

# Mechanical Engineering Doctoral Defense

## Micro- and Macro-scale Characterization of Fatigue Damage Behavior in Metallic Materials under Constant and Variable Amplitude Multiaxial Loading

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### Abstract

Engineering materials and structures undergo a wide variety of multiaxial fatigue loading conditions during their service life. Some of the most complex multiaxial loading scenarios include proportional/in-phase loading, non-proportional loading, mix-mode loading, overload, underload, etc. Such loadings are often experienced in many critical applications including aircraft, rotorcraft, and wind turbines. Any accidental failure of these structures during their service life can lead to catastrophic damage to life, property, and environment. Therefore, it is essential to investigate the fatigue mechanism leading to failure under such complex multiaxial loading conditions. All fatigue failure begins with the nucleation of a small crack, followed by crack growth, and ultimately the occurrence of final failure; however, the mechanisms governing the crack initiation and the crack propagation behavior depend on the complexity of fatigue loading. Therefore, an in-depth understanding of fatigue damage initiation and propagation behavior under such complex multiaxial loading conditions is indispensable for predicting failure modes and useful residual life. A systematic approach has been adopted in this research to understand the evolution of fatigue damage in AA 7075, an aerospace grade material, by conducting a comprehensive investigation at micro-scale as well as macro-scale. A series of fatigue tests were conducted on specially designed specimens under different forms of multiaxial loading that included proportional as well as non-proportional bending-torsion coupled loading, biaxial fatigue loading with shear as well as mix-mode overloads.

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Zoom Link: <https://asu.zoom.us/j/88362977881>