Fraunhofer
IWS

FRAUNHOFER-INSTITUT FÜR WERKSTOFF- UND STRAHLTECHNIK IWS

INSEPERATABLE – LASER ROLL BONDING OF BIMETAL STRIPS

Lightweight construction with laser roll bonded, semi-finished composites

Fraunhofer-Institut für Werkstoff- und Strahltechnik IWS
Winterbergstraße 28, 01277 Dresden, Germany

Contact:
Dipl.-Ing. Volker Fux
Phone +49 351 83391-3243
Fax +49 351 83391-3210
volker.fux@iws.fraunhofer.de

www.iws.fraunhofer.de

The task

Current automotive industry demands with regard to reduced CO_2 emissions address applications of new and improved drive technologies and a constant reduction of vehicles' weight. Not only car bodies and motors are affected but also components in the field of vehicle electric engineering.

The increased implementation of aluminum materials implies considerable weight reductions; however, since specific parameters of these materials are still furthermore required a complete replacement of conventional materials is not possible. A partial use of aluminum implies numerous joining challenges as mixed materials joints consisting of aluminum, steel or copper cannot be performed with melt joining processes. Alternative joining concepts and suitable semi-finished products are to be developed to successfully join mixed compounds.

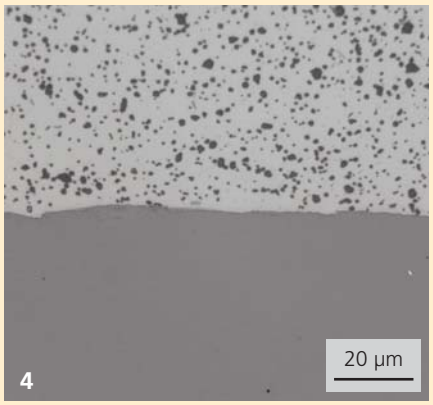
Solution

Engineers of the Fraunhofer IWS collaborated with several industrial partners to develop a special laser roll bonding process, which enables the joining of hard-to-weld metals. In contrast to conventional roll bonding processes the IWS process feeds the two metal strips to-be-joined at angles of 45 ° towards the gap. When passing the laser focus line the surfaces of both strips are heated to the necessary temperature just prior to the roll bonding gap (see cover image).

The process implies that deformations are limited to these strip areas and, if necessary, the strips can be additionally inductively pre- or post-heated.

Due to the different deformation behavior of the materials to-be-joined a material flow emerges directly at the material transition against the feed direction. This disturbs the local accumulation of alloy elements at the transition. As a result, no or only partially formed brittle phases can be seen. This is particularly true for material combinations with a strong tendency for forming intermetallic phase seams at the transition, (Fig. 4).

Cross section, material transition steel/AlSi12



Results

The IWS process enables material composites with high strengths and good cold formability and is, thus, highly suitable for combinations of steel or copper with aluminum alloys. As a result of the low energy input very low overall degrees of deformation are sufficient to generate high-strength material composites. Compared to conventional roll bonding processes, the IWS process offers the advantages of near-net-shape bondings and higher degrees of freedom with regard to the thickness combination of semi-finished parts to-be-joint. The available laser power determines the width of the platings. The width is 24 mm at 8 kW laser power. Strip widths of appr. 100 mm are achievable and hot material areas are possible with inert gas protection.

Application examples

The IWS laser roll bonding process enables a huge variety of material combinations. Bimetal strips made of almost all steel types can be produced as well as material mixed joints made from steel and copper, steel and aluminum, silver-based contact material with silver or copper or titanium and aluminum (see Fig. 1).

Three different kinds of semi-finished forms are possible:

- homogeneous strip-shaped bondings (e.g. for bearing materials, stampings for connecting or contact elements),
- strip-shaped bondings with overlaps (connecting elements, transition joints),
- homogeneous wire-shaped bondings (e.g. semi-finished products for electric connecting elements, further processing to transition joints).

Al or Cu cell connectors enable positive material joints of aluminum or copper electrodes with permanently low electric transition resistance (see Fig. 2). Figure 3 presents a steel/aluminum hybrid plate for applications in the automotive industry. The plate was welded and deep drawn by means of laser roll bonding transition joints.

1 Examples of laser roll bonded, semi-finished products made from copper and aluminum
2 Al-Cu cell connector (Bosch, BMBF-project Batcon)
3 Deep drawn steel-aluminum hybrid plate