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The Multiaxial Load Proportionality Effect on the Fracture Surface Topography of Forged Magnesium Alloys

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Abstract : This extended abstract investigates the influence of the multiaxial loading on the fatigue behavior of forged magnesium through quantitative analysis of its fracture surface topography and mesoscopic cracking orientation. Fatigue tests were performed on hollow tubular sample geometries extracted from closed-die forged AZ80 Mg components, with three different multiaxial strain paths (axial/shear), proportional, 45° out of phase, and 90° out of phase. Regardless of the strain path, fatigue cracks are initiated at the outer surface of the specimen where the combined stress state is largest. Depending on the salient mode of deformation, distinctive features in the fracture surface manifested themselves with different topographic amplitudes, surface roughness, and mesoscopic cracking orientation in the vicinity of the initiation site. The dominant crack propagation path was in the circumferential direction of the hollow tubular specimen (i.e., cracking transverse to the sample axis, with little to no branching), which is congruent with previous findings of low to moderate shear strain energy density (SED) multiaxial loading. For proportional loading, the initiation zone surface morphology was largely flat and striated, whereas, at phase angles of 45° and 90°, the initiation surface became more faceted and inclined. Overall, both a qualitative and quantitative link was developed between the fracture surface morphology and the level of non-proportionality in the loading providing useful insight into the fracture mechanics of forged magnesium as a relevant focus for future study.

Keywords : fatigue, fracture, magnesium, forging, fractography, anisotropy, strain energy density, asymmetry, multiaxial fatigue

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