

THERMOMECHANICAL SIMULATION AND OPTIMIZATION OF L-PBF SUPPORT SUCTRUCTURES FOR MITIGATING DISTORTION

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Abstract

The additive manufacturing of titanium alloys (Ti-6Al-4V) by L-PBF is characterized by severe thermal gradients that induce high residual stresses, which can be mitigated by using adequate support structures for preventing distortion. The main challenge lies in the difficulty of predicting how the spatial distribution, mesostructure and orientation of supports influence the resulting dimensions and shape of L-PBF parts. For instance, inefficient configurations may result in warping or torsion failures. This work evaluates the influence of the orientation and mesostructure of support blades on the magnitude of the maximum displacement of cantilever-type specimens. Thermomechanical simulations are performed using the Autodesk Netfabb software. For design optimization, a parametric study was conducted comparing different supports: parallel to the base (standard), inclined (at 45°) and perpendicular (at 90°), for different mesostructures. The results reveal that the 90° orientation is significantly more effective in reducing displacements for the same support density. Furthermore, it was observed that supports positioned at 45° angles can induce undesirable torsional phenomena in specimens. Finally, the mesostructure can be used for finely tuning responses and saving material and manufacturing time. It is concluded that optimizing supports, based on agile numerical computations, is a prerequisite for mitigating defects inherent to rapid solidification and ensuring the manufacturability of complex components.