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研究论文

应变速率对一种无铼单晶高温合金低周疲劳性能的影响

张小强, 王栋, 张健, 楼琅洪

中国科学院金属研究所 沈阳 110016

摘要: 研究了一种无铼镍基单晶高温合金在1223 K、不同应变速率(5×10-4s-1、1×10-3s-1、5×10-3s-1、1×10-2s-1)条件下的低周疲劳行为。结果表明: 在四种应变速率条件下, 合金均表现出循环稳定。随着应变速率的增加, 合金的疲劳寿命逐渐增加, 且其半寿命稳定滞后回线环内面积逐渐减少, 表明低应变速率合金更容易积累蠕变塑性变形。疲劳裂纹源均萌生于试样表面, 随着应变速率的增加, 疲劳过程中产生的塑性变形越来越少, 疲劳裂纹扩展区的面积逐渐增大。低应变速率时, 较大的塑性变形导致合金取向发生明显的偏转, 诱发多滑移系开动进而形成位错网; 反之, 高应变速率时, 合金没有产生明显的塑性变形, 只有单一方向的位错塞积形成位错束。

关键词: 金属材料 单晶高温合金 低周疲劳 应变速率

Effect of Strain Rate on the Low Cycle Fatigue Properties of Re-free Nickel-base Single Crystal Superalloy

ZHANG Xiaoqiang, WANG Dong, ZHANG Jian, LOU Langhong

Institute of Metal Research, Chinese Academy of Sciences, Shenyang 110016

Abstract: Low cycle fatigue (LCF) behavior of a Re-free nickel-base single crystal superalloy at different strain rates (5×10−4s−1, 1×10−3s−1, 5×10−3s−1 and 1×10−2s−1) has been investigated at 1223 K. It was found that the alloys were cyclically stable at all strain rates. With the increasing of strain rate, the low cycle fatigue life increased, and the area of cycle hysteresis loop at N=1/2Nf decreased, indicating that more creep deformation was happened at low strain rate. All fatigue cracks initiated at
the surface. With the increasing of strain rate, the areas of instantaneous rupture region decreased on the fracture surface due to the suppressed creep. At low strain rate, extensive creep led to more slip systems working and forming networks. On the contrary, dislocation bundle was formed at high strain rate.

Keywords: metallic materials single crystal superalloy low cycle fatigue strain rate

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通讯作者: 王栋

作者简介:

通讯作者E-mail: dwang@imr.ac.cn

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