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Investigation on evolution mechanisms of site-specific grain structures during metal additive manufacturing

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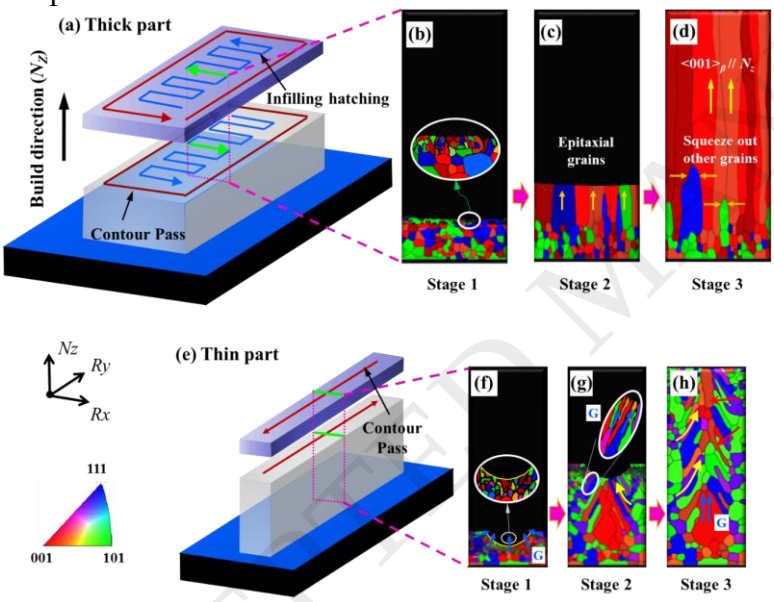
Graphical abstract



Abstract

A multiscale model is developed to investigate the evolution mechanisms of site-specific grain structures during additive manufacturing (AM) of metallic alloys, using the selective electron beam melting (SEBM) fabrication of Ti-6Al-4V as an example. Specifically, finite-element method is utilized to predict the thermal response at macroscale during SEBM, and the extracted thermal information is then input into a temperature-dependent phase-field model to simulate the grain growth at mesoscale. The grain epitaxial growth, grain selection, grain nucleation and layer-by-layer manufacturing fashion are incorporated, in order to accurately predict grain structure development and relevant physical processes during AM. It is found that, the development of the predominant grain structures in the thick and thin walls,