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Influence of Early Plastic Deformation on Yield Surface Evolution in LENS-Fabricated Inconel 718 Assessed by Multiaxial Testing and 3D EBSD

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Abstract

The present work examines the initial yield surface and its evolution under early-stage plastic deformation in Inconel 718 produced via Laser Engineered Net Shaping (LENS). Tubular specimens were tested under combined axial and torsional loading to determine yield surfaces at small plastic offsets and after pre-deformation levels up to approximately 1% plastic strain. Three-dimensional electron backscatter diffraction (3D EBSD) was used to quantify the as-built microstructural anisotropy and its evolution during the onset of plasticity, including changes in crystallographic texture and intragranular misorientation. The initial yield surface of LENS-manufactured Inconel 718 displayed pronounced directional dependence, reflecting significant mechanical anisotropy associated with the additive manufacturing process. Early plastic deformation led to notable distortions and rotations of the yield surface, suggesting rapid evolution of anisotropic hardening behavior. The combined mechanical and microstructural analysis demonstrates a strong linkage between microstructural heterogeneity, texture evolution, and yield surface development during the earliest stages of plastic deformation in Inconel 718.

Keywords: plastic deformation, Inconel 718, LENS, EBSD