In-Situ Synchrotron X-ray Computed Microtomography and Diffraction Investigation of Deformation and Fracture Behavior in a Laser Powder Bed Fusion Processed 316L Stainless Steel

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The effect of built-in macroscopic defects in a laser powder bed fusion (L-PBF) processed samples on tensile behavior was studied using high-resolution synchrotron x-ray computed microtomography (sXCT) and diffraction (sXRD) techniques.

Two different types of defects were introduced in L-PBF 316L stainless steel, namely spherical gas pores and flat lack-of-fusion defects, by controlling the laser power, scan speed, and scan pattern. First, the initial defect characteristics (density, size, shape, and orientation) and texture were characterized using sXCT and sXRD, respectively. Then, the changes in defect properties and texture during in-situ tensile loading were measured as a function of applied strain to failure.

The evolution of defect density and morphology will be discussed in the context of deformation and failure modes. Also, the texture evolutions will be interpreted in terms of plastic deformation behavior in correlation to the evolutions in defect characteristics.

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