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Effect of pre-deformation on the pre-corrosion multiaxial fatigue behaviors of 2024-T4 aluminum alloy

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Abstract

Pre-damages which contain pre-deformation and pre-corrosion have influences on multiaxial fatigue properties. In this paper, the effect of pre-tension of 1%, 2%, 3% and 4% as well as pre-torsion of 10°, 20°, 30° and 40° on fatigue life of 2024-T4 aluminum alloy under corrosion conditions is evaluated. Multiaxial fatigue tests are performed under constant amplitude sinusoidal wave loading with tension-torsion ratio of $\sqrt{3}$ in air at room temperature. The results indicate a reduction tendency of pre-corrosion multiaxial fatigue life with the pre-deformation level in the same pre-corrosion time. With the same pre-deformation level, the pre-corrosion multiaxial fatigue life decreases as pre-corrosion time increases. Pitting caused by corrosion is observed on the surface of specimens. The observed mechanical behavior and associated phenomena are directly linked to microstructure characteristics such as surface defects, corrosion pits and micro-cracks. The analysis of mechanism reveals that the synergistic combination of pre-deformation and pre-corrosion is more detrimental than that of either one acting separately. The alternate cyclic hardening and softening appear in the axial direction. The cyclic softening in the tangential direction becomes more serious with the increase of pre-deformation. The typical morphology of corrosion fatigue can be observed on the fracture. Involving the damage factors of single pre-damage conditions, which include pre-deformation and pre-corrosion effects, the damage factor for pre-corroded multiaxial fatigue after pre-deformation is deduced. Fine results are achieved according to the above methods with most predicted life in 2x scatter band.

Keywords: 2024-T4 aluminum alloy; Multiaxial fatigue; Pre-deformation; Pre-corrosion; Life prediction

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