Fraunhofer
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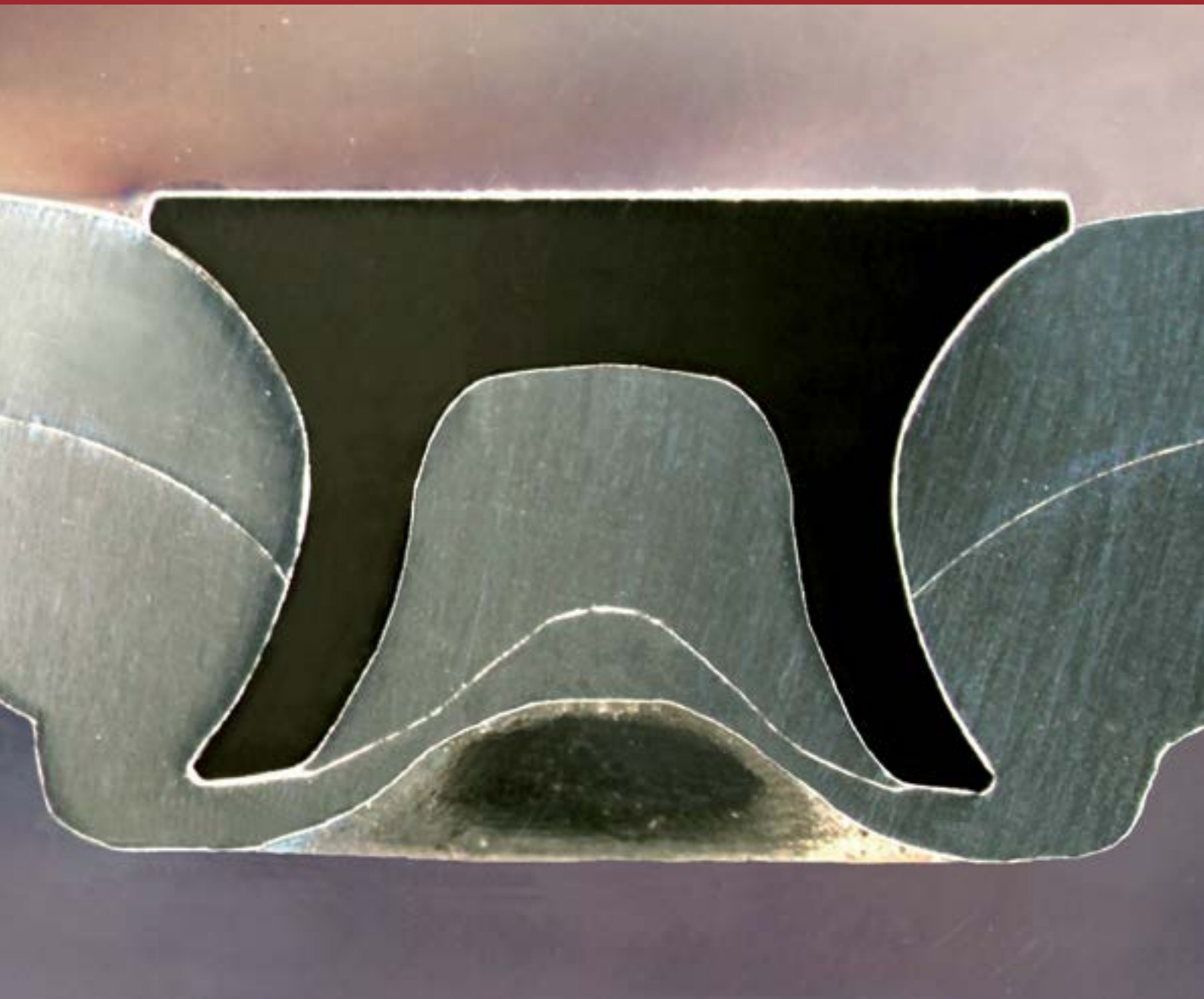
FRAUNHOFER INSTITUTE FOR MACHINE TOOLS AND FORMING TECHNOLOGY IWU

MECHANICAL JOINING



1

MATERIAL LIGHTWEIGHT DESIGN
... MORE THAN JOINING OF DISSIMILAR METALS

JOINING BY FORMING

Faced with current technological and economic changes in mechanical engineering and the automotive industry, Fraunhofer IWU responds with new ideas and developments in joining technology. We adapt proven joining methods to the latest demands and investigate innovative technologies in the context of resource-efficient production.

The mechanical joining technology offers innovative and cost-effective technologies for joining the same and different types of material. With regard to current lightweight construction concepts and the associated combination of materials, thermal joining processes are increasingly reaching their limits. Mechanical joining methods often are appropriate cost-effective and energy-efficient alternatives to resistance spot welding and other thermal joining methods.

Our research on mechanical joining covers the entire process chain of a component as well as its impact on the quality of the final product properties such as dimensional stability, or the examination of the component behavior under load. We use a range of equipment that meets the industrial standards and we also exploit the possibilities of modern scientific methods. Several robotic cells with joining devices from various system providers and modern press technology enable us to reproduce an industry-oriented environment from the forming process right down to joining.

2

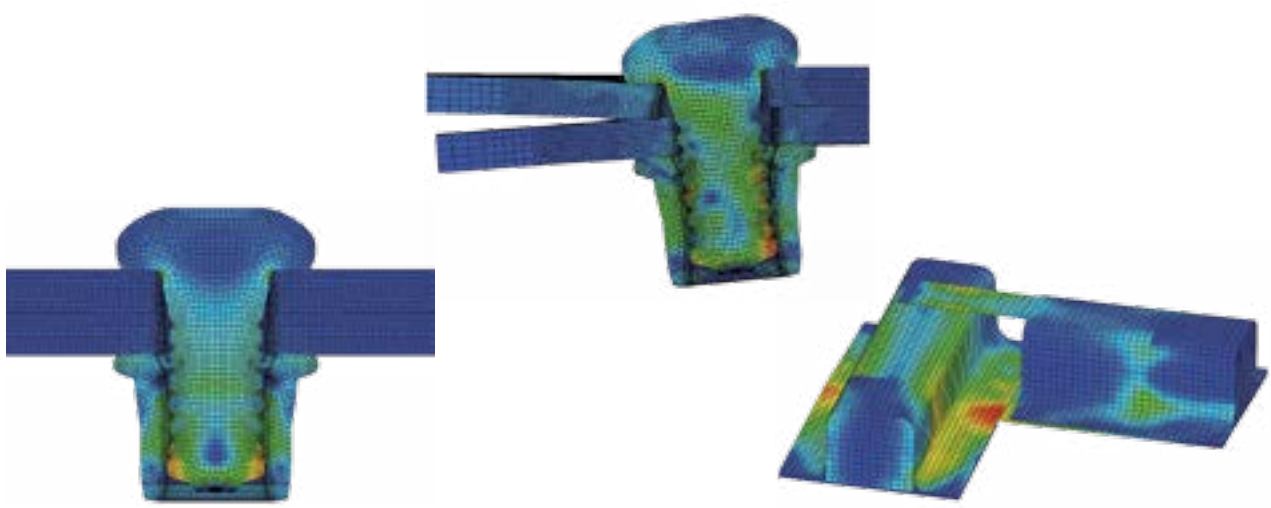
ASSEMBLY LIGHTWEIGHT DESIGN
... HYBRID JOINING TECHNOLOGIES COMBINE BENEFITS

MECHANICAL JOINING AND ADHESIVE BONDING

The systematic application of production processes also bears potential for lightweight engineering. The adhesive bonding technology provides an excellent example. Joints generated by adhesive bonding are increasingly gaining importance, considering the fact that they enable an effective load distribution and corrosion protection in mixed material joints. Combinations of joining methods are applied to combine the specific benefits of individual processes while compensating the deficits of basic technologies. Our research focuses on the combination of clinching or punch riveting with adhesive bonding and on hem flange bonding, since there is a particularly high potential in these combinations.

The tool and process parameters of basic joining processes cannot always be applied to the hybrid joining technology due to interactions between mechanical joining and adhesive bonding. Thus, investigations shall be carried out to evaluate the influence of relevant process parameters (such as adhesive viscosity and joining velocity) and to derive corresponding measures for improving hybrid joints.

An important focus of our research on hybrid joining lies on the global process analysis and improvement. Suitable joining parameters have to be determined, ensuring the quality of the local joining spot as well as the dimensional accuracy of the component after curing of the adhesive layer. For this purpose we increasingly carry out structural and computational fluid dynamics and experimental parameter studies considering the entire process chain.



3

SIMULATION AND TESTING
… FROM JOINING SPOT INTO STRUCTURE

MODELING, VALIDATING, OPTIMIZING

Mechanical joining processes are frequently characterized by complex stress distributions and a high level of local plastic deformations. Fraunhofer IWU uses adapted process models to study a wide range of joining methods using numerical simulation and retraces the essential parameters taking all actual mold movements and geometries into account. This enables us to analyze the stress distributions at the joint while identifying suitable process parameters.

Several testing methods are used for characterizing the material properties for the simulations: tensile, shear and pressure tests as well as optical measuring techniques. Furthermore, the necessary validation of the numerical results is realized by means of cross sections, hardness tests and evaluating experimental process data.

The actual behavior of a joining spot under load is determined with specifically developed specimen geometries, combined with a whole array of measuring methods available at Fraunhofer IWU. Then this is transferred to analogous models. The result is component modeling, which enables us to describe the behavior of spot joining while maintaining practical computation times. This enables more precise statements about the load limits of the joined structures and conclusions of the potential for improvement.

1 *Semi-tubular self-piercing rivets with different geometries*
2 *Hem flange bonding with seam-sealing*
3 *Simulation of a lockbolt*

JOINING AS A KEY TECHNOLOGY
... IN AUTOMOTIVE ENGINEERING AND BEYOND







OUR PORTFOLIO

At Fraunhofer IWU the following standard technologies of joining by forming are investigated with modern equipment:

– Self-pierce riveting, clinching, blind riveting
– Hybrid technologies
– Hemming, hem flange bonding
– Hydro self-pierce riveting, hydro-clinching
– Joining by lockbolt
– Nuts and studs

Our service is supplemented by further joining methods developed at Fraunhofer IWU. We advise you regarding the selection of the correct technology for specific joining assignments and regarding the adaptation of component design to joining methods while taking the requirements, materials and accessibility into account.

In conformity with applicable standards and guidelines we feature testing ranging from the individual sample right down to major components:
– Monitoring of the component geometry during paint desiccation in industrial heating and drying ovens
– Quasi-static, cyclic and crash testing
– Alternating climate and salt spray test

Editorial notes
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