微结构和应力比对 Ti-6Al-4V 高周和超高周疲劳行为的影响

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摘要： 采用旋转弯曲和超声疲劳实验分别测试了全等轴和等轴双态两种组织的 Ti-6Al-4V 的高周和超高周疲劳性能，并用 SEM 观察了断口特征。结果表明：两种组织的高周和超高周疲劳行为相似，不同应力比下，S-N 曲线表现出单线形或双线形的形式；存在两种疲劳破坏机制，即滑移机制和解理机制。随应力比增加，两种组织的高周和超高周疲劳破坏机制从滑移机制向解理机制转变。基于疲劳寿命和疲劳极限模型分析了应力比对两种机制之间竞争行为的影响，模型结果与实验结果趋势符合。

关键词： Ti-6Al-4V，超高周疲劳，微结构，应力比，滑移机制，解理机制

EFFECTS OF MICROSTRUCTURE AND STRESS RATIO ON HIGH-CYCLE AND VERY-HIGH-CYCLE FATIGUE OF Ti-6Al-4V ALLOY

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ABSTRACT: The effects of microstructure and stress ratio on high-cycle fatigue (HCF) and very-high-cycle fatigue (VHCF) of Ti-6Al-4V alloy have been investigated by rotating bending and ultrasonic fatigue testing, and fatigue fracture surfaces were observed by SEM. The results show that the HCF and VHCF behaviors of the fully-equiaxed and the bimodal Ti-6Al-4V alloy are similar. For different stress ratio cases, S-N curves present the single-line type or the bilinear type. The observations of fracture surface indicate that two crack initiation mechanisms prevail, i.e. slip mechanism and cleavage mechanism. With the increase of stress ratio, the crack initiation mechanism switches from slip mechanism to cleavage mechanism. A model based on fatigue life or fatigue limit is proposed to describe the competition between the two mechanisms, which is in agreement with present experimental results.

KEY WORDS: Ti-6Al-4V alloy, very-high-cycle fatigue, microstructure, stress ratio, slip mechanism, cleavage mechanism