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Abstract:

The remaining fatigue life for aluminum aerospace alloys is greatly reduced by the presence of corrosion damage; prediction of this deleterious influence via standard fracture mechanics methods is non-trivial. Several corrosion morphologies can develop at the aluminum depending on the local chemistry, pH as well as electrochemical potential along the geometry of the structure. Previous studies demonstrate that such variations in corrosion morphology can affect the fatigue behavior. This study aims to quantify the effect of corrosion morphologies relevant to a fastener-hole geometry of AA7050-T7451 on the initiation life, propagation life and total fatigue life. Four corrosion morphologies are considered: shallow and deep discrete pits widely distributed on the corroded surface, deep fissure-like features, and general corrosion with surface recession. Corrosion morphologies are carefully characterized using optical microscope, white light interferometer and x-ray computed tomography. The samples are subjected to fatigue using loading protocols that create identifiable marks on the fracture surface. These marker bands are used to determine the small scale crack growth rate (da/dN) of the samples, as well as the initiation life of the fatigue specimens to create a 10 μm crack. Results showed that initiation life plateaus to near constant values for varied corrosion morphologies, and crack growth rates converge to comparable values. The macro-scale corrosion metrics are considered and correlated to the location of the fatigue initiation. Severe macro-scale metrics such as pit or fissure depth, pit area, pit volume, pit density, root mean square, peak density, maximum valley depth, do not dictate the location of fatigue crack initiation. This points out to the possible strong effect of local micro-scale metrics on the location of the fatigue crack initiation.

KEYWORDS: Corrosion morphology; aluminum; fatigue initiation; fatigue crack growth