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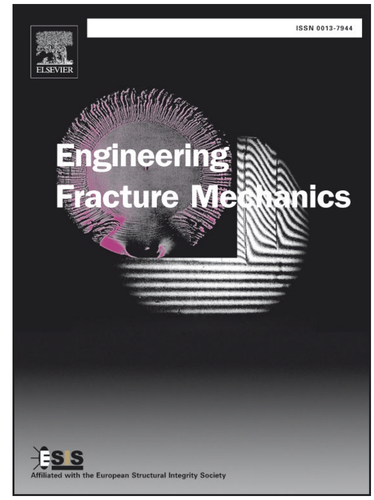

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The effect of crack wake roughness on the environmentally assisted fatigue behavior of an aerospace Al-alloy in low moisture environments

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ABSTRACT

Key words: fatigue, fracture mechanics, crack growth, water vapor, aerospace, aluminum

The effect of low P_{H2O} environments (pertinent to high altitude flight conditions) on the fatigue crack growth behavior of 7075-T651 were quantified via linear elastic fracture mechanics (LEFM) testing. Real-time compliance based crack monitoring enabled K-shed and constant ΔK testing at various P_{H2O}/f levels to elucidate the mechanical and chemical driving forces that govern the observed behavior. A breakdown in fracture mechanics similitude for constant ΔK, P_{H20}/f, and crack length experiments is observed due to varying levels of crack wake roughness. This behavior is understood based on the rate limiting molecular transport step of the H-environment embrittlement process. Specifically, crack wake roughness will lead to impeded transport in the crack growth direction, this leads to the development of an irregular crack front due to environment enhanced crack extension occurring on the crack flanks where the transport distance is low and slow crack progression at the specimen center. The resulting through thickness gradients in the environmental and mechanical driving forces for crack extension provide the means to understand the breakdown of similitude and variation of the crack growth rates. It is necessary to incorporate this understanding into the data generation protocol for these environment specific da/dN vs. ΔK relationships in order to accurately incorporate environment into LEFM based damage tolerant approaches.