



**Fraunhofer**

**IWU**

FRAUNHOFER INSTITUTE FOR MACHINE TOOLS AND FORMING TECHNOLOGY IWU

# THERMAL JOINING





# JOINING TECHNOLOGIES

## DEVELOPMENT OF NEW APPLICATIONS

The Fraunhofer IWU offers complete solutions for welding technology – starting with analysis of the joining task, considering the effects of the welding process on the structure, the material properties and the resulting product properties, optimization of product and technology up to industrial implementation.

### Modern joining technologies

Depending on the joining task, modern joining technologies are selected, providing the best results in regard to component properties, quality, production time and investment. Basic technologies are used which are developed and optimized according to the intended application.

#### – Laser technologies

- Welding/soldering with and without additional material
- Remote and scanner welding
- Hybrid welding (laser GMAW, laser plasma)
- Deposition welding (wire, powder)
- Cutting
- Heat treatment (hardening)

#### – Arc technologies

- Gas shielded welding and soldering (MAG, MIG, CMT, ColdArc, ForceArc)
- Plasma welding and soldering
- TIG welding and soldering

#### – Resistance spot-welding / resistance projection-welding

#### – Special technologies

- Friction welding (punctate, linear, areal)
- Magnet arc welding
- Joining technologies for material combinations (metal, FRP)

### Joining technologies for lightweight designs

Lightweight design is a key technology and a special challenge for joining technology. Based on the latest research findings, we offer highly customized solutions for a wide range of industrial sectors.

#### – Lightweight design for materials

- Super high strength steels
- Light metals (aluminum, magnesium, titanium)
- Fiber-reinforced plastics (CFRP, GFRP)

#### – Lightweight design for structures

- Tailored products (sheets, profiles)
- Structured sheets (partial or final strengthening)

#### – Functional lightweight design

### Joining technologies for mixed compounds

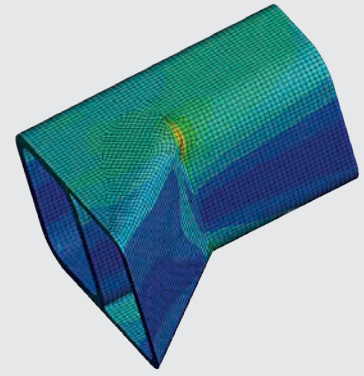
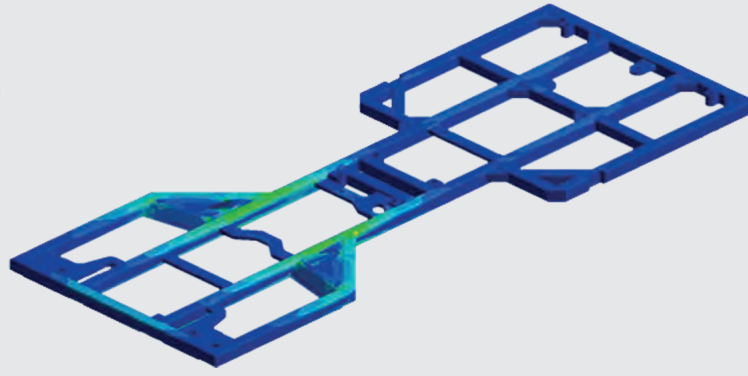
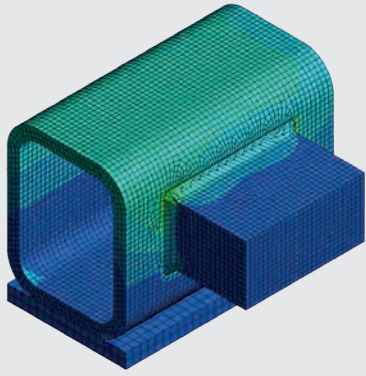
- Welding/soldering of metal compounds such as steel-aluminum alloys, steel-magnesium alloys or aluminum-magnesium alloys (punctate, linear, areal)
- Non-thermal joining technologies for metal-FRP-compounds

### Energy and resource efficiency of joining

Consumption of energy and resources while using joining technologies is a central cost factor for companies.

Our offer includes:

- Evaluation and comparison of joining technologies
- Evaluation of joining technologies in process chains
- Comparison of variants
- Development of new joining strategies



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## PROCESS AND COMPONENT ANALYZING, MODELING, OPTIMIZING

### Process analysis

The properties of joints are determined by various process factors. Modern methods and equipment are used for analysis, modeling and optimization of welding processes.

### Welding process and distortion simulation

Welding simulation is a standard tool which is used to calculate and optimize the welded joint, its metallurgic properties and dimensional accuracy.

Our offer includes:

- Simulation for laser beam welding, arc welding and resistance pressure welding
- Determination of thermal fields
- Estimation of welding distortion and internal stress for punctate and linear welded joints

### Damage analysis

Defective welded joints are a common cause of damage. Damage reports include damage mechanisms, repair concepts and concepts to avoid damage.

### Component design

Component design determines the most important constraints on production and later on the component properties. Welded joints put high requirements on the design and have significant influence on properties.

Our support for your component design:

- CAD design (from the concept via prototyping and optimizing up to comparison of variants)
- Integration of welded joints
- Dimensioning and proof of strength according to current standards (DIN EN 1993 (EUROCODE 3), FKM-recommendations, IIW-recommendations)
- Creation of design documents and tests (especially with regard to the welding execution)

### Simulation and optimization of components

- Interconnection of complex structures (CAD/FEM)
- Effect simulation (deformation, stress)
- Optimization of topology

### Component and material properties

- Test of components and small samples
- Mechanical and thermal properties
  - Static stability
  - Fatigue behavior
  - Crash properties
- Corrosion properties
- Metallographic properties
- Determination of weld quality according to standards

1 High speed recording of the laser-MIG-welding of magnesium

2 Tension analysis of welded components

3 Inner part of a car door with laser-welded tailored blanks of magnesium



# PROTOTYPING

## FROM THE IDEA TO THE PRACTICAL IMPLEMENTATION

We will support you along the entire development chain – from the selection of the appropriate material and the welding process up to the construction of suitable welding devices, the design of optimal process chains to welding of prototypes and to industrial implementation. In this context, it is essential for us to prepare and follow strategies for quality assurance.

### Production concepts

- Development of specific production concepts
- Screening of joining technologies (systematic comparison of possible joining strategies)
- Development, establishment and testing of welding units

### Laboratory implementation and research factory

- Virtual and real mapping of sub-processes
- Analysis of sensitivity
- Optimization of the process
- Prototypes and test series

### Manufacturing implementation

- Transfer of technologies to the business
- Preparation of production files
- Monitoring of the production start-up with experts
- On-site training
- External monitoring of the production

### Quality management

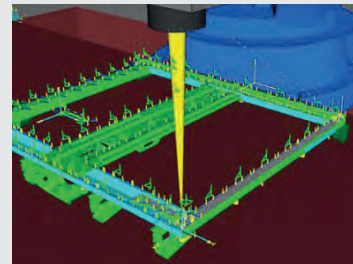
- Concepts of quality management (including automatic weld monitoring) and implementation
- Development and optimization of test methods
- Documentation
- Training

### Frame of a backseat: from design to the use in the automobile

DESIGN



SIMULATION

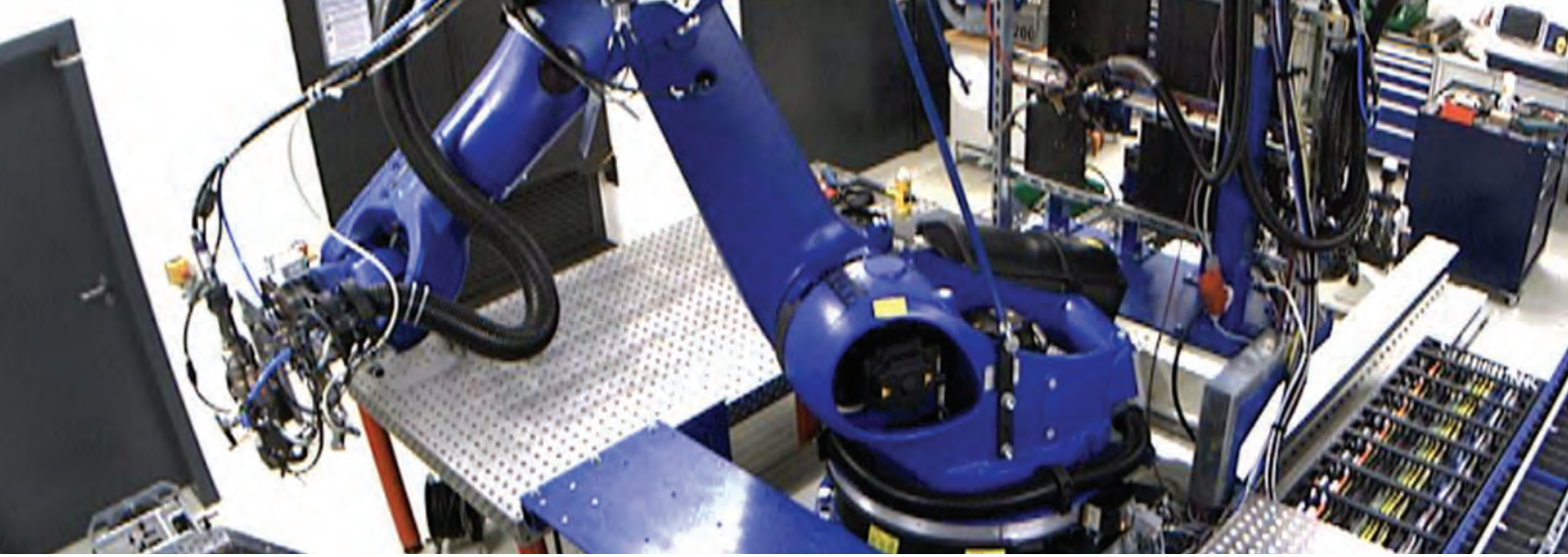


MANUFACTURING



APPLICATION





## EQUIPMENT FOR THERMAL JOINING (SELECTION)

### Laser machining equipment

- 10 kW disc laser with portal system (TRUMPF TruLaser Cell 7020 with TruDisk 10002)
- 6 kW disc laser with industrial robot system and linear axis (TRUMPF TruDisk 6002, KUKA KR100HA on linear axis and DKP 400)
- Diode laser 2x500 W for laser hardening and laser soldering
- Different laser lens systems for welding, deposition welding, soldering, cutting and heat treatment
- Process sensors and weld tracking systems

### Gas shielded arc welding equipment

- GMAW welding power source (EWM Phoenix 522 ColdArc/ForceArc, Fronius Transpuls Synergic 5000, Merkle 55 HighPuls RS)
- Plasma-/TIG welding power source (EWM Tetric 400, Fronius TransTig 4000 Job, Fronius MagicWave 5000)
- Hanging welding robot (REIS RV20-16 und RDK05)

### Hybrid laser welding

- Laser GMAW and laser plasma

### Resistance welding

- Medium-frequency resistance welding equipment driven by servo motors
- Capacitor discharge welding equipment (GLAMATRONIC GKS-C 24/40-Q-V)

### Friction welding equipment

- Punctate, linear, areal

### Process analysis

- High speed camera system up to 100,000 Hz (different frequencies, without external illumination)
- High-speed thermography camera (frame rate: 800 Hz, temperature sensitivity: 10 mK)
- Pyrometer (5–500 K and 300–1 600 K)
- Quenching dilatometer up to 1 500 K/s
- Welding data acquisition for arc welding (HKS WeldAnalyst)
- Process monitoring (Lessmüller, LWD Precitec)

### Joint and component testing (selection)

- Machines for strain/compression testing (up to 100 kN, multi-axis)
- Vibration testing ( $\pm$  100 kN, up to 400 Hz, multi-axis)
- Impact testing (dynamic impact, up to max. 40 kJ)
- Metallography (incl. SEM, EDX, measurement of hardness)
- Corrosion test (salt spray test, cyclic corrosion test, condensation water test, simulation of outdoor weathering)
- Heat treatment
- Non-destructive testing (ultrasonic, x-ray, tomography)
- Assessment of weld quality (DIN EN/ISO standards)

### Software (selection)

- Pro-Engineer/CATIA/AutoCAD/Inventor
- ANSYS/ABAQUS
- DEFORM/PAM-STAMP/AUTOFORM
- Simufact welding

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