

THERMOMECHANICAL PROPERTIES OPTIMIZATION OF L-PBF SUPPORT STRUCTURES VIA ASYMPTOTIC HOMOGENIZATION AND RESPONSE SURFACES

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Abstract

In the Laser Powder Bed Fusion (L-PBF) additive manufacturing process, support structures are essential to ensure mechanical anchoring and heat dissipation, preventing the part from warping due to accumulation of thermal residual stresses. Reliable simulation of these mesostructures requires extremely refined finite element meshes, resulting in high computational costs. This work aims to develop a methodology to numerically obtain equivalent mechanical and thermal properties of supports, allowing their representation as a homogeneous medium, for saving time in thermomechanical simulations. The Asymptotic Homogenization (AH) technique is used, applied to 2D unit cells. Shape optimization of the unit cell is considered for equivalent properties, using response surfaces. Sampling of the design domain is performed via Taguchi Orthogonal Matrix, for two unit cell design variables: wall thicknesses and wall opening angles. Therefore, it becomes possible to find optimal configurations for unit cells. The results demonstrate that the calculation of equivalent properties allows replacing the complex geometry of supports by an equivalent homogeneous medium, eliminating the need for excessive mesh refinement for the support domain. This approach enables the optimization to maximize stiffness and thermal conductivity of unit cells, with low computational effort and ensuring the dimensional integrity of the manufactured part.