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FRAUNHOFER INSTITUTE FOR MATERIAL AND BEAM TECHNOLOGY IWS

BUSINESS UNIT JOINING

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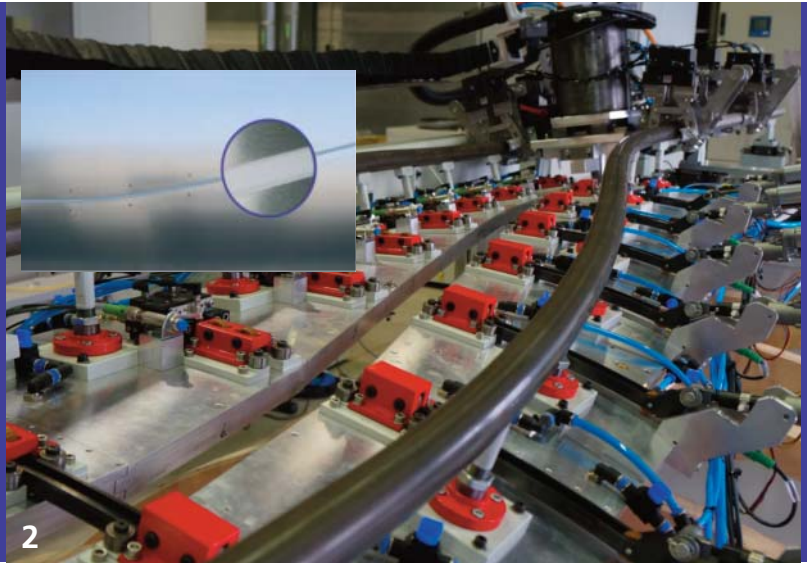


NEW TECHNOLOGIES FOR JOINING METALLIC AND NON-METALLIC MATERIALS

The Fraunhofer IWS can draw on long-standing experience in the business unit "Joining", especially in laser welding, friction stir welding, magnetic pulse welding, bonding, composite technologies and component design. Following the credo "everything from a single source", custom joining technologies based on the analysis of the behaviour of the material – through the observation of the effects of the joining process, the development of the process up to the implementation of machine based solutions – are developed, accompanying the customer up to the industrial application.

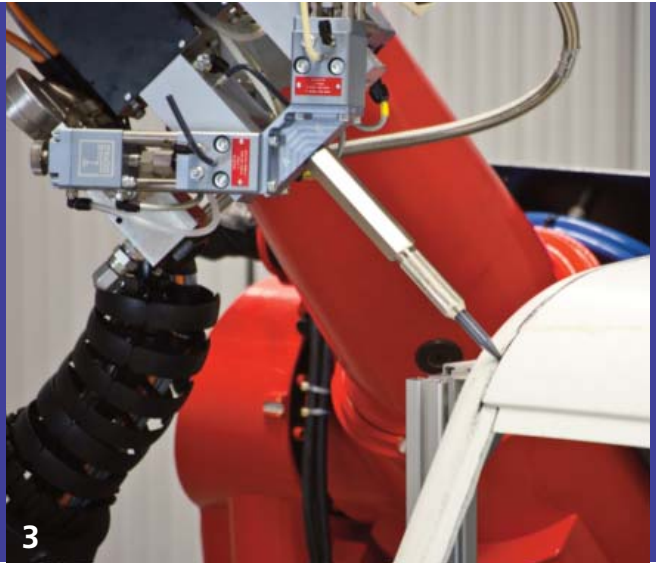
Scientific basis

- application of scientific knowledge about the material in the development of appropriate joining methods
- derivation of treatment strategies adapted to materials, loads and components based on in-depth knowledge about the influence of micro-structure and real structure on the spectrum of properties
- characterisation of the thermal, mechanical and electromagnetic influences on material structure and component properties resulting from the joining processes
- finite element analysis of structural-mechanical and thermomechanically coupled field problems and their experimental validation
- development of process-adapted test equipment and system technology

Trends

Lightweight engineering, based on a load-adapted material selection, increasingly requires the development of new, adapted joining technologies for mixed metal compounds, light metals and for metal-plastic mixed compounds.

Efficient joining methods, such as laser welding with brilliant beam sources, friction stir welding, and electromagnetic pulse welding as a solid phase joining method, as well as modified adhesives, composite technology and direct thermal joining are in the focus of development. The FEM-based structural and thermomechanical coupled calculation of joined and processed components and the derivation of design criteria as well as the development of custom systems are further important development elements for the required comprehensive approach.



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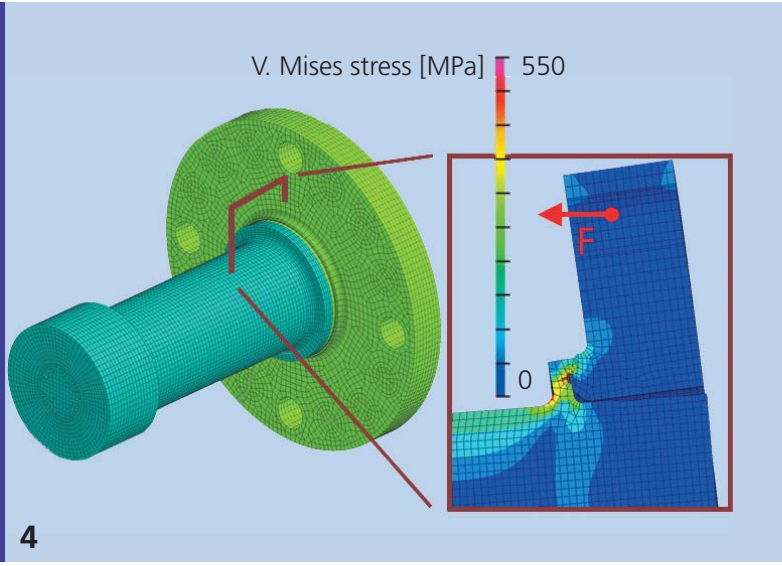

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OUR EXPERTISE

Laser beam welding

Process understanding and metal physical background knowledge are the basis for custom laser welding processes. Procedures with integrated short-time heat treatment, with material-matched filler materials and high-frequency beam manipulation, allow for a new approach for producing crack-free welds from curable, high-strength steels, cast iron, light metal casting and heat-cracking susceptible Al or Ni materials, mixed compounds and components with high rigidity and high wall thickness.

Special joining methods

The further development of solid-phase joining procedures, friction stir welding and electromagnetic pulse welding is indispensable for the firm joining of modern functional materials and metal mixed compounds, which can only be joined in a limited manner using standard fusion welding without cracking. Our range of services includes development of procedures, prototype welding and system technology developments.

Bonding and composite technology

By pooling their expertise, modern laboratories and highly efficient plant technology for the development of new plasma and laser pretreatment procedures for large-area bonding of metals, polymers and fiber composites are available. The expertise in structural bonding is currently being transmitted to thermal direct joining of thermoplastic composite materials in order to both substitute adhesive systems and to reduce process times. To prove joint strength under environmental conditions, in addition to mechanical testing methods also aging studies, such as climate and salt spray tests are conducted.

Component design

More stringent component requirements, innovative materials, material combinations and new manufacturing processes typically require new constructive approaches. Thus, for successful implementation of the procedures, we offer structural-mechanical FE simulations, thermomechanically coupled calculations as well as their experimental verification. The objective is a process-oriented and stress-adapted component design according to the specifications of the customer, in close cooperation with the development of procedures and the characterization of materials at our facilities.

1 *Laser welding process of a conceptual shaft-hub mixed compound (cast iron/heat-treated steel) for stress tests*

2 *MUVAX – new concept for friction stir welding of aircraft fuselage components*

3 *Robot-coupled adhesive application by means of a 2K adhesive application unit*

4 *Model of a laser welded shaft-hub mixed compound with stress distribution under operating load*

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HIGHLIGHTS

Due to the advanced state of development of industrial-grade and efficient joining technologies, technology developments are continuously transferred to industrial use. Examples of the transfer of IWS innovations and new developments are:

- laser welding in the field of gears and power trains – a variety of Fraunhofer IWS-supervised industrial applications testifies to the successful collaboration with motor vehicle manufacturers such as BMW, Daimler, Ford, Volkswagen and gear manufacturers and suppliers such as AAM, GETRAG, GKN, Visteon, Winkelmann and ZF throughout Europe, the US and the Far East
- development of laser welding of metallic fuselage structures – the Fraunhofer IWS has decisively contributed to the development of the necessary technologies crucial in cooperation with the Airbus Group
- development of a new machine concept for friction stir welding of aircraft fuselage structures as part of aeronautical research programs
- procedure and system technology for several-level narrow gap laser welding of wall thicknesses from 50 to 200 mm of aluminum and steel materials
- development of a laser module and system concept based on high-frequency beam oscillation for welding of cooling components made of die-cast aluminum for car engines

The basis for these industrial solutions is the continuous development of new system solutions which allow their transfer to industrial scale processes and environments already in the lab phase. Among other things, this is based on:

- unique laser beam welding system for simultaneous both-side 3D welding of large-size components (size up to 10 x 3 x 1 m^3) with 22 CNC axes and integrated CNC controlled component management and clamping technology
- multi-remote system for large area remote processing for laser welding and surface preparation
- 3D processing system for combined milling, laser beam welding and friction stir welding based on Pentapod parallel kinematics (working space 6.5 x 2.5 x 1.5 m^3)