Joining Competence on RWTH Aachen

Welding and Joining Institute (ISF)

Dipl.-Ing. Alexander Schiebahn

ISF WELDING AND JOINING INSTITUTE | RWTH AACHEN UNIVERSITY

Facts

Staff:

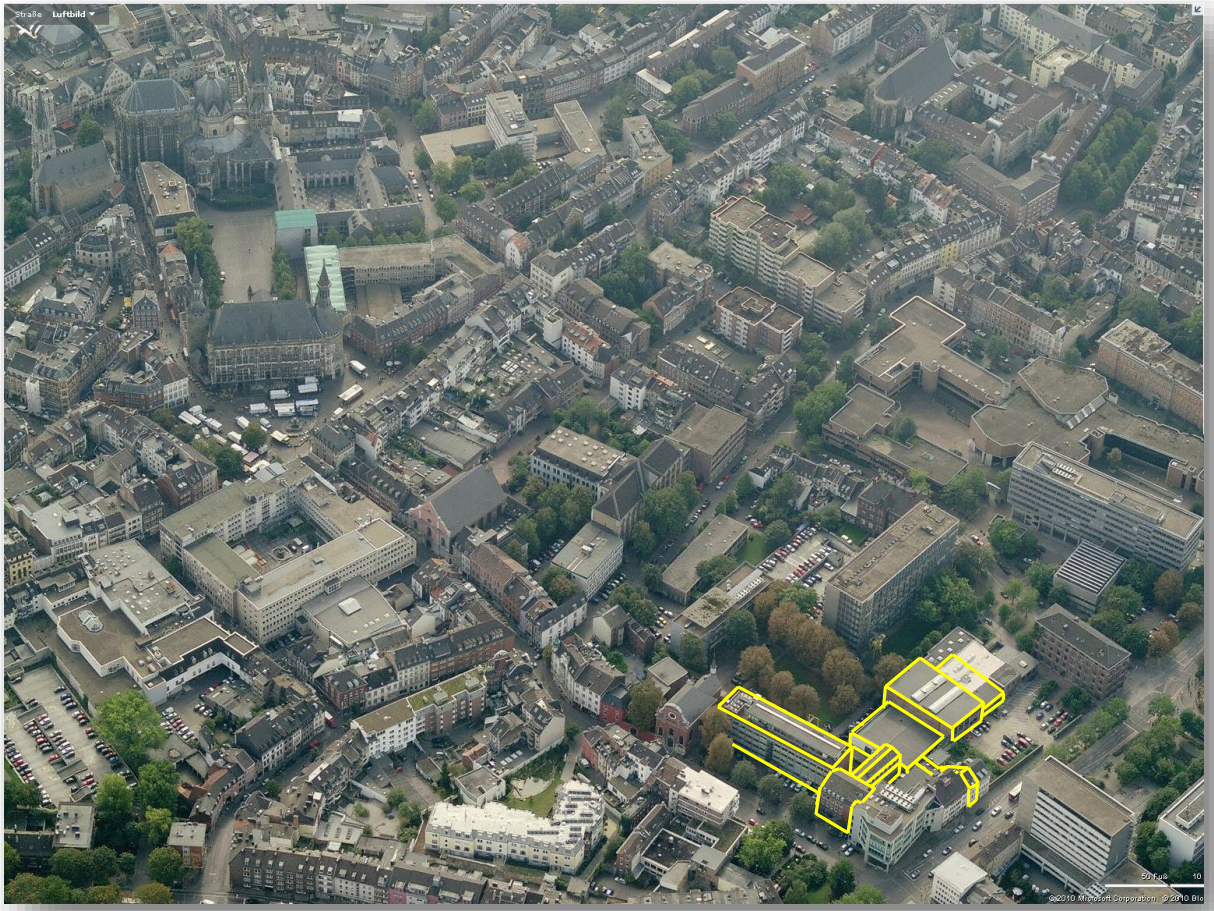
- 36 scientific staff
- 24 technical and commercial staff
- 5 trainees
- 39 student assistants

Space for tests and laboratory:

- 2700 m^2

Budget:

- 5.1 million €
  (85% 3rd party funds)



Organization Structure

ISF - Welding and Joining Institute

Univ.-Prof. Dr.-Ing. U. Reisgen
- Head of Institute -

Operations (R&D)

A: Arc Welding

Dipl.-Ing. K. Willms
- Head of Department -

B: Beam Welding

Dr.-Ing. S. Olschok
- Head of Department -

C: Cold Technologies

Dipl.-Ing. A. Schiebahn
- Head of Department -

Close Cooperation

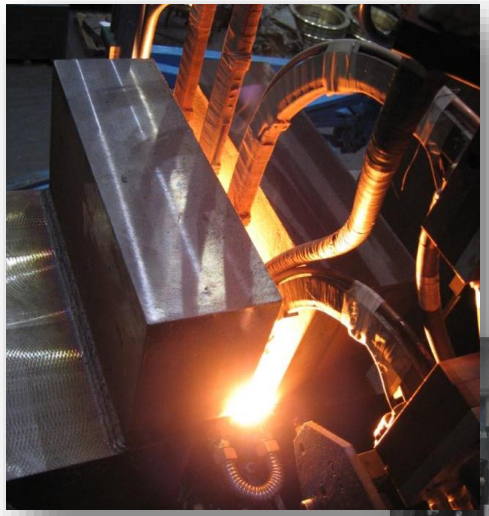
Operations (Industry)

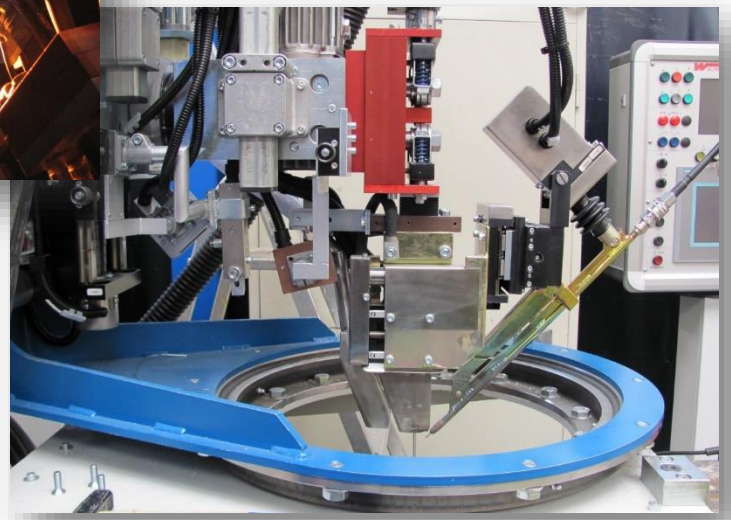
FEF GmbH

Dipl.-Ing. C. Geffers
- Industrial Solutions & Services -

Department A: Arc Welding Processes and Automation Technologies

- Gas Metal Arc Welding
  - different process variations
  - power sources of different manufacturers
- Submerged Arc Welding
  - fine wire technology
  - cold wire addition
  - constant-current power sources
  - square-wave power sources
- TIG- and Plasma Welding
  - power sources of different manufacturers
- Surfacing
  - plasma powder arc surfacing
  - SA strip surfacing
  - RES surfacing
- Vertical Position Welding
  - electro slag welding
  - electro gas welding

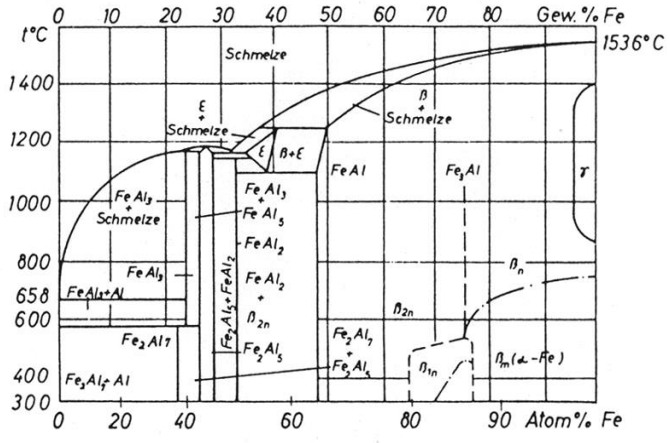




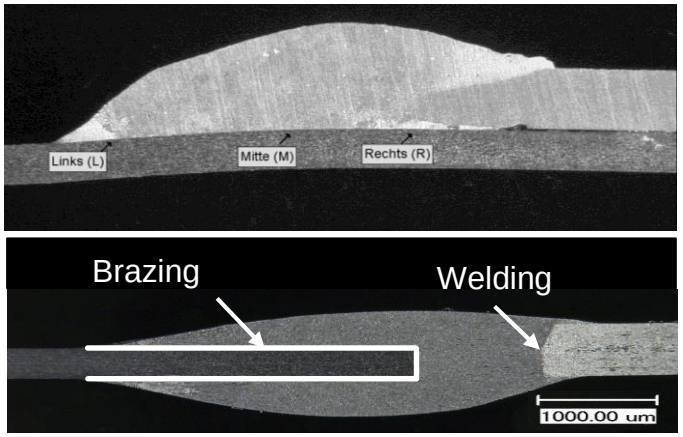
- Application Technology
  - different robots
  - handling devices and jig cranes
- Process Sensor Systems
  - arc sensor systems
  - optical sensors
  - quality assurance
- Process Development

Arc Brazing Steel to Aluminium

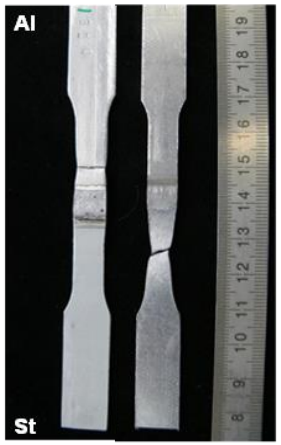
Problem



Approach

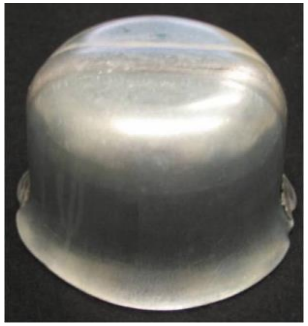


Result

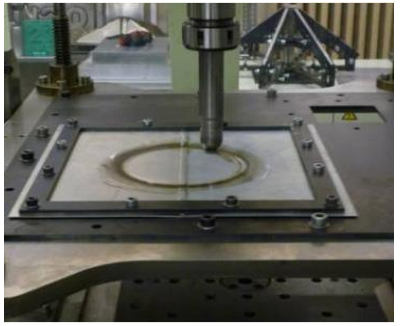


Formability Steel/Aluminium-Joints

Innenhochdruckumformen



Napfzugversuch



Inkrementelle Blechumformung

DFG FOR505 "Hochleistungstechnik für Hybridstrukturen"
NRW-EU-Ziel2 "Energiearmes thermisches Fügen mit Zink- und Zinnbasisloten für den Einsatz im Fahrzeugbau"
DFG Exzellenzcluster "Integrative Produktionstechnik für Hochlohnländer" ICD C-2.1

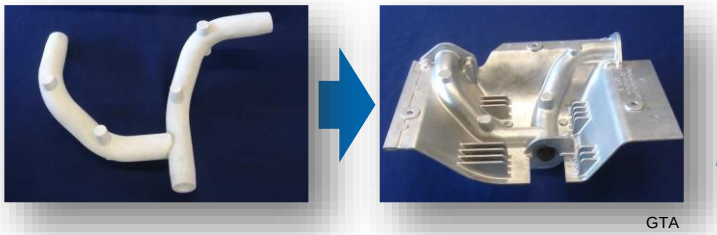
AMAP Project P10: Design and Process Development of hollow structural HPDC Components (High Pressure Die Cast)

- Substitution of welded steel sheet components e.g. torque box

Q1 2016

- Design of weight reduced Al-component

nemak fka



- Casting process development of HPDC using lost cores

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- Integration of HPDC in steel body

nemak ISF WELDING AND JOINING INSTITUTE RWTH AACHEN UNIVERSITY

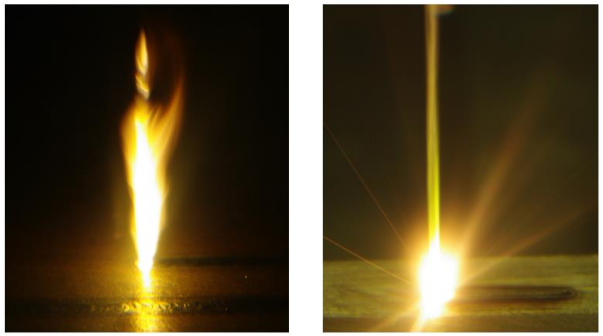
Q4 2018

Department B: Laser and Elektron Beam Welding

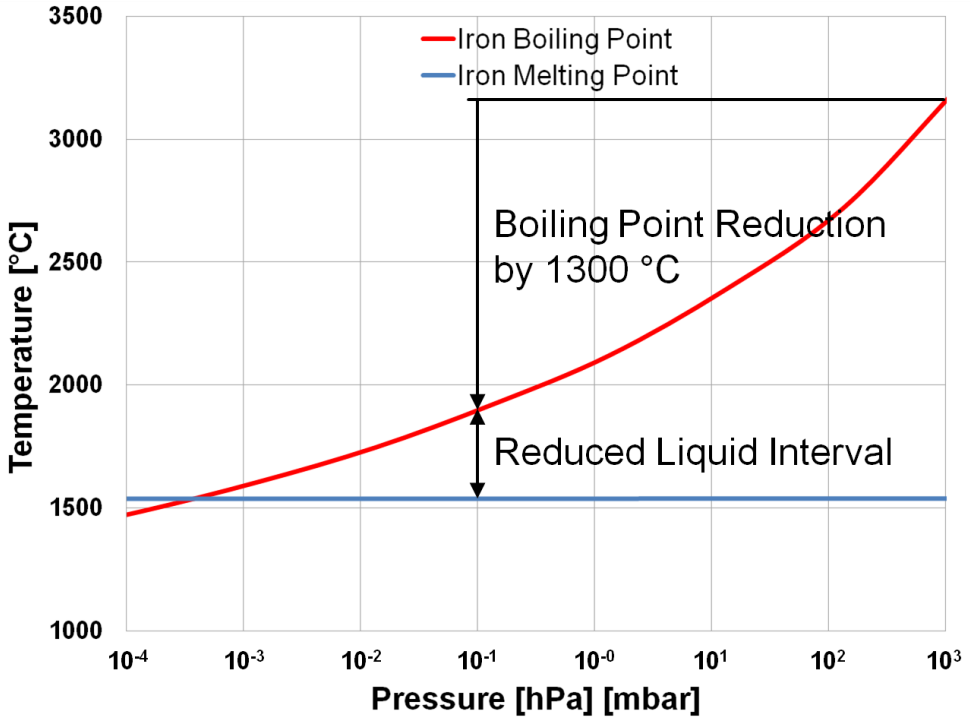
- Laser and Laser Hybrid Welding
  - Welding with Modern, Brillant Beam Sources
  - Process Development with TIG, GMA, SA
  - Sensor Development
  - System Engineering
- Laser Beam Welding in Vacuum
  - Process Development
  - Sensor Development
  - Drafting of New Fields of Application
- Electron Beam Welding
  - Process Development
  - EBW with Filler Material
  - Surface Sculpt®
  - Beam Diagnosis
  - Sensor Development
  - System Engineering
- Material Technology
  - Special Solutions for Specific Materials
  - Welding/Brazing of Material Combinations
- Individual Training

Laser Beam Welding at different Pressures (without Shielding Gas)

Ambient Pressure 10 hPa



v_S = 4,5 mm/s P_L = 600 W

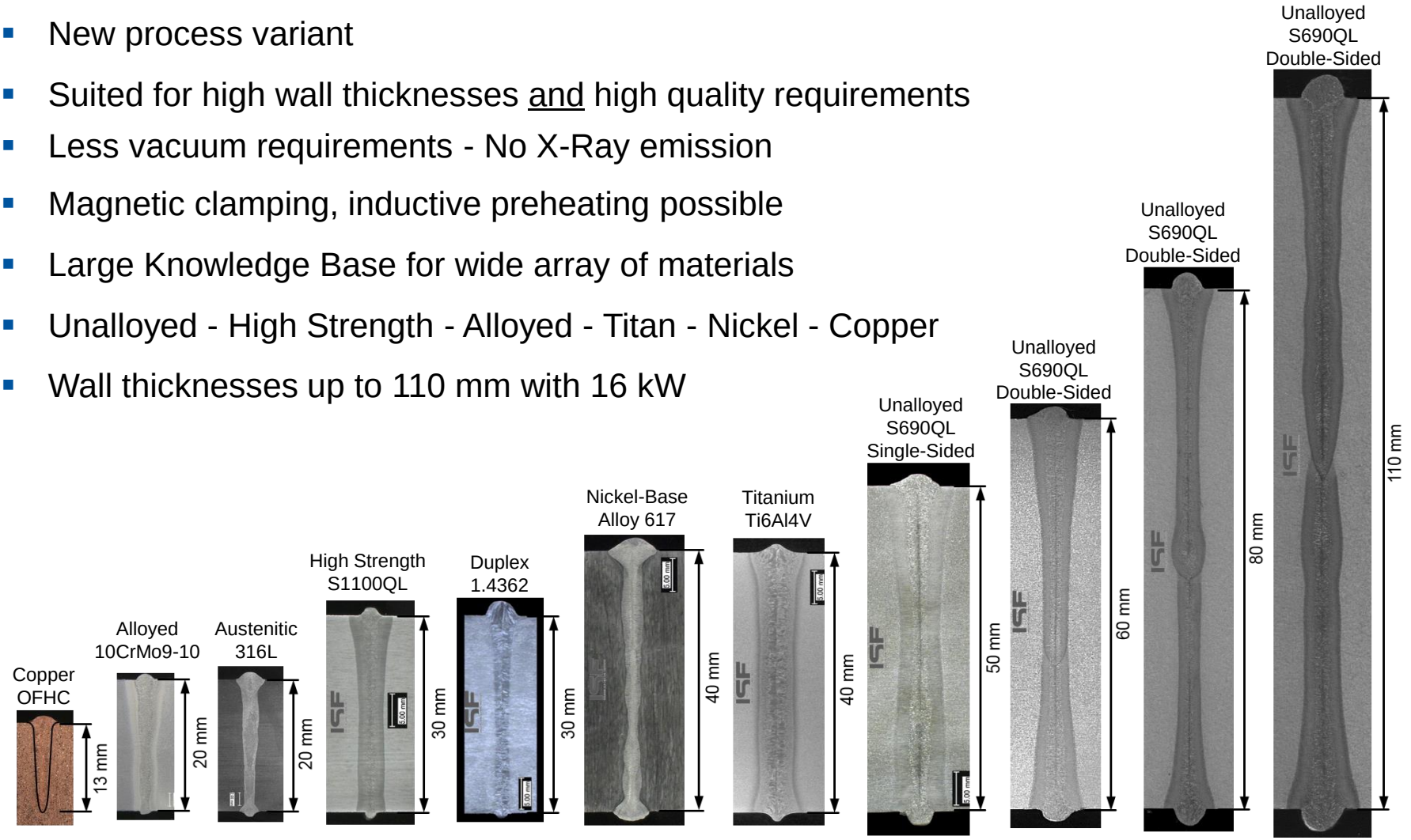


- Reduction of Plasma / Metal Vapor Plume
- Significant Reduction of Boiling Point > 1000 K, Melting Point unchanged
- Thinner molten pool around vapor capillary

➔ Reduced Losses above Keyhole
➔ Increased Weld-In Depth and Process Stability, less to none Spatters
➔ Higher Process Performance and Weld Seam Quality

Laser Beam Welding at different Pressures (without Shielding Gas)

- New process variant
- Suited for high wall thicknesses and high quality requirements
- Less vacuum requirements - No X-Ray emission
- Magnetic clamping, inductive preheating possible
- Large Knowledge Base for wide array of materials
- Unalloyed - High Strength - Alloyed - Titan - Nickel - Copper
- Wall thicknesses up to 110 mm with 16 kW



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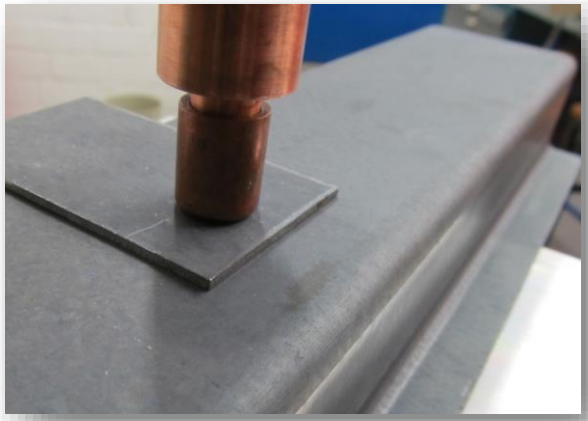
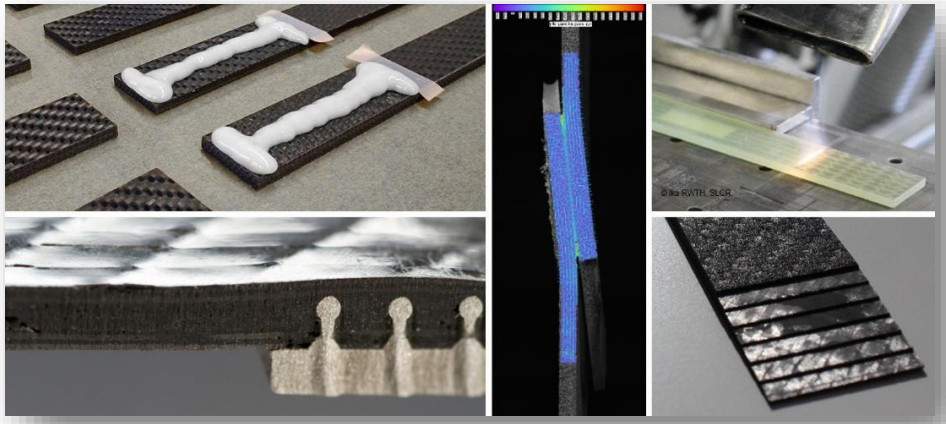
Department C: „Cold Joining“ Processes and Process Simulation

- Resistance Welding
- Friction Stir Welding
- Ultrasonic Welding
- Adhesive Bonding
- Direct Thermal Joining
- FRP-Joining Technologies

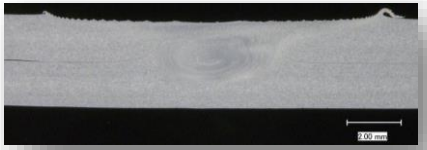




Friction Stir Welding

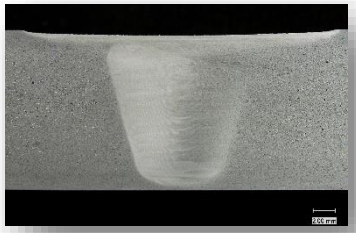
- Weldability verification for several material combination
- Conductively supported friction stir welding to increase welding speeds
- Clamping by contact adhesive for reduced apparatus

Friction Stir Welding
Material

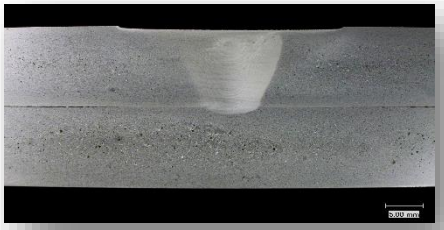


Aluminiumknetlegierung
(1,5 mm mit 1,5 mm Dicke)

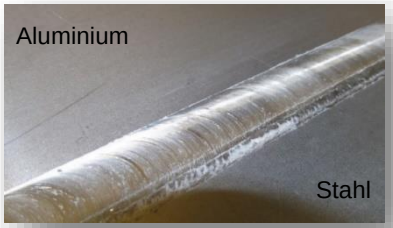
Aluminiumknetlegierung
(0,5 mm mit 1,5 mm Dicke)



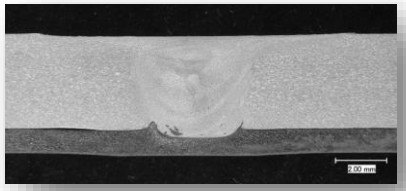
Aluminiumgussplatte
(14 mm dick)



Überlapp-Rührreibschweißverbindung,
Aluminiumgussplatten, jeweils 14 mm dick



Aluminiumknetlegierung
mit Stahl (1 mm dick)



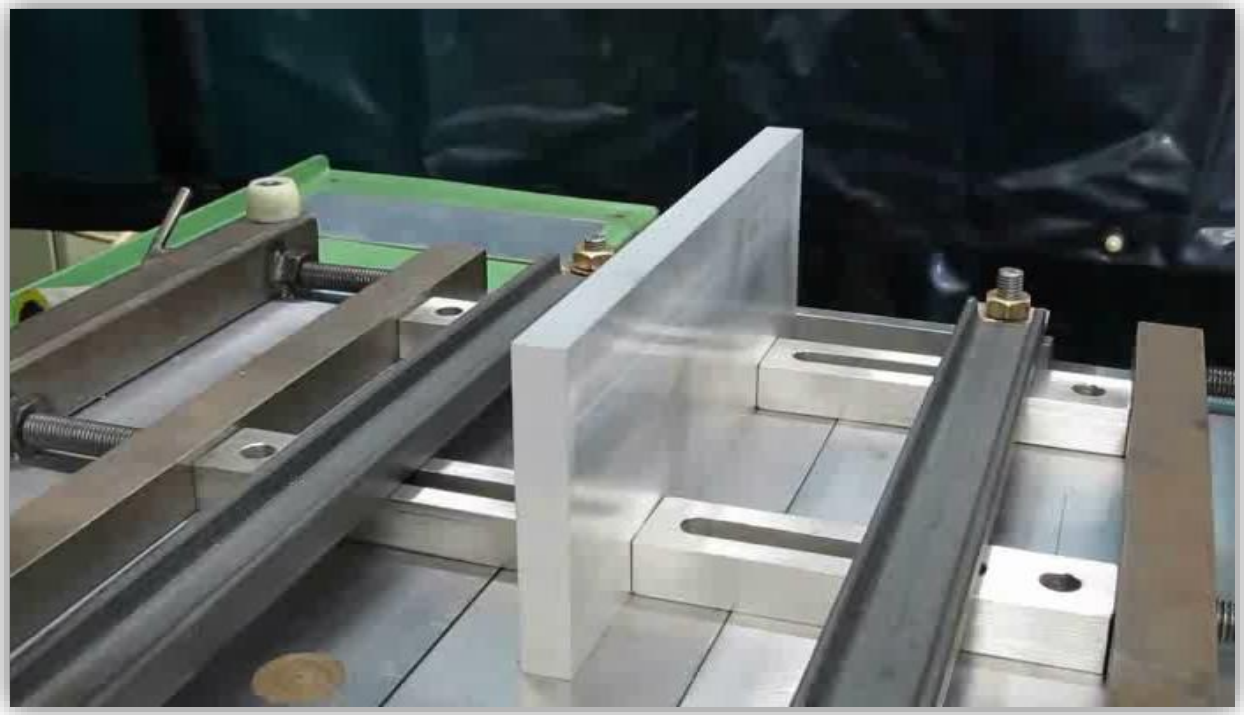
Aluminium (3,5 mm) mit
Stahl (1 mm dick)

Reinaluminium mit
Kupfer (3 mm dick)

Magnesium (2,5 mm) mit
Stahl (1 mm dick)

Friction Stir Welding
BondWELD Technology

- Development of BondWELD technology
- Clamping by contact adhesive for reduced apparatus complexity and for welding thin metal sheets
- Research work on different adhesives and joint geometries



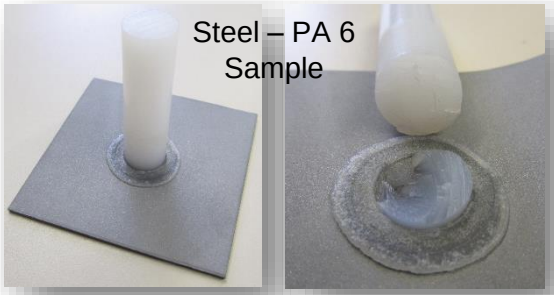
Thermal direct joining of metals and (fiber-reinforced) plastics

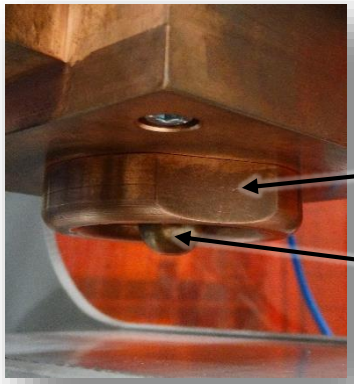
Process flow:

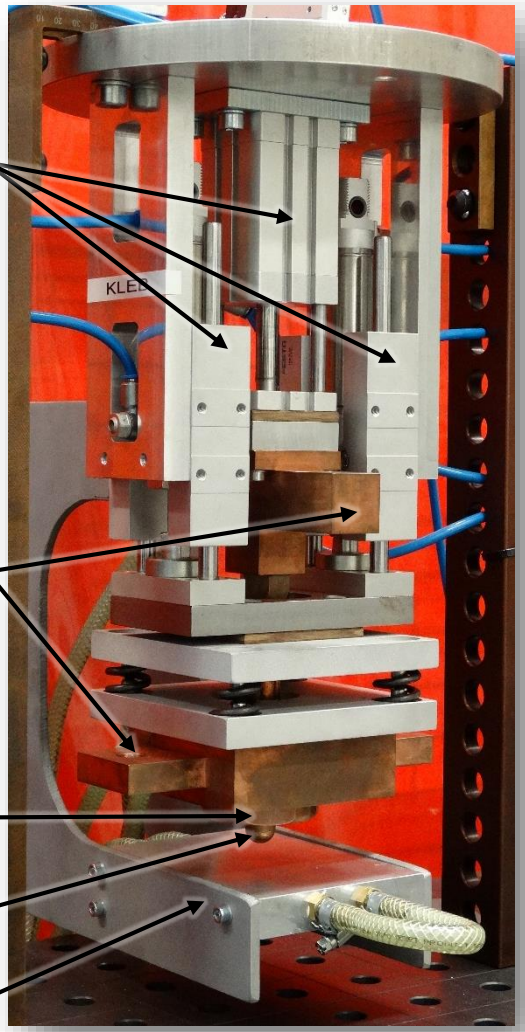
- Local resistance heating of metal
- Conductive heating and melting of the plastic at the contact surfaces
- Wetting of the metal through plastic melt
- Key Parameter:
  - Material combination and surface pretreatment
  - Joining temperature
  - Joining pressure
  - Process time

Advantages:

- No need for an additional adhesive
- Process times < 15 sec
- High bond strengths up to 25 MPa







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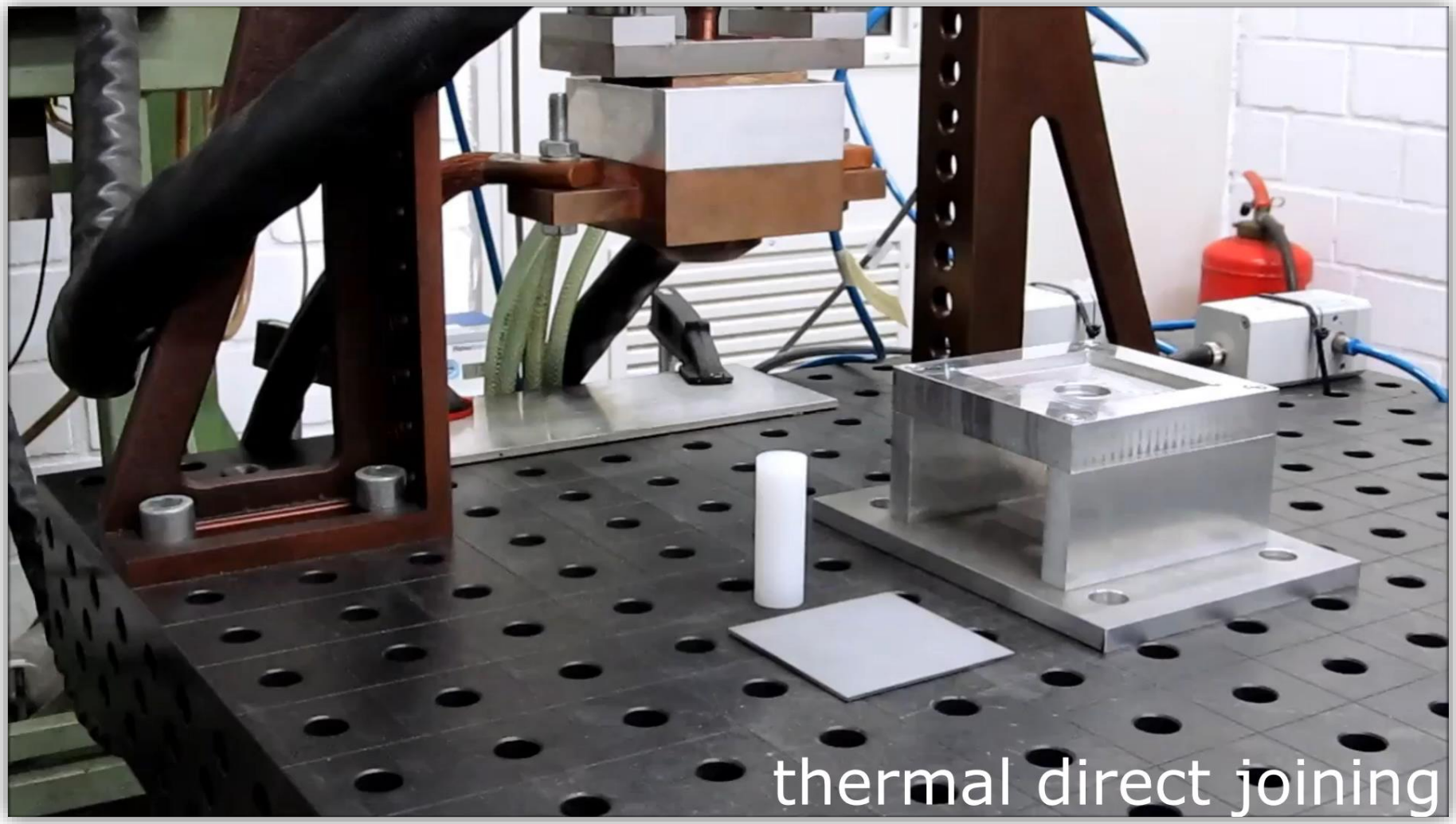
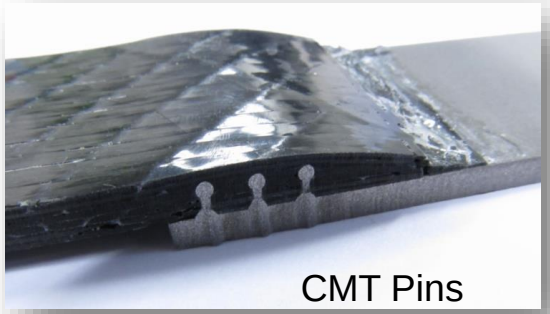
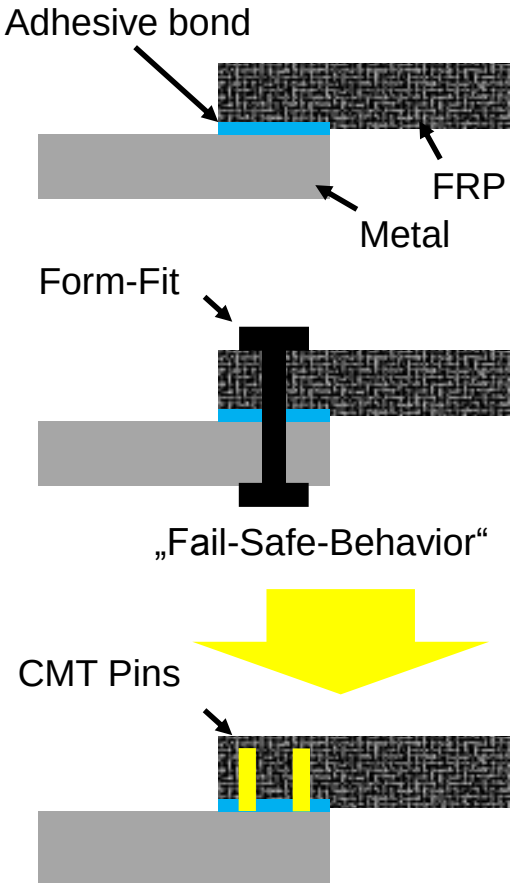
Thermal direct joining with resistance heating II



AiF-Research Project „SMMJ – Smart Multi Material Joint“

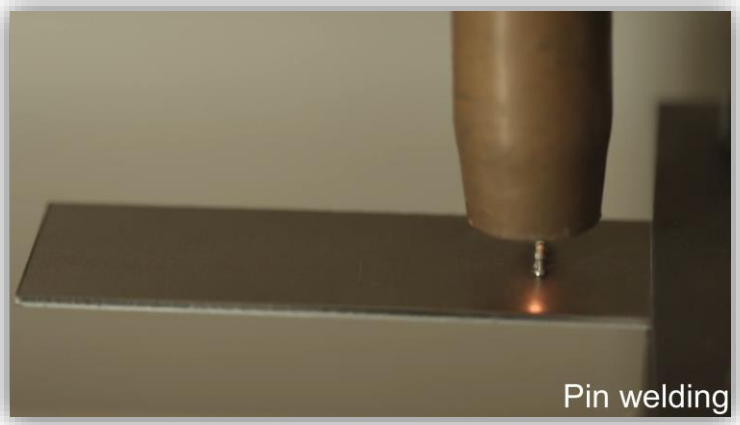
- “Intrinsic Joining” allows adhesive bond and form-fitting
  - FRP still moldable
  - Polymer matrix as adhesive
- Approach
  - Form-Fitting by use of pin shear connectors
  - "Lamination" of the FRP-component
  - Load transfer in fiber by “flow-around" of the pins
  - Load distribution over the entire laminate thickness
  - no fiber damage
  - "Bolting" without riveting process or FRP machining

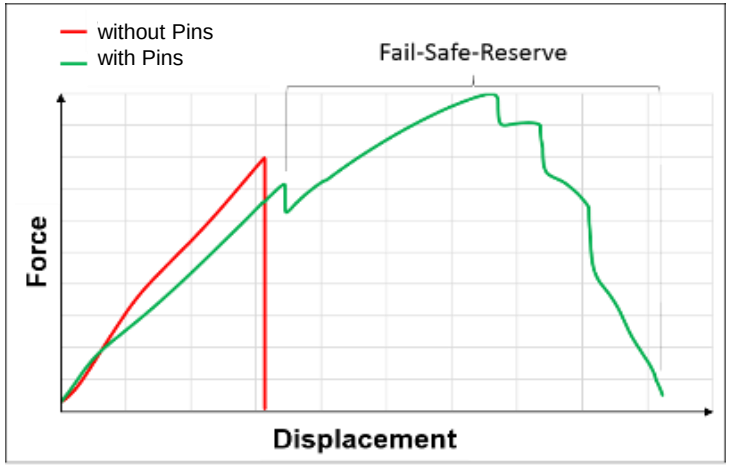




AiF-Research Project „SMMJ – Smart Multi Material Joint“

- Process
  - Generating small-scale metallic interlocking elements by a modified CMT process
  - Intrinsic joining process of FRP on textured steel surface
    - Matrix polymer is used as an adhesive
    - Fibers "wrap around" Pins (FRP still malleable)
- Advantages
  - Fibers of FRP remain undamaged
    - Power flow remains undisturbed
    - Force is transferred into deeper layers of the laminate
  - Form-fitting elements allow ductile failure behavior
  - Joint can be monitored by an integrated sensor system





Picture: opportunities by the use of CMT-Pins

The IGF-project 17971 N/2 of the research association "Forschungskuratorium Textil e.V." and “Forschungsvereinigung Stahlanwendung e.V.” is funded within the framework of the industrial collective research programme (IGF) by the Federal Ministry for Economic Affairs and Energy on the basis of a decision by the German Bundestag.

Composite Competences along the Value Chain are present at the new RWTH Campus

ISF WELDING AND JOINING INSTITUTE | RWTH AACHEN UNIVERSITY

INSTITUT FÜR KUNSTSTOFFVERARBEITUNG IN INDUSTRIE UND HANDWERK AN DER RWTH AACHEN

ITA | RWTH AACHEN UNIVERSITY

Institut für Strukturmechanik und Leichtbau | RWTH AACHEN UNIVERSITY

AZL Aachener Zentrum für integrativen Leichtbau | RWTH AACHEN UNIVERSITY

WZL | RWTH AACHEN UNIVERSITY

Fraunhofer IPT

Fraunhofer ILT

ika INSTITUT FÜR KRAFTFAHRZEUGE | RWTH AACHEN UNIVERSITY

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Thank you for your attention!

ISF - Welding and Joining Institute
RWTH Aachen University
Pontstraße 49
52062 Aachen
Germany

Tel.: +49 (0)241 80-93870
Fax: +49 (0)241 80-92170
E-Mail: office@isf.rwth-aachen.de
www.isf.rwth-aachen.de