Deformation and Fracture Behavior during In-Situ Tensile Loading of a Laser Powder Bed Fusion Processed 316L Stainless Steel Alloy

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Using in-situ high-energy synchrotron x-ray microtomography, the evolution of defect characteristics during tensile deformation of a laser powder bed fusion (LPBF) processed 316L stainless steel alloy was investigated. Specimens with two different types of defects, namely a near-optimal density case with spherical pores and a porous case with lack-of-fusion defects, were studied.

The defects in as-printed specimens are characterized first by quantitative image analysis of microtomography data for size, shape, orientation, and density. Then, changes in such defect characteristics in the elastic, plastic, and fracture regimes during uniaxial tensile deformation were studied. The effect of built-in defects on macroscopic tensile behavior, subsequent changes in the defect characteristics during deformation/fracture, and the interaction between the built-in defects and the damage propagation during tensile fracture will be discussed.

Moreover, volumetric texture evolution during tensile loading, measured using in-situ synchrotron x-ray diffraction, will be discussed to illustrate differences in plasticity in LPBF samples with different types of initial defects in correlation to the defect and damage evolutions.

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