电弧离子镀制备 NiCrAlY 涂层及其抗高温氧化性能 *

谭 飞[1],林松盛[2],石 倩[2],代明江[2],杜 伟[2],汪云程[1],吕 亮[1]

(1. 中国航发南方工业有限公司,湖南 株洲 412000;2. 广东省新材料研究所,现代材料表面工程技术国家工程实验室,广东省现代表面工程技术重点实验室,广东 广州 510651)

摘 要: 为提高高温合金材料抗高温氧化性能,利用真空阴极电弧离子镀在 DZ22B 高温合金上沉积 NiCrAlY 涂层,研究涂层的抗高温氧化性能。采用扫描电镜观察膜层表面和截面形貌,化学容量法测试膜层成分,X 射线衍射仪分析涂层的物相组成,万能试验机检测涂层结合力。结果表明:所制备的 NiCrAlY 涂层厚度约 50μm,涂层致密且与基体结合良好;涂层成份除 Al 元素有所损失外基本与靶材一致。NiCrAlY 涂层主要相为 γ′-Ni_3Al/γ-Ni,同时含有少量的 β-NiAl 相。在 1050℃高温下,NiCrAlY 涂层表面形成致密的氧化铝层有助于减缓氧化速度,对基材起到良好的保护作用;涂层失效的主要方式是随着氧化的进展,氧化层产生裂纹并剥落,新的表面被氧化,剥落和被氧化往复进行,直至涂层失效。

关 键 词: NiCrAlY 涂层;抗高温氧化;电弧离子镀;高温合金

中图分类号: TG174 **文献标识码:** A **文章编号:** 1002-0322(2020)05-0007-04

doi:10.13385/j.cnki.vacuum.2020.05.02

Fabrication of NiCrAlY Coating by Arc Ion Plating and Its High Temperature Oxidation Resistance

TAN Fei[1], LIN Song-sheng[2], SHI Qian[2], DAI Ming-jiang[2], DU Wei[2], WANG Yun-cheng[1], LV Liang[1]

(1.Aecc South Industry Company Limited, Zhuzhou 412000, China; 2.Guangdong Institute of New Materials, National Engineering Laboratory of Modern Materials Surface Engineering Technology, Guangdong Provincial Key Laboratory of Modern Surface Engineering Technology, Guangzhou 510651, China)

Abstract: In order to improve the high temperature oxidation resistance of superalloy, NiCrAlY coatings were deposited on DZ22B superalloy by cathode arc ion plating. Scanning electron microscopy was used to observe the surface and cross-section morphology of the coatings. The volumetric analysis was applied to test the composition of the coating, X-ray diffraction was used to analyze the phase composition of the coating, and adhesion of the coatings was measured by universal testing machine. The results show that the thickness of NiCrAlY coating is about 50 μm, and the coating is compact and well bonded with the substrate. The composition of the coating is basically the same with target except for the small loss of Al. The main phase of NiCrAlY coating is γ′-Ni_3Al/γ-Ni, with a small amount of β-NiAl phase. During the high temperature oxidation process, a dense Al_2O_3 layer was quickly formed on the surface of NiCrAlY coating, therefore provide good oxidation resistance protection for substrate at 1050 ℃. The failure of the coating should be caused by the continuous growth of cracks in oxide layer and finally exfoliation, resulting in the consumption of antioxidant element.

Key words: NiCrAlY coating; high-temperature oxidation resistance; arc ion plating; superalloy

随着现代工业和科技的迅猛发展,对材料性能的要求越来越高。航空发动机及燃气轮机的热端部件材料除了要具有足够优异的高温力学性能和组织稳定性外,还要求材料具有优异的抗高温氧化及热腐蚀性能。DZ22B 是一种高性能定向凝固铸造高温合金,具有良好的高温力学性能和抗蠕变性能,在航空发动机及燃气轮机热端部件中应用广泛,但该合金中的 Al 含量较低和 W 含量较高,导致其高温抗氧化和耐腐蚀性能较差[1]。研究表明[2-4],在高温合金表面施加防护涂层来提

收稿日期: 2020-04-01

作者简介: 谭飞(1987-),女,吉林省辽源市人,本科。 **通讯作者:** 林松盛,教授级高工。

* **基金项目:** 广东省自然科学基金研究团队项目(2016A030312015);广东省科学院科技提升项目(2018GDASCX-0402)。