

论文

一种镍基单晶高温合金的蠕变各向异性

贾玉贤^{1,2)}, 金涛¹⁾, 刘金来¹⁾, 孙晓峰¹⁾, 胡壮麒¹⁾,

1) 中国科学院金属研究所, 沈阳 110016

2) 沈阳理工大学材料科学与工程学院, 沈阳 110168

摘要:

分别制备了[001]和[011]取向的Ni-Co-Cr-Mo-W-Al-Ti-Ta镍基单晶高温合金试样. 在750 °C/750 MPa条件下, [001]取向合金的平均蠕变寿命明显高于[011]取向合金, [011]取向合金延伸率稍高. 在982 °C/248 MPa条件下, [001]取向合金的平均蠕变寿命和延伸率均高于[011]取向合金, 各向异性主要表现在加速蠕变阶段, 但各向异性程度比低温高应力时显著降低. 在高温低应力条件下, 2种取向合金中 γ' 相均已形核, [001]取向合金的筏化方向垂直于应力轴, 而[011]取向合金的筏化方向与应力轴的夹角约为45°. γ' 相形核后, 阻碍了位错运动, 导致加工硬化, 因此, γ' 相筏化是各向异性程度降低的主要原因. 在[011]取向合金的蠕变后期观察到孪晶组织同时穿越 γ 和 γ' 相, 导致试样塑性大幅度降低, 迅速断裂.

关键词: 镍基单晶高温合金 蠕变 各向异性 晶体取向

ANISOTROPIC CREEP IN A Ni-BASED SINGLE CRYSTAL SUPERALLOY

JIA Yuxian^{1,2)}, JIN Tao¹⁾, LIU Jinlai¹⁾, SUN Xiaofeng¹⁾, HU Zhuangqi¹⁾,

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

2) School of Materials Science and Engineering, Shenyang Ligong University, Shenyang 110168

Abstract:

Constant load creep tests were performed on the [001] and [011] oriented Ni-Co-Cr-Mo-W-Al-Ti-Ta single crystal superalloys. The [001] oriented alloy has much longer creep life than that of [011] oriented alloy, but the elongation of [011] oriented alloy is slightly higher under the condition of 750 °C/750 MPa. The average creep life and elongation of [001] oriented alloy are both higher than that of [011] oriented alloy at 982 °C/248 MPa, and the anisotropy occurs mainly during the accelerating creep stage, but anisotropic degree decreases obviously. The SEM analysis reveals γ' phases are rafted in the two directions, which blocks the glide/climb of dislocations and causes creep hardening, the rafting of γ' phase is the dominant reason to decrease of creep anisotropy at higher temperature. The TEM observation indicates deformation twins formed in [011] oriented alloy, which lowers the plasticity of the sample and induces the sample to fracture rapidly.

Keywords: Ni-based single crystal superalloy creep anisotropy crystal orientation

收稿日期 2009-03-18 修回日期 2009-06-08 网络版发布日期 2009-10-23

DOI:

基金项目:

国家自然科学基金资助项目50931004

通讯作者: 贾玉贤

作者简介: 贾玉贤, 女, 1975年生, 博士生

作者Email: yxjia@imr.ac.cn

参考文献:

[1] Leverant G R, Kear B H. Metall Trans, 1970; 1: 491

[2] Caron P, Ohta Y, Nakagawa Y G, Khan T. In: Duhal D N, Maurer G, Antolovich S, Lund C, Reichman S, eds., Superalloys 1988, Warrendale: The Metallurgical Society, 1988: 215

[3] Peng Z F, Yan Y H. Acta Metall Sin, 1997; 33: 1147

(彭志方, 严演辉. 金属学报, 1997; 33: 1147)

[4] Sass V, Feller-Kniepmeier M. Mater Sci Eng, 1998; A245: 19

扩展功能

本文信息

▶ Supporting info

▶ PDF(1019KB)

▶ [HTML全文]

▶ 参考文献[PDF]

▶ 参考文献

服务与反馈

▶ 把本文推荐给朋友

▶ 加入我的书架

▶ 加入引用管理器

▶ 引用本文

▶ Email Alert

▶ 文章反馈

▶ 浏览反馈信息

本文关键词相关文章

▶ 镍基单晶高温合金

▶ 蠕变

▶ 各向异性

▶ 晶体取向

本文作者相关文章

▶ 贾玉贤

PubMed

▶ Article by Gu,Y.X

- [5] MacKay R A, Maier R D. *Mater Sci Eng*, 1982; 13: 1747
- [6] Liu J L, Jin T, Sun X F, Zhang J H, Guan H R, Hu Z Q. *Mater Sci Eng*, 2008; A479: 277
- [7] Kakehi K. *Metall Mater Trans*, 1999; 30A: 1249
- [8] Knowles D M, Chen Q Z. *Mater Sci Eng*, 2003; A340: 88
- [9] Ardakain M G, McLean M, Shollock B A. *Acta Mater*, 1999; 47: 2593
- [10] Matan N, Cox D C, Rist M A, Rae C M F, Reed R C. *Acta Mater*, 1999; 47: 1549
- [11] Knowles D M, Gunturi S. *Mater Sci Eng*, 2002; A328: 223
- [12] Fredholm A, Strudel J L. In: Gell M, Kortovich C S, Bricknell R H, Kent W B, Radavich J F, eds., *Superalloys 1984*, Warrendale: AIME, 1984: 211
- [13] Feller-Kniepmeier M, Kuttner T. *Acta Metall Mater*, 1994; 42: 3167
- [14] Shui L. PhD Thesis, Shenyang University of Technology, 2006
(水丽. 沈阳工业大学博士学位论文, 2006)
- [15] Chen Q Z, Knowles D M. *Mater Sci Eng*, 2003; A356: 352

本刊中的类似文章

1. 杨王Yue, 李志文. θ 相预测12Cr1MoV钢主蒸汽管道材料剩余寿命[J]. 金属学报, 1999,35(7): 721-725
2. 田素贵, 张静华, 金涛, 杨洪才, 徐永波, 胡壮麒. 单晶镍基合金高温压缩蠕变的微观特征[J]. 金属学报, 1999,35(4): 392-396
3. 李军伟, 彭志方. 用人工神经网络法预测镍基单晶高温合金的蠕变断裂寿命[J]. 金属学报, 2004,40(3): 257-262
4. 王飞, 徐可为. 加载速率对Al膜纳米压入蠕变性能的影响[J]. 金属学报, 2004,40(11): 1138-1142
5. 张邦文, 任忠鸣, 王晖, 李喜, 壮云乾. 合金凝固过程中晶粒磁取向的动力学研究[J]. 金属学报, 2004,40(6): 604-
6. 侯介山, 张玉龙, 郭建亭, 冀光, 周兰章, 叶恒强. 铸造镍基合金K44的高温蠕变行为[J]. 金属学报, 2004,40(6): 579-
7. 任维丽, 郭建亭, 周继扬. 两相共晶NiAl-9Mo合金的蠕变行为[J]. 金属学报, 2002,38(9): 908-913
8. 骆宇时, 刘攀, 彭志方. 镍基单晶合金枝晶典型区域相成分最优化测算算法[J]. 金属学报, 2002,38(8): 804-808
9. 冯维存, 高汝伟, 李卫. 晶粒尺寸分布对纳米硬磁材料有效各向异性和矫顽力的影响[J]. 金属学报, 2005,41(4): 347-350
10. 田素贵, 杨景红, 于兴福, 孙根荣, 金敬铉, 徐永波, 胡壮麒. AZ31镁合金蠕变初期的变形特征[J]. 金属学报, 2005,41(4): 375-379