Research theme	Additive manufacturing
Research title	Reducing residual stress and part deformation in SLM through scanning strategies
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Research period	From September 2014 to July 2015
Company	TNO
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Background

This research is performed at TNO within the Equipment for Additive Manufacturing group. Experiments were conducted in collaboration with the National Aerospace Laboratory (NLR). A main challenge within metal Additive Manufacturing is to resolve the high residual stresses within the produced parts. SLM-produced parts are built layer by layer, in which each separate layer is melted by a laser that follows a predefined path. This predefined path is called the scanning strategy and contains an individual set of lines (scan vectors).

Assignment

The objective of this research is to reduce residual stress and part deformation in SLM-produced parts by applying smart scanning strategies. In order to understand the influence of the scanning strategy onto the residual stress, a thermal-mechanical numerical model is developed. Different scan vector lengths are investigated. The numerical model is validated with printed test parts.

Results

The results from the numerical model showed that with an increase in scan vector length an initial deformation is introduced. Therefore the results of stress and strain are uncertain. This observed initial deformation could be resolved by introducing a hatch spacing in the numerical model. For the experimental part, five cantilever test parts with varying scan vector lengths were printed using the alloy Ti6Al4V. For all test parts the final deflection was reviewed. The experimental results showed that the direction of the scan vector, with respect to the part geometry, influences the part deflection. The test parts where the scan vectors were oriented in the perpendicular direction showed less distortion than the test parts where the scan vectors were oriented in the longitudinal direction.

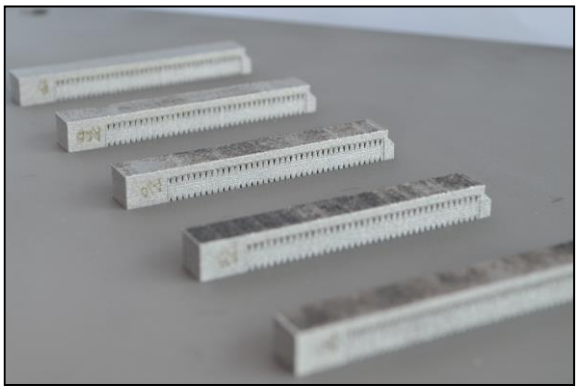

Figure 1 – The printed cantilever test parts.

Personal experience

It was a great experience to conduct research in the field of Additive Manufacturing. During this thesis I had the opportunity to do theoretical and practical work. Gaining both theoretical and experimental knowledge, gave me more insight in the physics of the process and also the complexity of metal additive manufacturing.

The guidance at TNO was great. Throughout my thesis I was supervised by two mentors. They gave good guidance on theoretical and practical topics. There was always the opportunity to have a good discussion about the direction of my research or the content, which I experienced as very pleasant.