Micromechanical investigation of the fatigue crack propagation and damage development in Al/Al_2O_3/SiC hybrid metal matrix composite

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ABSTRACT
In this study, the micro-mechanisms involved in fatigue crack propagation are investigated qualitatively in a Al/Al_2O_3/SiC hybrid metal matrix composite (MMC) and the results are compared with Al_2O_3 fibre reinforced MMC and monolithic Al alloy. The three-point bending fatigue test was carried out in a rectangular notched specimen and crack propagation was monitored until the fracture of the specimen. The crack profile on the surface of the specimen was analyzed via optical microscope. The fracture surface and the crack-path profile in the fracture surface were analyzed by scanning electron microscopy (SEM) and three dimensional (3D) surface analysis respectively. The hybrid MMC shows higher crack propagation resistance than that of fibre reinforced MMC and Al alloy in the low ΔK region. In the threshold region, the crack in hybrid MMC is directed by the reinforcement–matrix debonding, followed by void nucleation in the Al alloy. Additionally, the crack propagation in the stable-crack-growth region is controlled by reinforcement-matrix interface debonding caused by the cycle-by-cycle crack growth along the interface, as well as by the transgranular fracture of particles and fibres. The presence of large volumes of inclusions and the microstructural inhomogeneity reduces the area of striation in hybrid MMC, leading to unstable fracture.

KEYWORDS
Metal matrix composite (MMCs); Fatigue crack propagation; Stress intensity factor; 3D analysis; Fracture

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