High-throughput process mapping and microstructural control in additively manufactured 316L stainless steel

Ankur Kumar Agrawal

Advisor: Dan Thoma

Department of Materials Science and Engineering, University of Wisconsin-Madison, Madison, Wisconsin (53706)

ankur.agrawal@wisc.edu

Abstract:

In SLM techniques, processing parameters like laser power and scanning speed affects the solidification conditions (i.e. cooling rate and thermal gradient) and the melt pool geometry. The aim of the work is to investigate and build a coherent relationship between the processing parameters and as-fabricated microstructural features. High-throughput experimentation on hundreds of specimens was carried out to rapidly identify a processing window. Within the processing window, microstructural investigation at different length scales (i.e., grains size and morphology, texture, primary dendrite arm spacing, and melt pool geometry analysis) were performed on different specimens. Finer grain size and dendritic spacing, more random texture, and shallower melt pool was obtained at lower energy density values. A model is proposed to explain the dependence of microstructure on the melt pool geometry and the solidification conditions. This method also provides a roadmap for identifying SLM processing windows for novel materials, expanding the pool of materials available for SLM additive manufacturing.