**SFB 1120**

**Annual report 2018**

## Subproject A2

### Title

Local residual stress build-up during solidification of technical alloys during welding

### Project management/-processing

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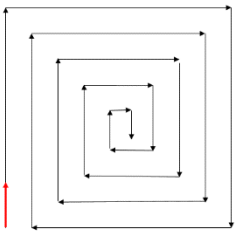
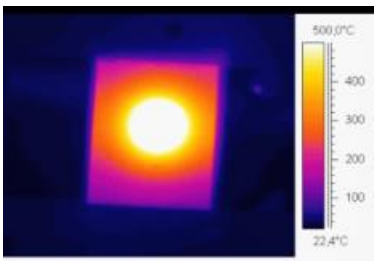
### Task definition

In this subproject, a verification and extension of existing theories on residual stress build-up by direct observation of the strain curve during welding is to be worked out. This will be done by in-situ experiments to measure temperature and strain. The temperature and deformation data serve as a basis for the validation of thermo-mechanical simulation models.



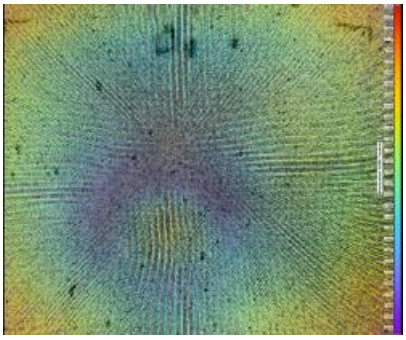
### Procedure

In the fifth project year, in situ measurements of temperature distribution and strain fields during deposition welding were carried out. For this purpose, a test rig was set up which records the deformation and temperature distribution of a substrate plate during welding from the underside. Furthermore, the relationship between phase transition temperatures and mechanical properties was investigated.




### Results

In the tests it could be shown that the method of image correlation can be successfully transferred to additive manufacturing. In this way, the influence of different pressure paths on the temperature field distribution and the deformation of the substrate plate could be made visible. It became clear that path planning has a considerable influence on the deformation and microstructure of the substrate plate. A path planning strategy was identified which allows for a heat input that is as homogeneous as possible and thus allows for a homogeneous expression of the heat-affected zone. A disadvantage is a strongly pronounced deformation of the substrate plate.



For joint welds on steel materials it could be shown that an estimation of the mechanical properties is possible by in-situ measurement of the phase transition temperature. By measuring during the welding process, a local prognosis of the property distribution can already be given, so that in the future a compensation is possible.

**Summary and Conclusion**

The work provides an important basis for a better understanding of the deformation behaviour during welding. Further work will combine the results with the work from subproject A4 and produce microstructures with reduced residual stresses and distortion with the aid of supplementary wire LTT. The cooling effect of filler wires and the chemical homogeneity of the microstructure produced by the multi-wire process will be investigated.

**Publication**

Sharma, Rahul; Reisgen, Uwe. Assessment of mechanical properties in high-strength steel weld metals by means of phase transformation temperature. Welding in the World, 62, 2018, 6, pp. 1237 – 1236. Springer, Heidelberg. DOI: 10.1007/s40194-018-0605-7.