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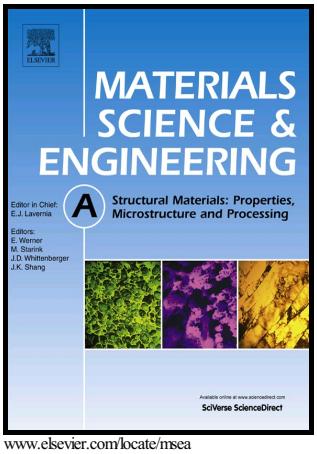

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Deformation in fatigue crack tip plastic zone and its role in crack propagation of titanium alloy with tri-modal microstructure

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Abstract

A combination of scanning electron microscopy and electron backscatter diffraction is used to investigate the deformation in the fatigue crack tip plastic zone and its role in the crack propagation of Ti-6Al-2Zr-1Mo-1V alloy with a tri-modal microstructure. The results show that heterogenous slip and secondary micro-cracks are the main features of the fatigue crack tip plastic zone. These features play important roles in fatigue crack propagation. In particular, the unique lamellar α in the tri-modal microstructure can deflect and delay the crack propagation effectively, thus, improving the fatigue life.

Keywords: Titanium alloy; Tri-modal microstructure; Fatigue crack propagation; Crack tip plastic zone

1. Introduction

Titanium alloys are of vital importance in the aviation and aerospace industries because they exhibit excellent specific strength, corrosion resistance, and fatigue resistance [1-3]. The titanium alloy components in aircrafts are usually subjected to cyclic loading during service. In these applications, fatigue crack propagation (FCP) resistance is one of the most important properties that is critical for the life-management design and safe service of the titanium alloy components. It is well known that FCP is sensitive to the microstructure of the material. The volume fraction, scale, morphology, and crystal orientation distribution of each constituent phase (α and β) in titanium alloys considerably affect its FCP resistance [4-7]. Therefore, it is important to reveal the FCP characteristics of titanium alloys and the dependence of these characteristics on the alloy microstructure.

Szczepanski et al. [8] studied the role of microstructural heterogeneity (neighborhoods of grains with similar crystallographic structures) on the FCP in Ti-6246 alloy with a bimodal microstructure.