NIST Internal Report
NIST IR 8551

High Pressure Heat Treatment Development for Laser Powder Bed Fusion Ti-6Al-4V Alloy

Observations and Findings

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Abstract

This report summarizes a year long study carried out by NIST into the processing-structure-properties-performance (PSPP) relationships in laser powder bed fusion (PBF-L) additively manufactured (AM) Ti-6Al-4V alloy. In this study, the effects of heat treatments as they influence microstructure is investigated with respect to uniaxial tensile properties and rotating bending fatigue. Given that slight differences in chemistry can drastically influence mechanical properties, this study utilized a single PBF-L build to construct 90 specimens for characterization. These 90 specimens were split up into 15 groups, 14 of which were subjected to novel heat treatments in order to investigate the effects of different microstructures achieved through these heat treatments on the mechanical properties. Microstructural characterization techniques included scanning electron microscopy measurements via secondary electron (SE) and backscatter electron (BSE) imaging, and electron backscatter diffraction (EBSD). Additional measurements were taken via X-ray diffraction, X-ray computed tomography, and synchrotron X-ray diffraction. Mechanical characterization included uniaxial tension testing of miniaturized (mini) tensile specimens, Rockwell hardness. Three of the test conditions were down selected for fully reversed (R = -1) rotating bending fatigue testing.

Keywords

Additive manufacturing; Ti-6Al-4V; Laser Powder-bed fusion; heat treatment development; microstructure; mechanical properties; fatigue.

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