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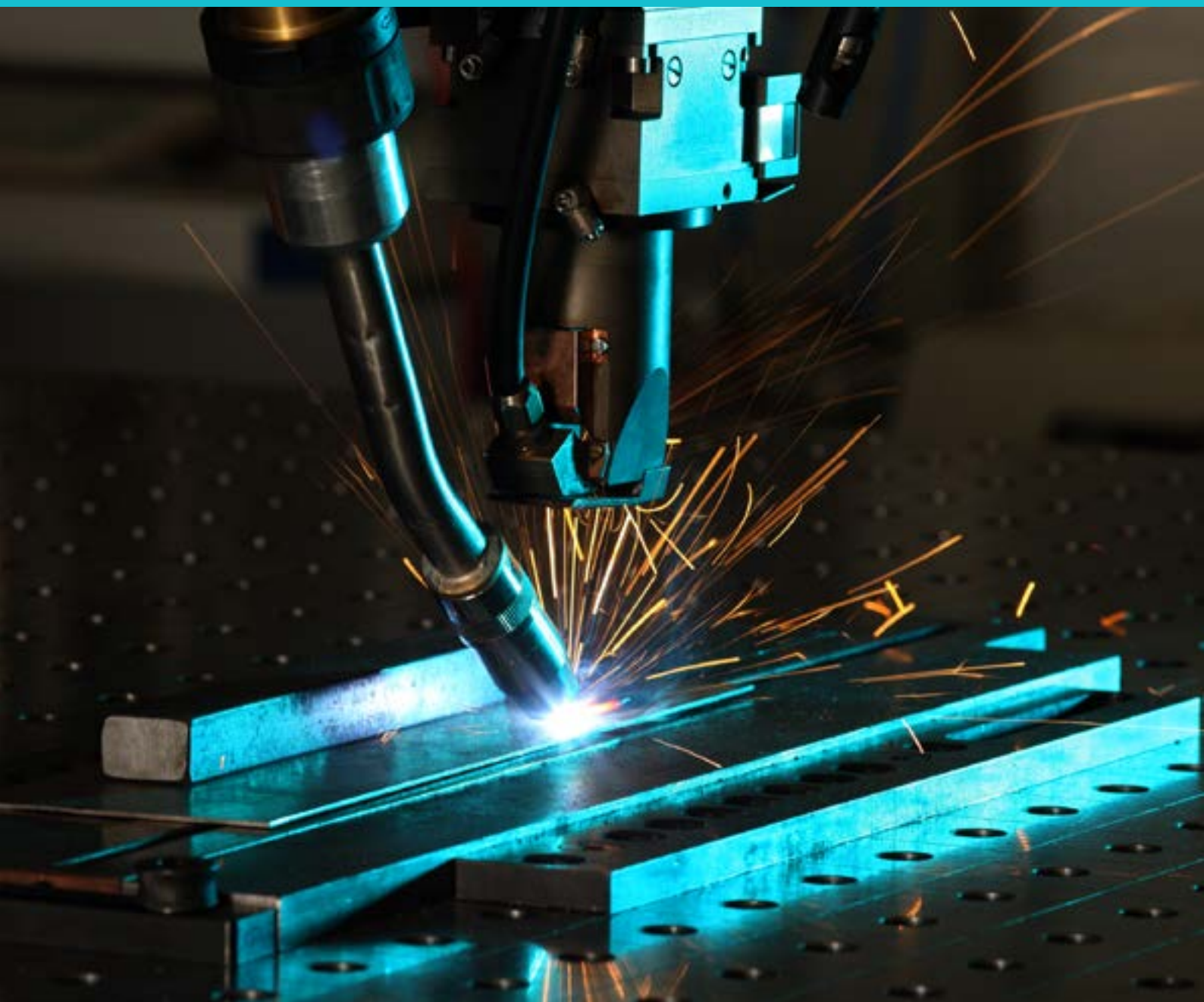
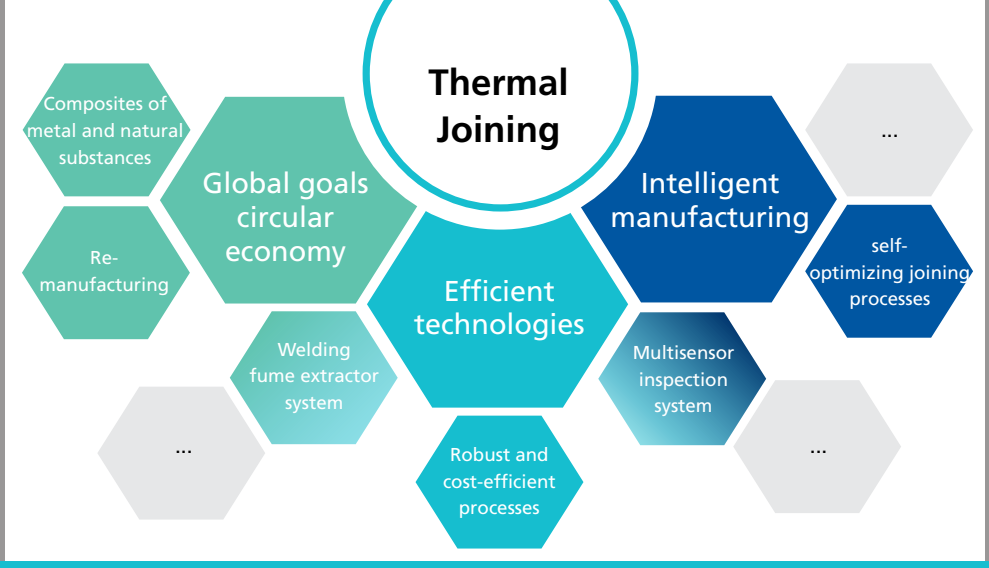
FRAUNHOFER INSTITUTE FOR MACHINE TOOLS AND FORMING TECHNOLOGY IWU

THERMAL JOINING





JOINING TECHNOLOGIES

DEVELOPMENT OF NEW APPLICATIONS

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

Our goal:
– Maximum productivity and efficiency
– Minimal cost
– Robust processes

Implementation of new developments
Depending on the joining task, modern joining technologies are selected, providing the best results regarding component properties, quality, production time and investment. Basic technologies are used, which are further developed and optimized according to the intended application:
– Laser technologies
– Arc technologies
– Resistance spot-welding technologies
– Hybrid technologies
– Additive manufacturing
– Joining technologies for material combinations (metal, FRP)

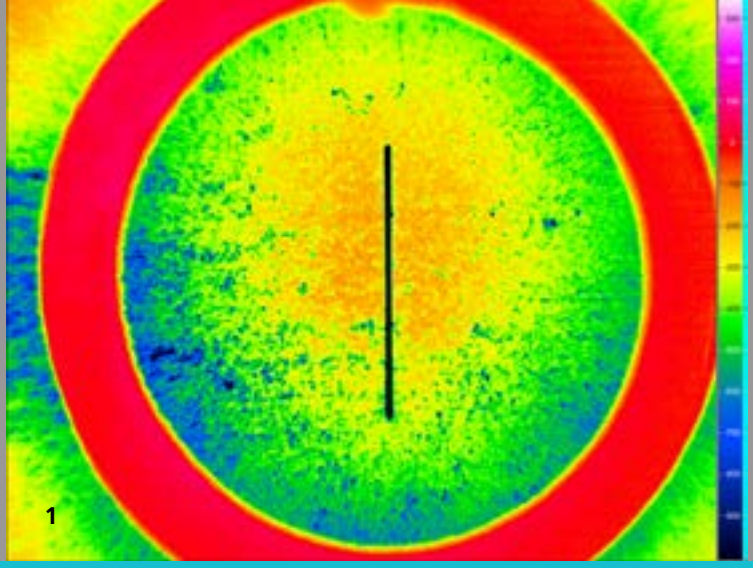
Joining technologies for e-mobility
An incomparable change is currently taking place in the field of mobility. When it comes to battery or hydrogen technologies, joining technology is faced with particular challenges in the production processes of such components.

We offer novel solutions for non-ferrous metal alloys (e.g. copper, aluminum) and we can implement research activities for processes ready for series production, especially in the manufacturing of fuel cells, hydrogen storage systems and batteries.

Joining technologies for lightweight design
Lightweight design remains a key technology, especially in connection with the requirements of e-mobility. We offer the implementation of various developments:
– Joining technologies for multi-material design
– Joining technologies for FRP composites
– Technologies for new sustainable lightweight materials such as composites made of metal and natural substances

Machine learning and AI in joining technology
Due to the complex boundary conditions of thermal joining technologies, machine learning and and artificial intelligence have a high application potential. Today, it is possible to implement the first self-optimizing systems, especially in association with the latest systems for inline seam tracking and seam monitoring (such as OCT systems).

Efficiency in thermal joining technology
Maximum quality at minimal cost is one of the main demands of almost all production areas. This means that the processes have to be evaluated regularly:
– Holistic evaluation of process chains
– Evaluation and comparison of joining technologies
– Analysis of the latest developments
– Development of new joining strategies



PROCESS AND COMPONENT

ANALYZING, MODELING AND OPTIMIZING

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

Welding process and distortion simulation
Welding simulation is a standard tool that is used to calculate and optimize the welded joint, its metallurgical 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.

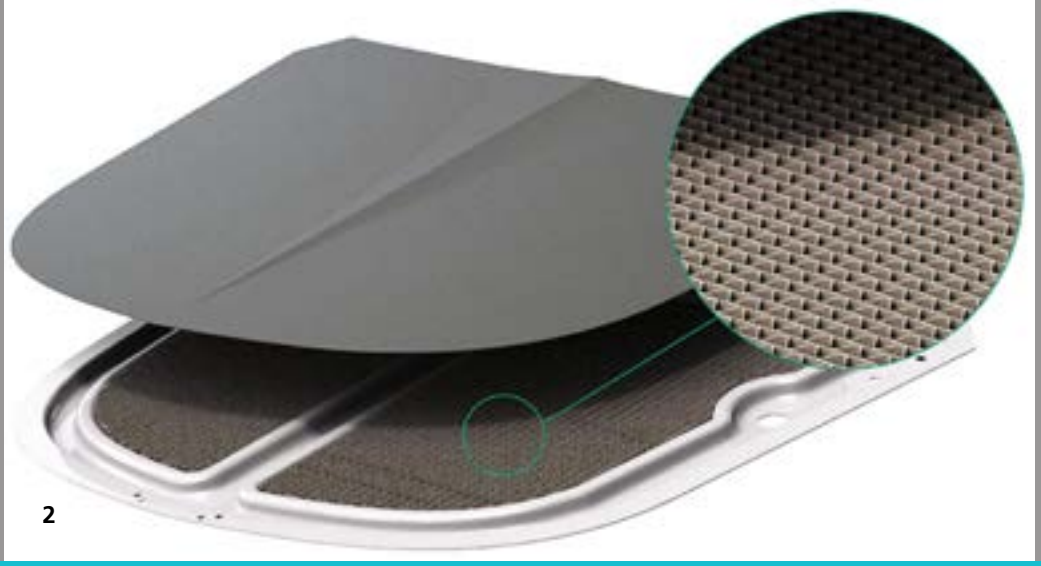
Suitable design for welding
Component design determines the most important boundary conditions for component production and the final component properties. Here, welding joints play a fundamental role.

Our support for your component design comprises
– CAD design (from the concept through 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 guidelines, IIW recommendations
– Preparation 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 *Thermographic crack detection at welding seams*
2 *Composite made of metal and natural substances*



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PROTOTYPING

FROM THE IDEA TO THE PRACTICAL IMPLEMENTATION

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

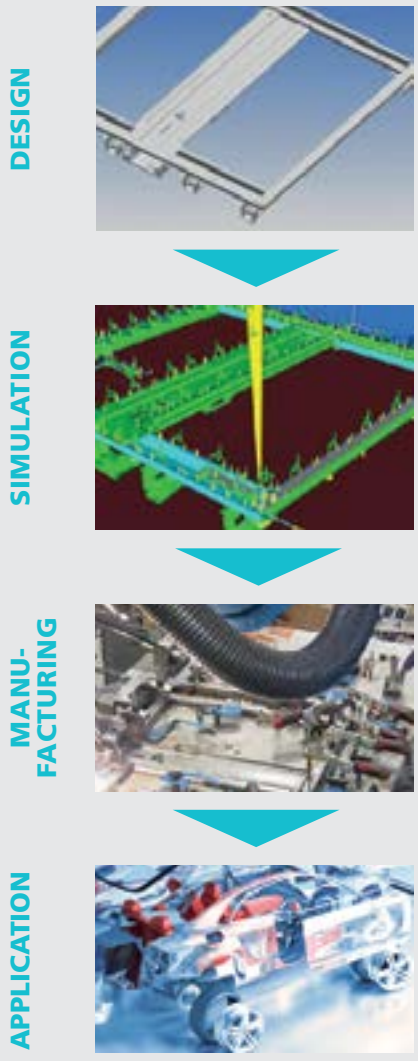
Laboratory implementation and research factory
– Virtual and real mapping of sub-processes
– Analysis of sensitivity
– Optimization of the process

Prototypes and test series
– Joining strategies for prototypes
– Design and manufacturing of prototype devices and jigs
– Manufacturing of production-oriented prototypes
– Analysis and evaluation of experiences (quality, dimensional accuracy, parameters, special features) for serial implementation

Industrial implementation
– Transfer of technologies to the enterprise
– Preparation of production files
– Production start-up supported by experts
– On-site training
– External monitoring of the production

Quality assurance
Development and implementation of holistic concepts of quality assurance (inline monitoring of each welding seam, documentation, self-optimization with the goal of zero-failure production)

Backseat frame:
from design to use in the automobile



EQUIPMENT
FOR THERMAL JOINING (SELECTION)

Laser machining equipment
– 10 kW disk laser with portal system (TruDisk 10002, wavelength: 1030 nm, beam quality: 8 mm*mrad)
– 6 kW disk laser with industrial robot system and linear axis (TruDisk 6001 with BrightLineWeld option, wavelength: 1030 nm, beam quality: 4 mm*mrad)
– Green 1 kW Disk Laser (TruDisk 1020, wavelength: 515 nm, beam quality: 2 mm*mrad)
– Diode laser 2 x 500 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

Handling systems
– Gantry machine system TRUMPF TruLaser Cell 7020
– 2 interactive 6-axis robots type Comau NJ110/NJ40 with 2 rotary tilting tables type DKP 400 (CNC-control unit)
– Rotation axis for both systems

Gas shielded arc welding equipment
– GMAW welding power source (Fronius Transpuls Synergic 5000, Fronius CMT 4000 advanced, Merkle 55 HighPuls RS)
– Plasma-/TIG welding power source (EWM Tetrix 400, Fronius Magic Wave 5000)
– Hanging welding robot (REIS RV20-16 und RDK05)

Software (selection)
– Pro-Engineer/CATIA/AutoCAD/Inventor
– ANSYS/ABAQUS
– DEFORM/PAM-STAMP/AUTOFORM
– Simufact welding
– Sorpas®2D.welding

Resistance welding equipment
– Medium-frequency resistance welding equipment driven by servomotors
– Capacitor discharge welding equipment (GLAMATRONIC)
– Various robot-guided systems of resistance spot welding for aluminum and steel

Friction welding equipment
– Punctate, linear, planar
– Friction stir welding machine RPS100 (Harms+Wende)

Process analysis
– High-speed camera system up to 100,000 Hz
– High-speed thermography camera (frame rate: 800 Hz, temperature sensitivity: 15 mK, image size: 256 x 256 pixels)
– Optical 3D measuring system (GOM-Aramis, GOM-Pontos) for the analysis of welding distortion
– Measuring system WeldQAS by Fa. HKS for the temporal process analysis of arc welding processes in high-resolution
– SPATZMulti04 weld recorder for the analysis of resistance spot welding processes
– Pyrometer (5 – 500 K and 300 – 1,600 K)
– Quenching dilatometer up to 1,500 K/s

Testing of joints and components (selection)
– Vibration testing (± 100 kN, up to 400 Hz, multi-axis)
– Impact testing (dynamic impact, up to max. 40 kJ)
– Corrosion testing (salt spray test, cyclic corrosion test, condensation water test, simulation of outdoor weathering)
– Non-destructive testing (ultrasonic, X-ray, tomography)

Editorial notes
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