Graduate Student Research Seminar

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Investigating the Effect of Deformation Twins on Fatigue Crack Growth Rate

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3:00 pm (EST) – 132 Fluor Daniel Building

Abstract

Design methods to mitigate fatigue failures have remained relatively stagnant as engineers have depended on existing continuum-level models and adhered to damage tolerance design methodology. Although damage-tolerant design has led to increased safety, extended component in-service life, and better life predictions, it still relies on maintenance routines to identify dangerous cracks. There are several experimental techniques and processes to nucleate deformation twinning, including but not limited to heat treatment (HT) for grain growth, liquid nitrogen (LN2) implementation to get the cryogenic temperature, and pre-strain test for plastic deformation. On the other hand, a few other processes are required to identify deformation twinning consisting of etching to disclose grain boundary, electron backscatter diffraction (EBSD) to get grains' information, transmission electron microscopy (TEM) to support the evidence of twin and X-ray diffraction (XRD) to measure dislocation density. The material chosen for this research is a dog-bone-shaped copper with seven atomic percent Aluminum (Cu7at%Al) due to its very low stacking fault energy, which makes it comparably easier to nucleate twins. Based on the adequate threshold stress intensity factor, samples went under high cycle fatigue (>10^4 cycles) to initiate a crack. The crack tip was monitored optically and with the aid of the digital image correlation (DIC) method. The results show a descending da/dN behavior in stage I FCG for the deformation twin-induced sample. Moreover, the same behavior for stage II FCG was revealed for the sample after HT, which represents a non-Paris behavior in this material.

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