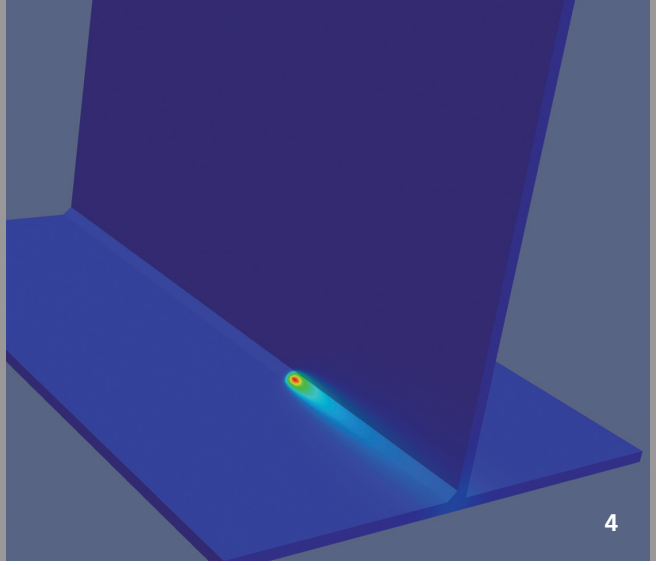

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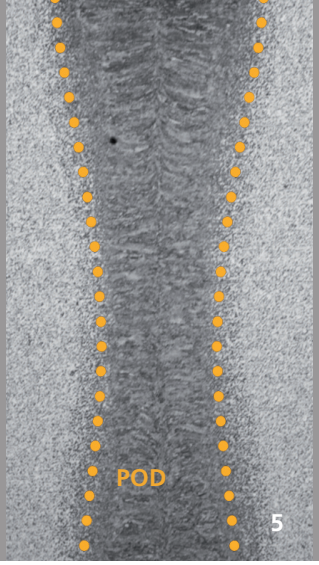

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AUTOMATED HEAT SOURCE CALIBRATION WITH LASER WELDING

Task

Commercially available software for simulating laser welding normally does not incorporate all the physical phenomena, but rather maps the energy input on the basis of a parameterized volume source. In order to achieve an equivalent description of the heat input, the values of the parameters are calibrated in an iterative process by trial and error until there is sufficient agreement between the calculated and experimental values for the temperature. In each iteration step, a partial differential equation (PDE) is solved in three spatial dimensions; using conventional finite element (FE) methods, this entails considerable calculation effort. The number of iteration steps depends largely on the skillful adjustment of the parameters and requires sound expert knowledge.

Method

This project aims to automate and accelerate this calibration process while achieving at least the same reliability as the established method. Optimization techniques are used to adjust the parameter values and to assess the match between simulation and experiment. Parallelized efficient numerical techniques as well as the Proper Orthogonal Decomposition (POD) model reduction method are used to solve the PDEs.

Result

Rapid, automated and reliable determination of the parameter values eliminates the need for a phase of time-consuming and hence costly calibration by an expert.

The developed efficient numerical techniques combined with the POD method save a great deal of time compared to conventional FE methods. In this way, the parameter values of a volume source can be automated within a few hours and determined with a controllable error.

Applications

The methods developed support automated, rapid and reliable calibration of the parameterized heat source. This provides the basis for efficient weld simulation to predict process quality features such as distortion and residual stress.

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4 Temperature for welding a T-joint calculated using POD.

5 Calculated melt line and associated micrograph.