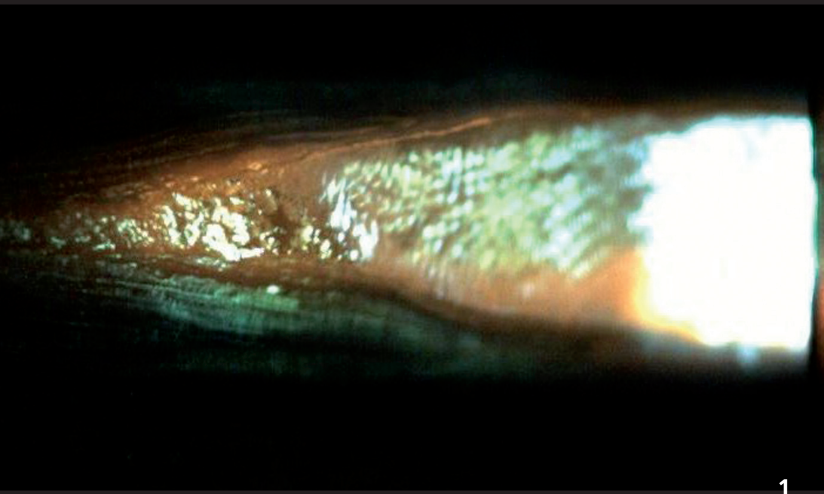
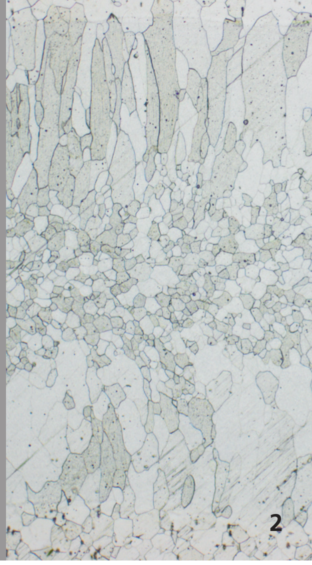
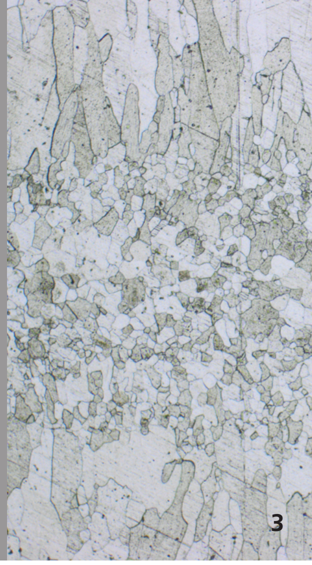

ULTRASONIC LASER WELDING

Task

The production of homogeneous weld seams in joints of dissimilar metals often poses major challenges for welding technology. To homogenize the weld micro strucure, the joining process must be able to minimize intermetallic phases and significantly reduce brittle-hard areas, rough graining and dendritic anisotropies.

Method

In order to resolve the aforementioned issues, a temporally and spatially modulated laser beam is combined with ultrasonic excitation of the weld pool. In an initial stage, the effect of structure-borne noise at 20 kHz on the formation of the microstructure in a ferritic stainless steel is tested. To this end, the sound field was coupled into the workpiece from various directions in relation to the weld direction. The weld seams were subjected to a metallographic analysis. Process monitoring using high-speed cinematography provided insights into the sound distribution in the melt and solidification.

1 Snapshot of melt pool.

2 Flat section of a weld seam in 1.4512, welded without acoustic irradiation.

3 Flat section of the weld seam in 1.4512 subject to a sound power of 100 W at 20 kHz, irradiated parallel to the weld direction.

Result

Under the aforementioned test conditions, coupling parallel to the weld direction provided the best results. Power output of up to 500 W could be coupled. Contrary to the literature, other coupling directions produced no effects. Additionally crack formation occurs above a certain threshold of sound power. In the case of a material with pronounced columnar solidification, the area with a rectified microstructure was widened, while the grain size increased slightly. Coupling of the sound waves to the melt was observed in the antinodes.

Applications

The results can be used wherever an isotropic microstructure is required in weld seams. Applications include the prevention of center dendrites when welding austenitic materials and the associated risk of cracking as well as microstructure homogenization with dissimilar joints. Here phase seams are resolved and the associated components finely dispersed over the weld seam cross-section. This reduces the crack frequency while increasing strength by means of dispersoids.

Contacts

Dipl.-Ing. Martin Dahmen
Phone +49 241 8906-307
martin.dahmen@ilt.fraunhofer.de

Dr. Dirk Petring
Phone +49 241 8906-210
dirk.petring@ilt.fraunhofer.de

Fraunhofer Institute for Laser Technology ILT, www.ilt.fraunhofer.de
DQS certified by DIN EN ISO 9001, Reg.-No.: DE-69572-01