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Annual report 2018

Subproject A4

Title
Simulation-supported determination of the effect of weld pool flows on the precise formation of the MSG weld

Project management/-processing
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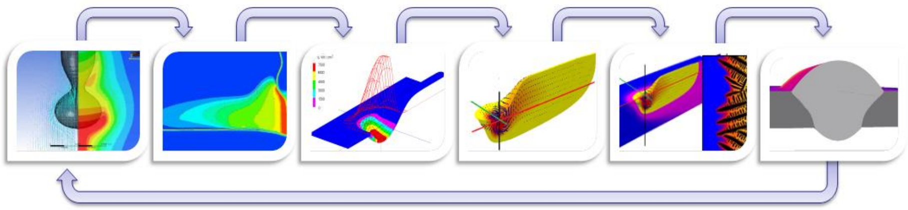
Task discription

The aim of the subproject is the simulation-supported prediction of the formation of the weld seams during arc welding (MIG/MAG) as a basis for a targeted influencing of the weld seam to increase the component precision. A self-consistent model is developed which covers the entire welding process area (Fig.1). A central focus of the research is, through an improved understanding of the interaction of electrodynamic and fluid dynamic effects and the influence on the formation of the weld seam.



a b c d e f

Fig. 1 Sub-areas of arc welding: (a) electrode wire and droplets, (b) arc, (c) drop zones (d) molten pool with free surface (e) solidification (f) weld seam.

In the fourth year of the subproject, the cathode model for the heat and current input was first implemented in a calculation code and with this code, the first numerical calculations could be carried out to clarify the relationship between surface temperature and cathode spot distribution (AP1.1.). The resulting findings were also taken into account and analysed in simplified form in the molten pool model when calculating the molten pool shape. The results were then presented at three conferences and presented for discussion to international experts. Finally, a series of welding tests with high-speed recordings was started in order to analyse the process even more precisely (AP3.1).

Procedure

First, a cathode model with detailed consideration of the cathode processes was developed, whereby the influence of evaporation was modelled here by an attenuation term in the ion current density. This physically well-founded relationship between surface temperature and heat flux density was used as a probability for the formation of a cathode spot and implemented in a two-dimensional distribution model, whereby the cathode spots in turn modified the temperature distribution and thus a non-linear relationship was established. Subsequently, the form of the distribution resulting from this model was also used in the molten pool simulation and significant effects on the maximum temperature as well as the evaporation losses could be determined. In order to confirm the distribution of the cathode spots on the molten bath, high-speed camera images were then taken, but the cathode spots could not be observed there with the expected clarity and the test setup was modified for a measurement campaign in the next year. The results were also presented and discussed at various international conferences.

Results

Together with the molten pool model developed in the first year and the consideration of the drop effect developed in the second year, the concept for the cathode model was implemented and analysed in detail, and in simplified form also implemented and also analysed in the model for the molten pool formation of MSG welding. The suggestions that were obtained at the international specialist conferences proved to be particularly valuable.

Summary and Conclusion

The models for the molten pool and cathode area developed last year allow a deeper understanding of the essential processes for molten pool formation in MSG welding. The hypothesis on which the model for the cathode area is based has also been experimentally investigated, but more detailed investigations are required. Due to the deeper understanding of the processes, an extension of the model to the impulse process is now possible.

Publication

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