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Co-Chairs: Mengnie Li, Kunming University of Science and Technology; Langping Wang, Harbin Institute of Technology; Yanfeng Han, Shanghai Jiao Tong University

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Assessment of high cycle fatigue crack growth under different stages based on crystal plasticity modeling

Duoqi Shi, Beihang University; Collaborative Innovation Center of Advanced Aero-engine; Shiwei Han, Beihang University; Xiaoguang Yang, Beihang University; Collaborative Innovation Center of Advanced Aero-engine

ABSTRACT

Different regimes and phenomenon are correlated with fatigue crack nucleation, microstructurally small crack, and mechanically long crack growth in high cycle fatigue. Polycrystalline representative volume elements with crack-free, crack in one grain, and crack across many grains are generated by Voronoi tessellation algorithm. Mechanical responses in these different configurations are computed by crystal plasticity theory. Several crack growth path criterion are applied to analyze the growth direction in these configurations. When crack is constrained in one single grain during stages of both fatigue crack nucleation and microstructurally small crack, crack always grows in certain slip plane by the slip-based criteria. While in the situation of mechanically long crack, it does not totally propagate along single slip plane to satisfy displacement continuity in the crack front. Finally, growth rates in fatigue crack nucleation, microstructurally small crack, and mechanically long crack are compared with each other by criterion of energy dissipation threshold and accumulated plastic slip distance. Crack growth rate increases with the progress of the fatigue crack propagation.

KEYWORDS: fatigue crack nucleation, microstructurally small crack, mechanically long crack, crystal plasticity, growth path, growth rate