IWS Group
Special Joining Technologies

The group Special Joining Technologies concentrates on the development of friction stir welding and magnetic pulse welding. Thereby the focus lies on the manufacturing of mixed material joints or conventional hard-to-weld aluminum alloys from the aerospace industry, car body manufacturing, plant manufacturing and components of the powertrain. For that the group has a widespread specialized expertise and competence in managing of bilateral and governmental funded projects.

Fig. 5: Commercially available magnetic pulse welding machine

Our service:

- development of cold weld processes for hard-to-weld material combinations
- consulting and acquiring of feasibility studies
- process development, concept studies
- performance of R&D topics together with industrial partners and in frame of governmental funded projects
- system development together with our partners
- pre-series tests and transfer into series production of our customers

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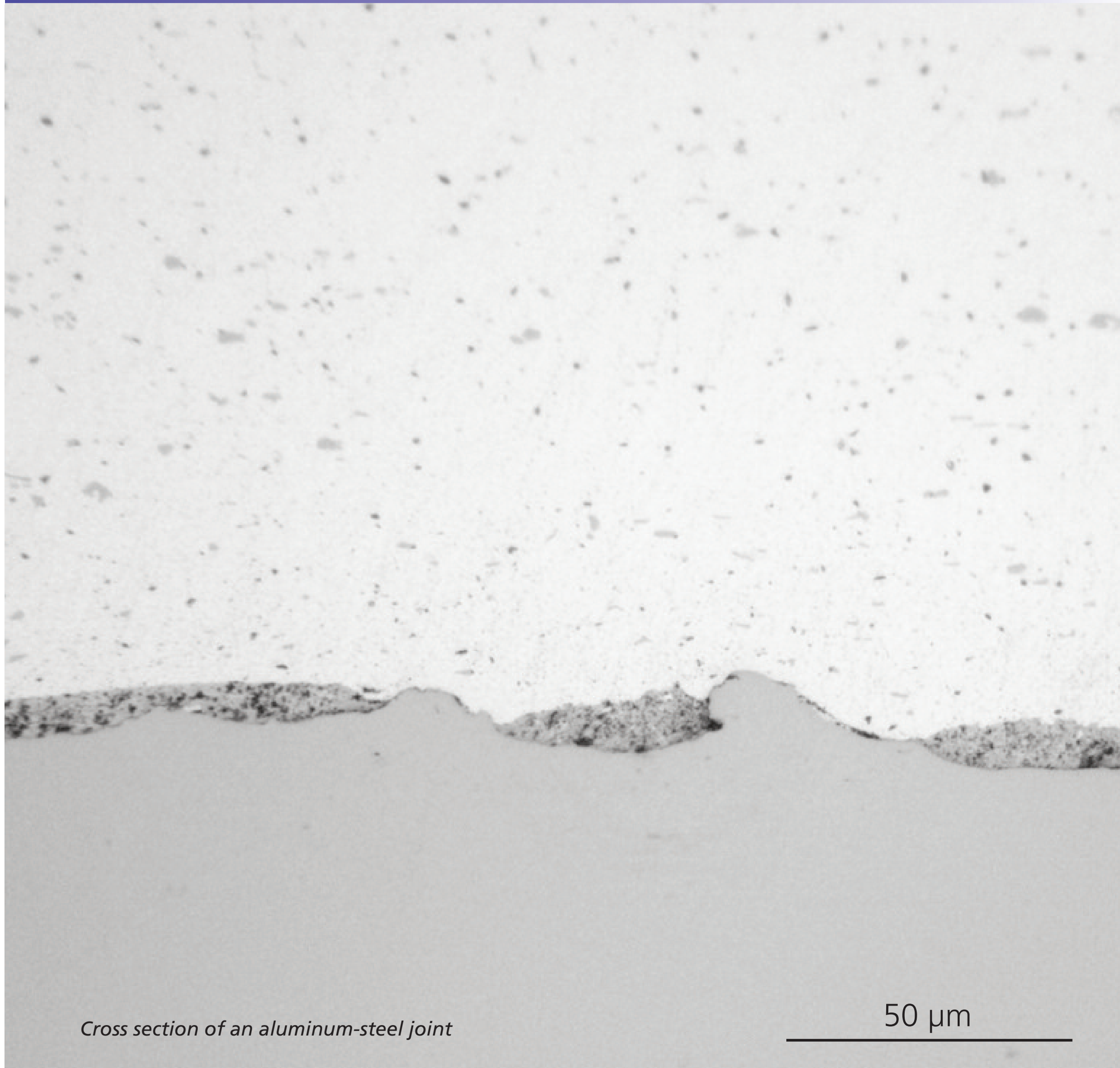

Cross section of an aluminum-steel joint

ELECTROMAGNETIC PULSE WELDING – AN INNOVATIVE TECHNOLOGY FOR MIXED MATERIAL JOINTS

JOINING TECHNOLOGY FOR METALLIC MIXED MATERIALS

Process

Electromagnetic pulse welding (MPW) is a modern joining technology that is suitable especially for mixed material joints. It enables firmly bonded metal joints between tubes and cylindrical parts as well as between metallic sheets in an overlap configuration. The joint creates a cold weld, so that intermetallic phases are reduced to a non-critical minimum. Thus a high strength joint is created.

The process' principle is based on the force action of temporarily changing magnetic fields. These forces accelerate the outer part to be joined to a speed of 200 to 300 m/s and move them into the direction of the second inner part to be welded. The magnetic pressure which acts on the outer part leads, together with the deformation, to the firmly bonded metal joint.

Equipment

The MPW equipment usually consists of an electric generator which is responsible for charging the capacitor bank. By shifting the capacitor bank, the capacitors discharge within 5 – 40 µs into the coil consisting oscillating circuit. A first half-wave of this strongly damped oscillation generates the magnetic field in the vicinity of the coil and thus the forces for the deformation of the parts to be joined.

At Fraunhofer IWS two machines are available for MPW applications. A commercial 32 kJ machine and a 40 kJ prototype system can be used for several welding tasks. The interchangeable coils that are used for the welding process allow a flexible application of the MPW equipment for rotationally symmetric and flat parts.

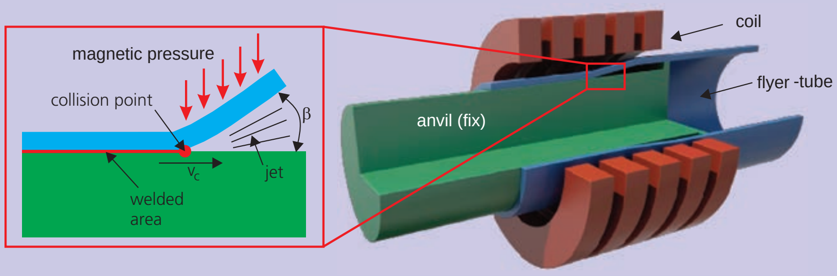

Fig. 1 : Process principle of electromagnetic pulse welding

Joint examples

The application bandwidth of MPW joints ranges from applications for the automotive industry up to the electric industry. Electromagnetic pulse welding is suitable for mixed material joints as well as for joining the same type of metals. Hereinafter some examples are given to clarify the variety of application of this joining process.

For electromagnetic pulse welding of flat sheets Fraunhofer IWS has developed a special flat coil. By utilizing this coil, joints of up to 120 mm can be created within a single pulse process. The application of this coil allows transferring the advantages of the method on larger geometries, while creating more joining zones sequentially between the parts. It is also conceivable, that e. g. aluminum-steel hybrid plates for the automotive industry can be manufactured by this method.

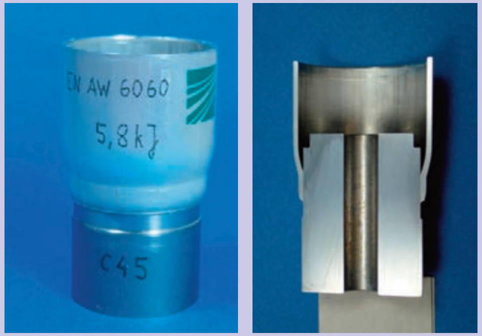

Fig. 2 : Aluminum tube joined with a steel cylinder

Fig. 3 : Aluminum-copper joint (top) and aluminum-aluminum joint after a torsion test (bottom)

Fig. 4 : Aluminum-steel joint (left) and 120 mm aluminum-aluminum joint (right)