Multi-Objective Optimization of PBF Workpiece Orientation

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ABSTRACT

Several key performance indicators are considered when defining the orientation of a work piece for laser-based powder bed fusion additive manufacturing. Printing time, powder cost, preparation and post processing costs as well as distortions and residual stresses are currently accounted for based on experience, intuition and trial and error. This paper discusses a mathematical formulation for multi-objective optimization scheme by which cost considerations as well as work piece manufacturability and quality are taken into account.

The calculation of geometric cost functions is performed using a Monte Carlo approach. Constraints related to base plate size and chamber height are taken into account. The results are analysed to identify best candidates' orientations in terms of cost. Those candidates are further analysed using an Integrated Computational Material Engineering platform (ICME) to take process parameters into account when quantifying distortion during print process. If the print job is confirmed to be printable, the final as-build shape and residual stresses are compared to work piece quality specifications. If geometric tolerances are exceeded the geometry is compensated for the found distortion and the print simulation is repeated to confirm the improved outcome.

If simulations do not confirm the manufacturability of a cost effect orientation, the next best candidate is analysed similarly.

The presentation will summarize multi-objective optimization scheme and the the multi-scale multi-physics approach transferring microscopic process parameters to large scale models characterizing the work piece quality.