The Summer Undergraduate Research Fellowship (SURF) Symposium
6 August 2015
Purdue University, West Lafayette, Indiana, USA

Characterizing Strain Accumulation, Residual Stress, and Microstructure of Additive Manufactured Materials

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ABSTRACT

Additive Manufacturing (AM) is a rapidly evolving fabrication technology beneficial for its cost-saving potential to produce complex, low-volume shapes. However, AM materials are currently limited to nonstructural applications due to variability in their structural integrity, particularly their fatigue lives. IN718, Ti64, and Al10MgSi specimens manufactured by Direct Metal Laser Sintering (DMLS) were characterized based on variation of post-processing techniques and build direction. To understand the impact of each variable, surface roughness, hardness, residual stresses, microstructure, and strain accumulation in response to Low Cycle Fatigue (LCF) were studied. The use of Electron Backscatter Diffraction (EBSD) provided grain orientation and grain size distributions in each material. This data also provided a grain boundary overlay to be used in conjunction with in-situ Digital Image Correlation (DIC) during LCF to analyze strain distribution with respect to grain characteristics. This work provides experimental background data to be used for computational modeling of the structural integrity of AM materials in order to establish relationships between microstructure and fatigue. The ultimate goal is to understand the influence of material type, post-processing, and build direction variables in AM processes so these materials can be further explored for structural applications.

KEYWORDS

additive manufacturing, DMLS, post-processing, low cycle fatigue