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Meso-scale modeling of multiple-layer fabrication process in Selective Electron Beam Melting: inter-layer/track voids formation

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Abstract

Selective Electron Beam Melting (SEBM) is a promising powder-based metallic Additive Manufacturing (AM) technology. However, most powder-scale modeling efforts are limited to single track process, while it is also difficult to experimentally observe the interaction between tracks and layers. In this study, we develop an integrated modeling framework to investigate the SEBM process of multiple tracks and multiple layers. This approach consists of a Discrete Element model of powder spreading and a Computational Fluid Dynamics (CFD) model of powder melting. These two models exchange 3D geometrical data as a cycle to reproduce the manufacturing process of multiple tracks along various scan paths in multiple powder layers. This integrated modeling approach enables further understanding of how current tracks and layers interact with previous ones leading to inter-track/layer voids. It also incorporates more influential factors, particularly the layer-wise scan strategy.The inter-layer/track voids due to the lack of fusion are systematically discussed in light of our simulation results which qualitatively agree with experimental observations in literature.

Keywords: Electron Beam, Additive Manufacturing, Thermal-fluid Flow, Discrete Element Method, Multiple Layers, Scan Path

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