**, 1223-1232, 2016
- L. Mrňa, M. Šarbort, Š. Řeřucha: "Autocorrelation analysis of plasma plume oscillations in deep penetration laser welding", *Lasers in Manufacturing (LiM)*, Munich: WLT, 75, 2015
- L. Mrňa, M. Šarbort: "Plasma bursts in deep penetration laser welding", *Physics Procedia*. 8th International Conference on Laser Assisted Net Shape Engineering (LANE 2014), 1-1436, 2014

■ We designed the optics to change the profile of the power of the laser beam.

- L. Mrňa, M. Šarbort, Š. Řeřucha, P. Jedlička: "Adaptive optics for control of the laser welding process", *OaM 2012 - Optics and Measurement International Conference*. Proceedings of a meeting **48**. Liberec: EDP Sciences, 00017:1-6, 2013

■ We participate in the design and construction of new types of solar absorbers, where it uses laser welding technology.

- L. Mrňa, Z. Lidmila, K. Podaný, M. Forejt, J. Kubiček: "Manufacturing of Solar Absorber by Unconventional Methods", *METAL 2012 Conference Proceedings 21st International Conference on Metallurgy and Materials*, Ostrava: TANGER Ltd, 2012

MAIN COLLABORATING PARTNERS

Collaboration with academic partners

Brno University of Technology (Brno, CZ)
Masaryk University (Brno, CZ)

Collaboration with companies

- Tescan Orsay (Brno, CZ)
- Aquadem (Brno, CZ)
- Matex PM (Plzeň, CZ)
- HIWIN (Brno, CZ+South Korea)
- Thermacut (Uherské Hradiště, CZ+USA)

EXPECTATIONS

Offers

- Licensing of the patent for automatic optimization of the laser beam geometry in laser welding
- Partnership in international projects
- Contractual research in laser welding, cutting, etc.
- Consulting in the field of laser welding, cutting, surface hardening etc.
- Cooperation in the development of solar absorbers and heat exchangers
- Design and production of custom thin film optical coatings
- Consulting in the field of optical coating deposition

Requirements

- Real interest in applied research and innovation
- Knowledge of grant projects
- Collaboration with industrial partners in common projects dedicated to applied science
- New complementary technologies



Laser cutting in action