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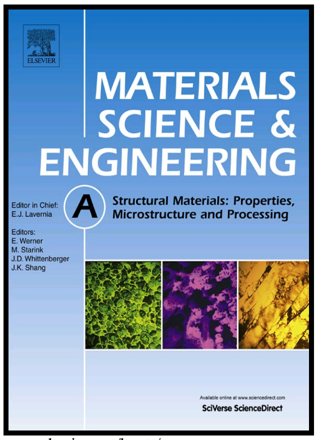

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Low-cycle fatigue behavior and property of TA15 titanium alloy with tri-modal microstructure

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Abstract

Low-cycle fatigue (LCF) behavior and property characteristics of titanium alloy with a tri-modal microstructure, consisted of equiaxed α (α_p), lamellar α (α_l) and β transformed matrix (β_t), were explored in this work. The results show that, at different strain amplitude (ε_{ta}) levels, the cyclic hardening/softening is determined by the competition (ε_{ta}<0.9%) or superposition (ε_{ta}≥0.9%) effect of the variations of back stress and friction stress. As well, the fractography shows remarkbly different features at different ε_{ta} levels. When ε_{ta}<0.9%, there exists only one fatigue crack initiation site activated by the dislocation pile-ups at α_p/β_t and α_l/β_t interfaces. Besides, narrow fatigue striation space in fatigue crack propagation region implies a relatively slower crack propagation. When ε_{ta}≥0.9%, the additionally high-stress-induced crossed slip bands and coarse slip bands in α_p cause the multiple fatigue crack initiations. Moreover, wider fatigue striation space in propagation region indicates a faster crack propagation. The above divisional LCF behavior and fracture features determine a two-part linear Coffin-Manson relationship. On the other hand, increasing α_p content could delay the fatigue crack nucleation and propagation due to its positive effect for improving deformation compatibility. This will effectively increase the LCF life. However, increasing α_l content would produce α_l colonies, which promote the dislocation slip and reduce the slip reversibility. So, the crack nucleation and propagation will be facilitated and then the LCF life is decreased.

Key words: Titanium alloy, Tri-modal microstructure, Low-cycle fatigue, Microstructure dependence

1. Introduction

Titanium alloys are widely used in the aviation and aerospace applications because of its excellent combination of superior mechanical and physical properties, such as preferable room-temperature specific stiffness and strength, good high-temperature strength and excellent corrosion resistance [1-3].