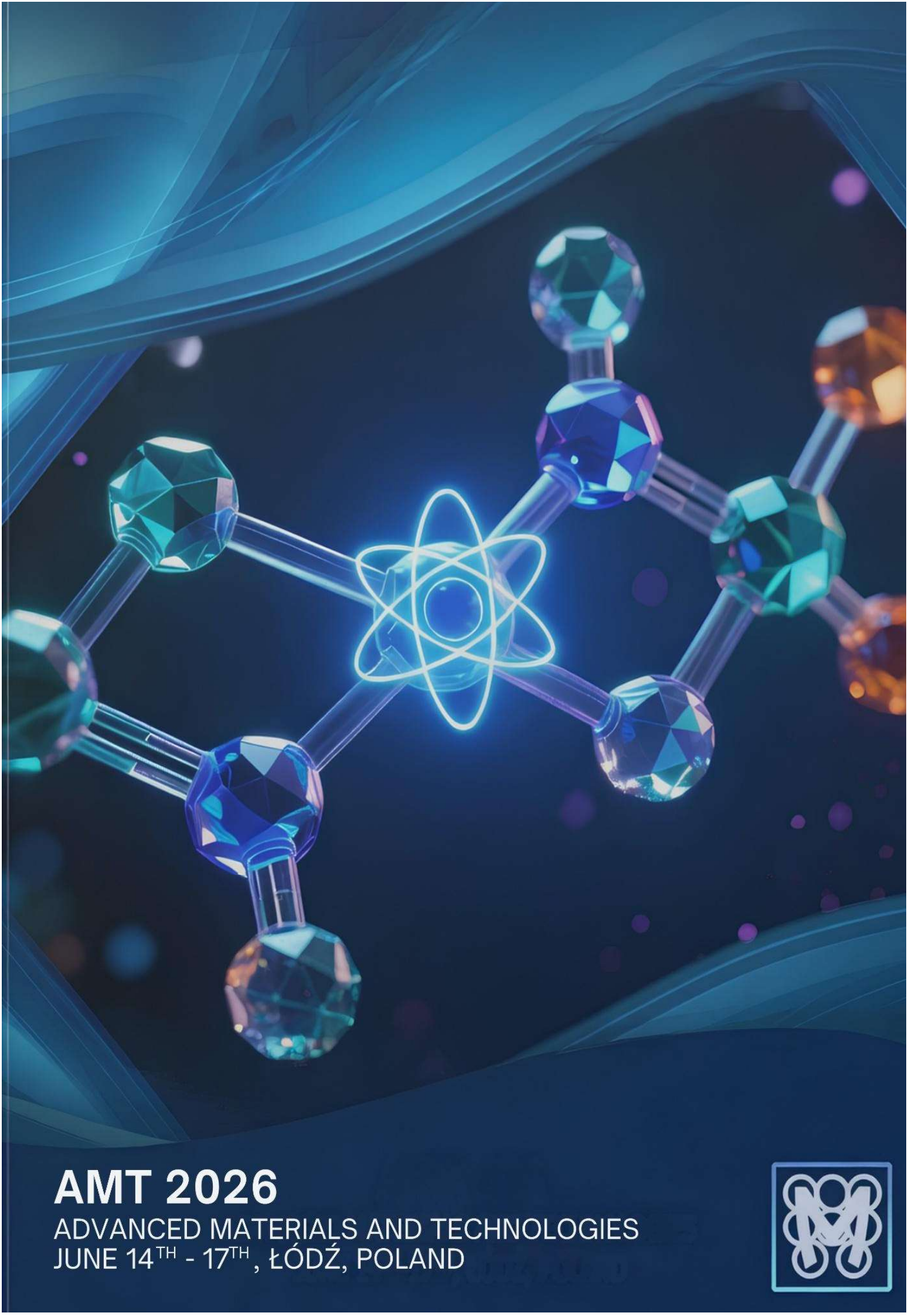

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Early-Stage Yield Surface Evolution in LENS-Manufactured Inconel 625: A Combined Multiaxial Testing and 3D EBSD Study

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Abstract

This study investigates the evolution of the yield surface in Laser Engineered Net Shaping (LENS) manufactured Inconel 625 with a particular focus on early-stage deformation behavior. Tubular specimens were subjected to multiaxial loading to experimentally determine yield surfaces at initial plastic offsets and following controlled pre-deformation up to approximately 1% plastic strain. Three-dimensional electron backscatter diffraction (3D EBSD) was employed to characterize the as-built microstructure and its evolution during early plastic deformation, capturing grain morphology, crystallographic texture, and local misorientation development. The initial yield surface exhibited near-symmetric tensile–compressive behavior with moderate anisotropy, consistent with the additively manufactured microstructure. Progressive pre-deformation resulted in measurable changes in the shape and orientation of the yield surface, indicating the onset of plastic-induced anisotropy. Correlations between yield surface evolution and microstructural features revealed by 3D EBSD highlight the role of grain-scale deformation heterogeneity and texture in governing the early plastic response of LENS-fabricated Inconel 625.

Keywords: additive manufacturing, LENS, yield surface, deformation, superalloy, inconel, multiaxial, EBSD, pre-deformation, anisotropy