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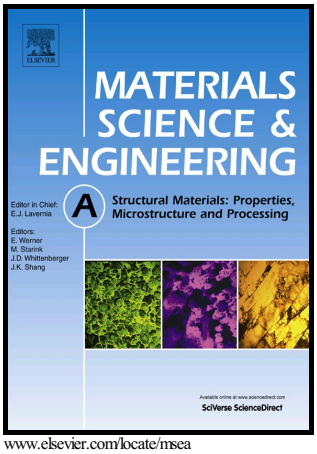

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Cyclic and Time-Dependent Crack Growth Mechanisms in Alloy 617 at 800°C

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Abstract

Crack growth mechanisms for alloy 617 at 800°C were investigated in air with specific emphasis on the transition from cycle-dependent to time-dependent crack growth mechanisms in the creep-fatigue regime. Crack growth studies were conducted using compact tension samples, a load ratio of 0.5, and triangular 5 Hz, 0.33 Hz, and 0.05 Hz waveforms, a trapezoidal 0.05 Hz waveform with 17 s hold time, and sustained loading. Fatigue crack growth rates were relatively insensitive to changes in frequency and hold times in air up to $\Delta K \approx 11.5$ MPa√m for $R = 0.5$, i.e, $K_{max} = 23$ MPa√m. Above this threshold, the onset of time dependent crack growth was observed via a creep void nucleation and coalescence mechanism for triangular and trapezoidal waveforms with a loading frequency of 0.05 Hz, and during sustained loading. An estimate of the threshold for stress assisted grain boundary oxidation (SAGBO) crack growth was calculated to be 23 MPa√m, and oxidized grain boundaries observed near the crack tip were mostly uncracked, suggesting the SAGBO threshold was not reached before the onset of the void nucleation mechanism. A comparison of results across all available studies suggests that a threshold-based transition from cycle- to time-dependent crack growth at 800°C likely exists. However, the stress intensity factor does not maintain similitude to accurately define a threshold across studies. Thus, gaining an understanding of the crack tip stress states that define the various time dependent mechanisms should be considered in future work.