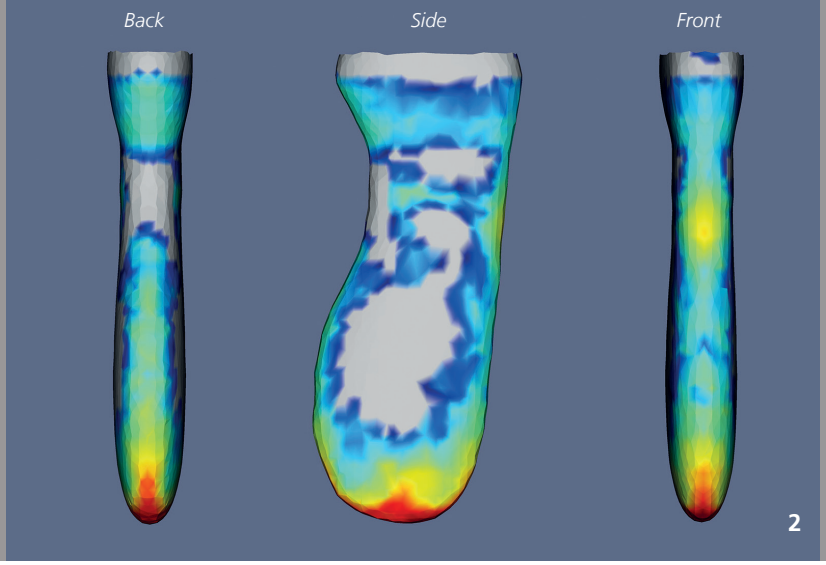

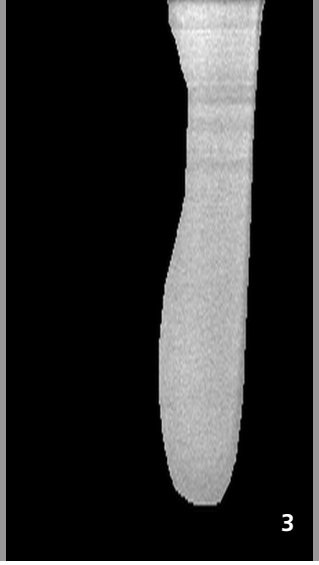

SIMULATION OF THE ABSORPTION DISTRIBUTION IN LASER BEAM MICRO-WELDING OF METALS

Task

Laser welding of metallic materials on the submillimeter scale is used to produce electronic components in the electromobility industry. The small spatial scales as well as the large thermal conductivities of copper and aluminum materials pose challenges for process stability, however. With the experimental diagnostics and numerical simulation, research can analyze causes of instabilities and derive measures for improving the quality of the weld seam.

Method

The laser welding process is conducted by scientists from Fraunhofer ILT and RWTH Aachen university LLT in an adapted setup at the German Electron Synchrotron (DESY) and exposed in-situ with high-brilliance X-rays from the PETRA III beam source. At RWTH Aachen University (NLD), the acquired contrast images are used to construct the three-dimensional shape of the weld capillaries. A GPU-parallelized ray tracing algorithm developed at NLD is used to calculate the radiation propagation and absorption.

Results

The temporal course of the calculated absorption distribution shows a predominantly uniform illumination of the capillary base. The dynamic variation of the capillary shape is mainly expressed by absorption fluctuations in medium depth regions as well as in the detection of the back-reflected light. Thanks to the process understanding gained from analyzing the time course of absorption distribution and capillary shape, Fraunhofer ILT has developed approaches for reducing pore formation and surface roughness.

Applications

The modeling and numerical simulation developed here can be applied in the process development of laser microwelding for metallic materials, especially for components of the electric vehicle industry (battery packs, fuel cells) and power electronics (direct bonded copper substrates).

Contact

Dr. Ulrich Halm, Ext: -680
ulrich.halm@nld.rwth-aachen.de

Prof. Wolfgang Schulz, Ext: -204
wolfgang.schulz@ilt.fraunhofer.de

2 Calculated absorption distribution on the surface of a welding capillary reconstructed from X-ray images.

3 Masked radiograph of a sweat capillary.