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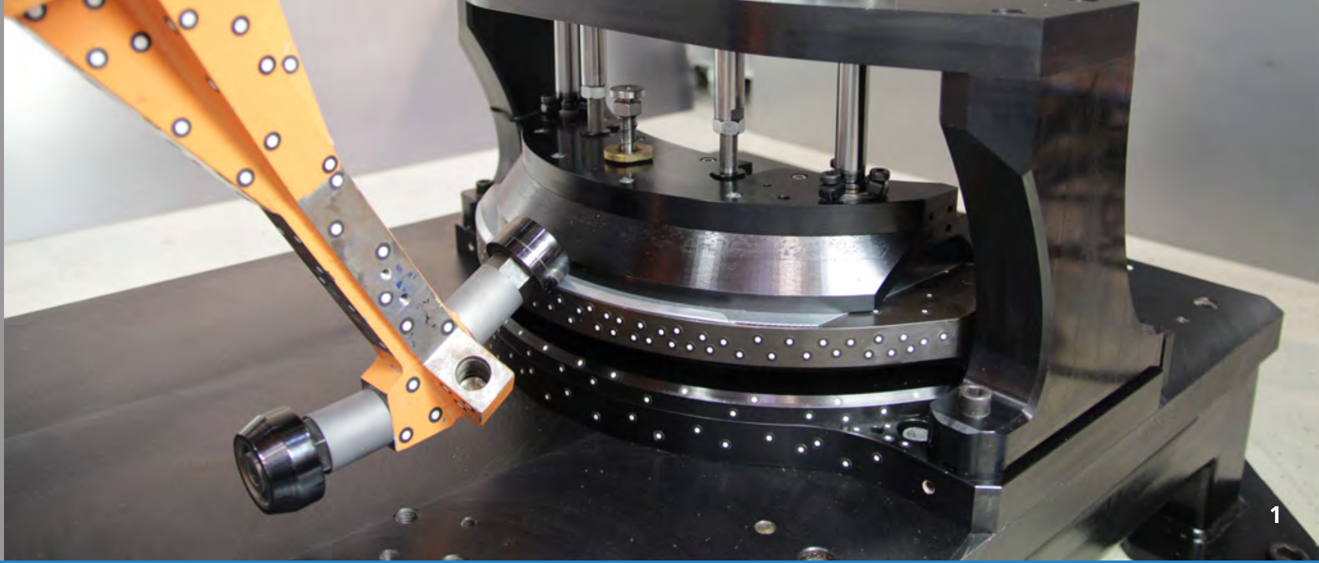
FRAUNHOFER INSTITUTE FOR MACHINE TOOLS AND FORMING TECHNOLOGY IWU

HEMMING AND HEM FLANGE BONDING



HEMMING TECHNOLOGY
... APPROVED AND REVIEWED FROM DIFFERENT PERSPECTIVES

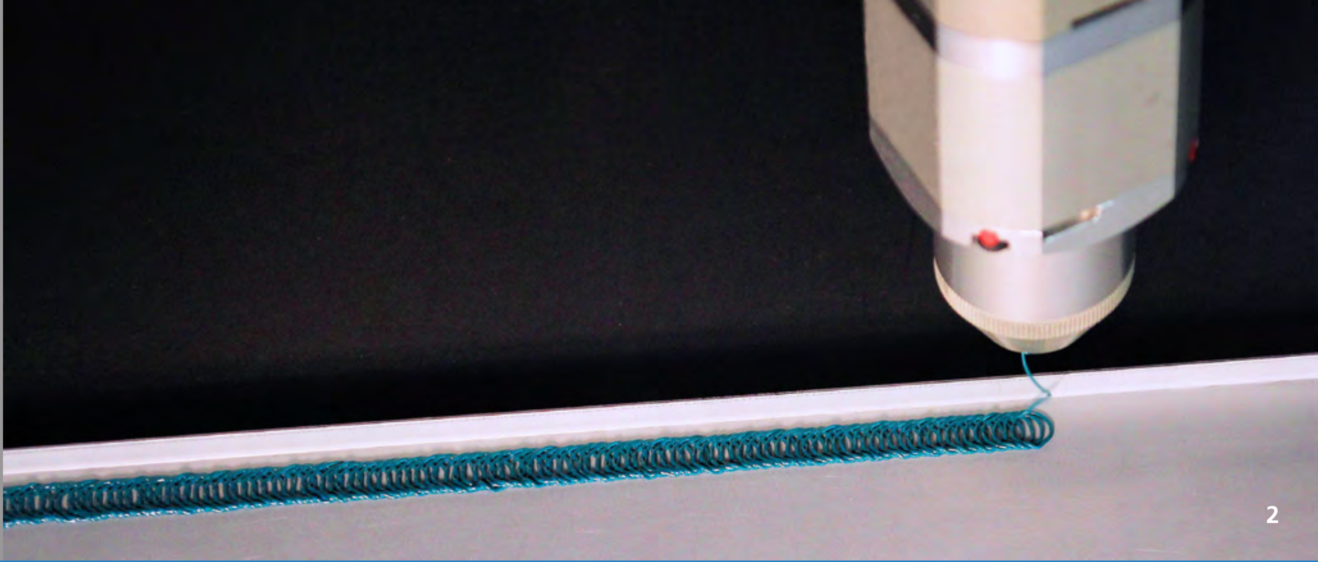
TABLETOP HEMMING, ROLLER HEMMING AND PLIERS HEMMING

Hemming is an established technology for joining sheet metal parts without an externally visible joint. The most common application is the joining of a skin panel and an inner part of a car body assembly. Therefore a previously produced flange at the outer edge of the skin panel is being bent around the inner part in a multi-stage process. In order to produce a hemming joint, the processes tabletop hemming and roller hemming are primarily used.

When assessing the quality of car bodies, the car body shell is a decisive feature. Inaccuracies in the surface or variations in clearance and conciseness of hang-on parts reduce the quality and appearance. Furthermore, the dimensional accuracy affects the functionality of the component. Thus, deviations in car doors, for example, can cause unexpected driving noises, sealing problems or high closing forces.

Key aspects of our hemming research include measuring and evaluation of hemming joints and optimizing the technology to ensure the quality of hemmed assemblies and process efficiency. In our laboratories we join different assembly geometries and sheet materials by using established hemming technologies as well as new methods. We systematically investigate the influence of different parameters for components and processes and specifically identify the dependencies of important parameters (e.g. dimensional accuracy, hemming thickness, roll-in). Beside established hemming technologies we keep developing new process types such as pliers hemming which makes it possible to close the hem in one process step.

1 *Roller hemming of a concave/convex curved assembly*



HEM FLANGE BONDING
... UNITY IS STRENGTH

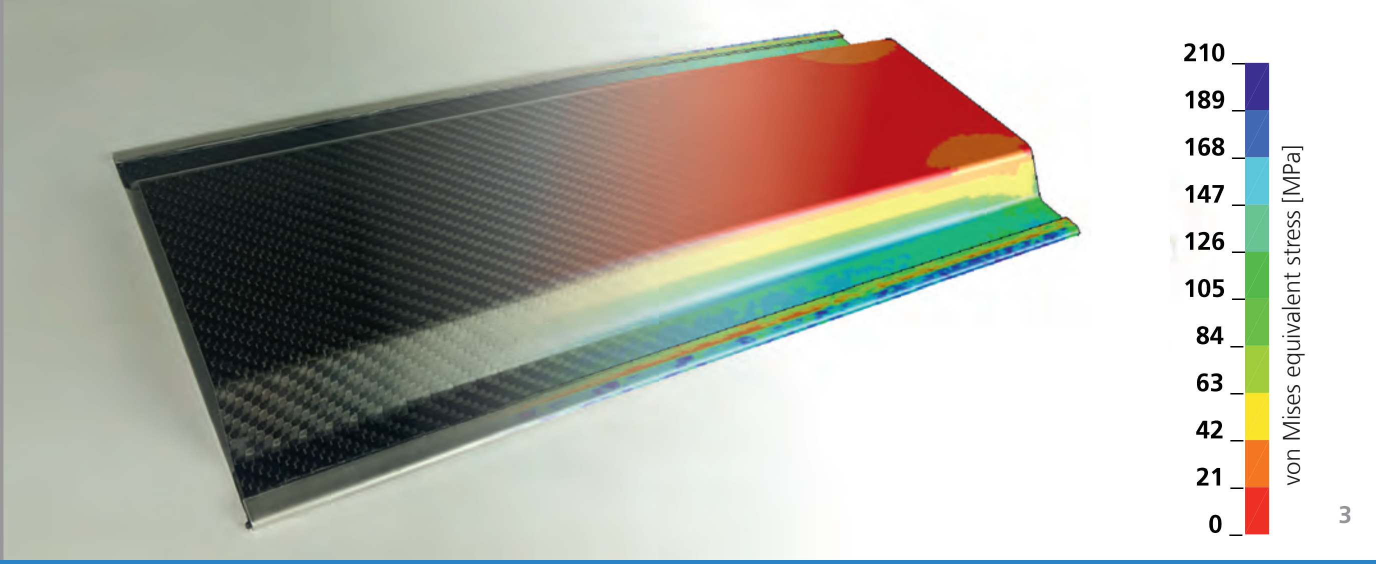
HYBRID JOINING TECHNOLOGY FOR CAR BODY HANG-ON PARTS

The combination of hemming and adhesive bonding is used in the automotive body shop to join car doors, hoods and tailgates with high load capacity. Therefore, an adhesive is applied onto the outer part before hemming. During the hemming process it spreads evenly between the inner and outer part. The adhesive bonding protects the hem flange against corrosion and significantly increases strength and stiffness of the assembly. Then the adhesive is cured while the entire car body passes through the cathodic dip painting dryer at temperatures of approx. 180 °C in the course of the painting process.

In industrial hem flange bonding various disturbances can cause voids in the adhesive layer. Fraunhofer IWU supports the industry in analyzing assemblies and processes to increase the quality of assemblies joined by hem flange bonding. In our testing facilities we experimentally demonstrate the entire process chain of hem flange bonding. Thus, we are able to analyze various adhesives, application technologies, sheet materials, assembly geometries, hemming technologies and strategies of adhesive curing. By specific variations of the influencing factors we systematically determine the dependence of important values such as the filling degree and quality of adhesive bonding. These findings allow process optimization and appropriate joint design for hem flange bonding.

Hem flanges in car doors and closures are often sealed using PVC fine seam sealing, which additionally protects the hem flange against corrosion. However, undesirable blistering in the seam sealing can occur in the PVC curing process. In current research activities we determine the causes for this defect and investigate solutions to reduce blistering in the seam sealing.

2 *Swirl application of the adhesive onto a car body part*



HEM SIMULATION
... ONE TIME STEP AHEAD

REPRESENTATION OF THE ENTIRE PROCESS CHAIN

Currently the Finite Element Method (FEM) is the standard tool for numerical depiction of forming processes. Hem simulation supports planning of facilities and tools and allows forecasts regarding dimensional accuracy and shape accuracy of the joined assembly. Due to the specific process, hemming places particular demands on FE simulations in terms of multi-level procedures, strain rate, contact conditions, mesh design and varying forming zones.

Fraunhofer IWU refines the challenging modeling process. Using a real component for simulation input is possible, for example, by performing optical measurements and process-adapted meshing. This is particularly important for hemming, as the hemming operation takes place at the end of the body framing process. In other words, the influencing parameters of the entire process chain and its variations cause a deviation between the real component geometry and the CAD data. By applying optical measurement technology, the real components can be measured after each individual process step. Subsequently, it is possible to match the results of the simulation precisely. Thus, the quality of the simulation forecast is evaluated and optimized. Additionally, the simulation results are compared to real components by using microsections of the hem.

Due to complexity and detail accuracy, high computing capacities and computation times are necessary to solve the simulation models. However, the limits of feasibility and profitability are reached quickly in this context. At Fraunhofer IWU the research focus lies on simplified models for hem simulation which ensure both, high quality of forecast and efficient computational expense.

3 *von Mises equivalent stress after simulated hemming and furnace process of a hybrid CFRP-aluminum assembly – cross-faded from real component*

PROCESS DEVELOPMENT
... FROM IDEA TO PERFECTION

OUR PORTFOLIO

Using modern measuring technology and efficient analysis methods, we examine tasks of hemming and hem flange bonding both in series equipment at the client's site or in test facilities at Fraunhofer IWU.

We provide the following services:
– Analyzing and evaluating the quality of hem joints and hem flange bonded joints
– Optimization of tools and processes to achieve hem geometry close to CAD
– Predetermining dimensional deviations of hemmed assemblies
– FE simulation of hemming processes for sensitivity analysis, process optimization and determination of process forces
– Optical measurement of the geometry of hemming tools and components, unloaded and under operating load
– Measurement of process forces of the hemming tools
– Analysis of causes for failure of adhesive bonding and optimization of adhesive application
– Deformation measurement of hemmed assemblies in furnace processes

For tasks of hem flange bonding, experimental procedure, evaluation and documentation are based on the requirements according to DIN 2304 "Adhesive bonding technology – Quality requirements for adhesive bonding processes".

4 *Specimen geometries for hemming experiments at Fraunhofer IWU (left: concave/convex curved specimen, approx. 300 mm x 250 mm, 2 hem flanges; middle: straight specimen, approx. 300 mm x 200 mm, 1 hem flange; right: complex hemming assembly, approx. 800 mm x 500 mm, hemming of the entire outline)*

Editorial notes

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