

本期目录 | 下期目录 | 过刊浏览 | 高级检索

[打印本页] [关闭]

## 研究报告

### 一种镍基单晶高温合金的恒温氧化行为

张泽海<sup>1</sup>, 孟杰<sup>2</sup>

1. 中航工业沈阳黎明航空发动机(集团)有限责任公司 沈阳 110043
2. 中国科学院金属研究所 沈阳 110016

#### 摘要:

通过静态增重法对一种镍基单晶高温合金在900℃和1000℃的恒温氧化行为进行了测定, 并利用X射线衍射和扫描电镜对氧化产物进行了分析。结果表明, 该合金在900℃和1000℃均为完全抗氧化级, 900℃的氧化速率明显低于1000℃的氧化速率。合金的氧化产物以(Ni,Co)O为主, 并形成了较多的 $\alpha$ -Al<sub>2</sub>O<sub>3</sub>和少量的Cr<sub>2</sub>O<sub>3</sub>, 同时形成了CrTaO<sub>4</sub>及(Ni,Co)Al<sub>2</sub>O<sub>4</sub>和Co(Al,Cr)<sub>2</sub>O<sub>4</sub>等尖晶石氧化物。氧化物呈层状分布, (Ni,Co)O在最外层, 而Al<sub>2</sub>O<sub>3</sub>在内层。另外, 在靠近 $\alpha$ -Al<sub>2</sub>O<sub>3</sub>层的合金基体中出现了内氮化物。

**关键词:** 单晶 镍基高温合金 恒温氧化

## ISOTHERMAL OXIDATION BEHAVIOR OF A SINGLE CRYSTAL NICKEL-BASED SUPERALLOY

ZHANG Zehai<sup>1</sup>, MENG Jie<sup>2</sup>

1. AVIC Shenyang Liming Aero-Engine (Group) Corporation Ltd. Shenyang 110043
2. Institute of Metal Research, Chinese Academy of Sciences, Shenyang 110016

#### Abstract:

The oxidation behavior of a single crystal superalloy at 900℃ and 1000℃ in air was investigated by using discontinuous thermogravimetric analysis (TGA). The oxidized samples were characterized by X-ray diffraction (XRD) and scanning electron microscopy (SEM). The results showed the oxidation kinetics of the alloy at 900℃ and 1000℃ followed parabolic law basically. The oxidation resistance of the alloy at 900℃ and 1000℃ was the first grade, while the rate of oxidation at 1000℃ was higher than that at 900℃. The oxidation scales were composed of (Ni,Co)O prevalently. However,  $\alpha$ -Al<sub>2</sub>O<sub>3</sub>, less Cr<sub>2</sub>O<sub>3</sub> and complex oxides, such as CrTaO<sub>4</sub>, (Ni,Co)Al<sub>2</sub>O<sub>4</sub> and Co(Al,Cr)<sub>2</sub>O<sub>4</sub> were found in the oxidation scales. The scales were layered with outer (Ni,Co)O layer and inner  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> layer. The inner  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> layer was continuous and dense and then provided good protection. Furthermore, there were nitride precipitates in the matrix of the alloy and close to the  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> layer.

**Keywords:** single crystal nickel-based superalloy isothermal oxidation

收稿日期 2010-05-07 修回日期 2010-06-10 网络版发布日期 2010-08-13

#### DOI:

#### 基金项目:

通讯作者: 张泽海

作者简介: 张泽海, 男, 1962年生, 高级工程师, 研究方向为熔模精密铸造工艺

通讯作者E-mail: zzhjrw@163.com

#### 参考文献:

- [1] Gell M, Duhl D N, Giamei A F. The development of single crystal superalloy turbine blades. Proc. of 4th Int. Symp. on superalloy [C], Seven Springs. PA. Sept, 1980: 205

#### 扩展功能

#### 本文信息

- Supporting info
- PDF(1544KB)
- [HTML] 下载
- 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

- 单晶
- 镍基高温合金
- 恒温氧化

#### 本文作者相关文章

- 张泽海
- 孟杰

#### PubMed

- Article by Zhang,Z.H
- Article by Meng,j

- [2] Duhi D N, Cetel A D. Development high strength single crystal superalloy compositions [P]. United States Patent. Patent Number: 4, 719, 080. 1988
- [3] Chen R Z. Development status of single-crystal superalloys [J]. Mater. Eng., 1995, (8): 3-12  
陈荣章. 单晶高温合金发展现状 [J]. 材料工程, 1995, (8):3-12 
- [4] Zhao Y, Yang G X, Yuan C. Isothermal oxidation behavior of a cast Ni-base superalloy K447 [J]. Corros. Sci. Prot. Technol., 2007, 19(1): 1-4  
赵越, 杨功显, 袁超等. 铸造镍基高温合金K447的高温氧化行为[J]. 腐蚀科学与防护技术, 2007, 19(1):1-4 [浏览](#)
- [5] Li M H, Sun X F, Li J G, et al. Oxidation behavior of a single-crystal Ni-base superalloy in air I: at 800 and 900 °C [J]. Oxid. Met, 2003, 59(5/6):591-605 
- [6] Li M H, Sun X F, Jin T, et al. Oxidation behavior of a single-crystal Ni-base superalloy in air II: At 1000, 1100, and 1150 °C [J]. Oxid. Met., 2003, 60(1/2) 195-210
- [7] Gobel M, Rahmel A, Schutze M, The isothermal-oxidation behavior of several nickel-base single-crystal superalloys with and without coatings [J]. Oxid. Met., 1993, 39(3/4): 231-261
- [8] Xiao J M, Cao C N. The Principle of Materials Corrosion [M], Beijing: Chemical Industry Press, 2002: 90  
(肖纪美, 曹楚南. 材料腐蚀学原理 [M]. 化学工业出版社, 北京, 2002: 90)
- [9] Giggins C S, Pettit F S. Oxidation of NiCrAl alloys between 1000 and 1200 °C [J]. J. Electron. Soc, 1971, 118:1782-1790 
- [10] Li M S. High-Temperature Corrosion of Metal [M]. Beijing: Metallurgical Industry Press, 2001: 248-250  
(李美栓. 金属的高温腐蚀 [M]. 北京: 冶金工业出版社, 2001: 248-250)
- [11] Huang L, Sun X F, Guan H R. Oxidation behavior of a single-crystal Ni-base superalloy in air at 900, 1000 and 1100 °C [J]. Oxid. Met, 2006, 65(3/4):207-222 
- [12] Krupp U, Christ H J. Selective oxidation and internal nitridation during high-temperature exposure of single-crystalline nickel-base superalloys [J]. Met. Mater. Trans. 2000, 31(1)A: 47-56

#### 本刊中的类似文章

1. 王华明;唐亚俊;张静华;张志亚;李英敖;于洋;胡壮麒.凝固界面形态对单晶高温合金组织与溶质偏析的影响[J]. 中国腐蚀与防护学报, 1991,27(2): 14-19
2. 王华明;唐亚俊;张静华;张志亚;胡壮麒.单晶高温合金定向凝固过程中初生碳化物的上浮现象[J]. 中国腐蚀与防护学报, 1991,27(4): 71-72
3. 艾素华;V.LUPINC;M.MALDINI.单晶镍基高温合金的蠕变断裂[J]. 中国腐蚀与防护学报, 1992,28(3): 32-37
4. 张济山;崔华;胡壮麒;村田纯教;森永正彦;汤川夏夫.应用d—电子合金设计理论发展新型抗热腐蚀单晶镍基高温合金 I .相稳定性临界条件的确定[J]. 中国腐蚀与防护学报, 1993,29(7): 5-12
5. 张济山;崔华;胡壮麒;村田纯教;森永正彦;汤川夏夫.应用d-电子合金设计理论发展新型抗热腐蚀单晶镍基高温合金—III.性能评价[J]. 中国腐蚀与防护学报, 1994,30(2): 70-78
6. 金涛 孙晓峰 赵乃仁 刘金来 张静华 胡壮麒 .单晶镍基高温合金DD8激光快速熔凝组织[J]. 中国腐蚀与防护学报, 2009,45(6): 711-716
7. 张济山;崔华;胡壮麒;村田纯教;森永正彦;汤川夏夫.应用d—电子合金设计理论发展新型抗热腐蚀单晶镍基高温合金——II 合金元素对显微组织和性能的影响[J]. 中国腐蚀与防护学报, 1993,29(7): 13-22
8. 王跃臣;李守新;艾素华;刘峰;周丽;张辉 .单晶镍基高温合金DD8反位相热机械疲劳后的层错[J]. 中国腐蚀与防护学报, 2003,39(2): 150-154
9. 王跃臣;李守新;艾素华 .同位相热机械疲劳形变后r/r'相界面上的位错网分析[J]. 中国腐蚀与防护学报, 2003,39(3): 237-241
10. 王跃臣;李守新;艾素华;刘峰;周丽;张辉 .DD8单晶镍基高温合金热机械疲劳后的微观结构[J]. 中国腐蚀与防护学报, 2003,39(4): 337-341