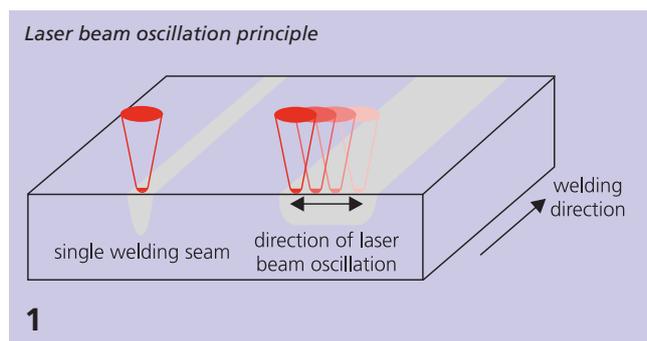


IMPROVED JOINT CONNECTION THROUGH BRAZING WITH LASER BEAM OSCILLATION

THE TASK

Joining by laser is still of interest to automobile manufacturers and provides the impetus to develop joints of lightweight materials, such as aluminum, high-strength steels, and mixed materials. Many assemblies, including doors, lift-gates and other car body sheet parts can be joined using laser processes. An advantage of the laser arises from the focused and controlled heat input, which, in turn, results in less part distortion.

Oscillation of the laser beam in welding or brazing (Fig. 1) can contribute to improving the seam quality. A high-speed camera system for process monitoring can be used to enhance understanding and optimization of the technique.

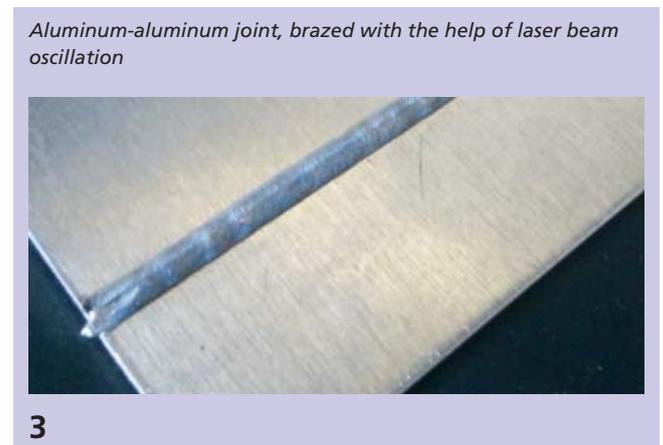


OUR SOLUTION

A laser technique for brazing aluminum-aluminum- and steel-aluminum joints was developed and intentionally engineered with a high-power 3D galvo scanner for manipulation of the laser beam (Fig. 2) at the Fraunhofer Center for Laser Applications (CLA) in Plymouth, Michigan, USA. Based on typical requirements from the automotive industry, two different joint types were examined. Zinc coated steel (dual phase steel) and

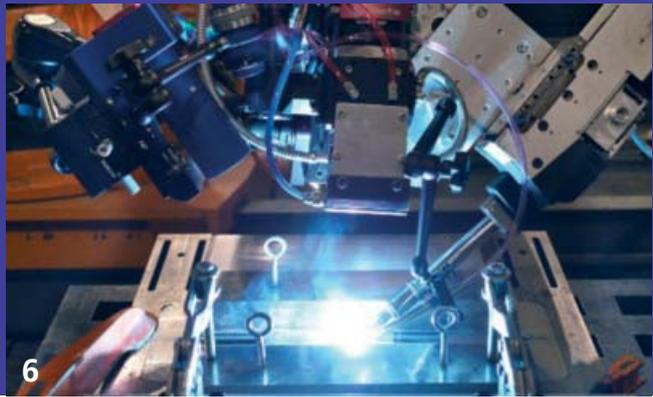
aluminum sheets made of a 6000 series AlMgSi alloy (thickness from 1.2 mm to 1.5 mm) (see Fig. 3), were used for the development. Wires of various aluminum alloys were supplied as filler metal to achieve defect-free brazing joints. Real-time process visualization and monitoring were performed by means of a high-speed camera system engineered at the Fraunhofer CLA in cooperation with Fraunhofer IWS (Fig. 4).

A special test program was designed and executed for a better understanding of the influence of wire positioning and alignment, as well as of the most important process parameters. Brazing tests were performed with and without laser beam oscillation and with different oscillation patterns; the test samples were analyzed afterwards by microscopy. During the experiments high speed video data of the process was captured and processed using software.





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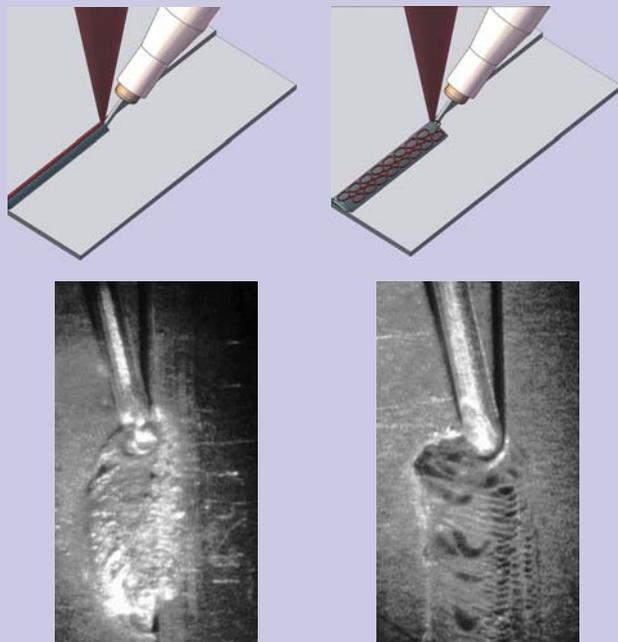


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RESULTS

Laser brazing with beam oscillation provided higher quality and wider brazing joints. The results demonstrated that the horizontal beam oscillation transverse to the feed direction (Fig. 5 right) led to the optimal brazing profile. The brazing profile can also be well controlled in terms of laser beam oscillation and seam position by process monitoring and keeping wire feeding constant.

Images recorded by means of the high-speed camera of the laser brazing process, without (left) and with beam oscillation (right)

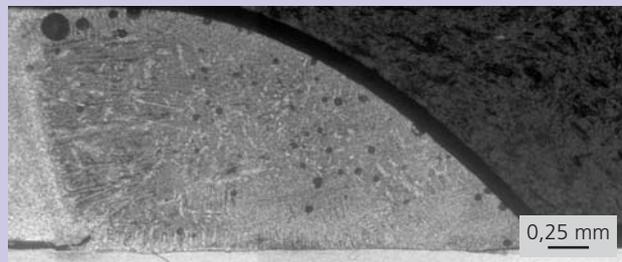


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The high-speed camera system significantly enhances the monitoring of both wire position and welding seam, simplifying process development and optimization of brazing processes (Fig. 6).

Examining the aluminum-aluminum joint, it was discovered that the brazing wire can either be located at the seam or at a position on the bottom base material at a certain distance to the seam. Nevertheless, the wire melts in a controlled manner, and the substrate material only minimally affects the process (Fig. 7).

Cross-section of aluminum-steel joint brazed by means of beam oscillation and aluminum filler wire



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The steel-aluminum joints brazed by laser with beam oscillation achieved higher strength and toughness values than joints brazed without beam oscillation. This can be attributed to the fact that heat supply to the steel sheet is better controlled and the formation of brittle intermetallic phases is minimized through beam oscillation.

- 2 Scanner system for laser beam oscillation
- 4 Process monitoring system created by the Fraunhofer CLA
- 6 Brazing process with process monitoring

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