沉积真空度对铝化物涂层相结构和高温氧化行为的影响 *

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摘 要:采用化学气相沉积(Chemical Vapor Deposition,CVD)工艺,在沉积真空度为 150mbar、200mbar 和 250mbar 的条件下分别在镍基单晶高温合金基体上制备了三种铝化物涂层,研究了沉积真空度对铝化物涂层相结构和高温氧化行为的影响。借助 X 射线衍射(XRD)、扫描电子显微镜(SEM)等表征方法系统分析了三种铝化物涂层的相结构、显微形貌和化学组成。结果表明:三种沉积态铝化物涂层的相结构均为 β-NiAl 相,沉积真空度为 200mbar 的涂层样品还存在 $Ni_{1.04}Al_{0.96}$ 和 $Ni_{1.1}Al_{0.9}$ 双相结构;经 1100℃静态氧化后,三种涂层表面均形成了 Al_2O_3,β-NiAl 相转变为 γ′-Ni_3Al 相,沉积真空度为 250mbar 的涂层样品中 γ′-Ni_3Al 相的峰强度最低;三种铝化物涂层的氧化增重速率分别为 0.037g/(m²·h)、0.022g/(m²·h)和 0.018g/(m²·h),沉积真空度为 150mbar 的涂层样品氧化增重值大于其他两种涂层样品;沉积真空度越低,涂层表面存在的微观孔洞数量越多,高温氧化后涂层表面所形成的氧化膜越易于萌生显微裂纹和出现氧化膜脱落现象。基于本文试验结果,沉积真空度为 250mbar 所制得的涂层样品,其显微组织、元素含量和高温抗氧化性能最佳。

关 键 词:化学气相沉积;铝化物涂层;沉积真空度;相结构;高温氧化

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Effect of Deposition Pressure on Phase Structure and High Temperature Oxidation Behavior of Aluminide Coatings

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Abstract: Three kinds of aluminide coatings were fabricated by chemical vapor deposition (CVD) on the surface of the nickel-based superalloy substrates at the deposition pressure of 150, 200 and 250 mbar, respectively. The effect of deposition pressure on phase structure and high temperature oxidation behavior of the specimens with aluminide coating was systematically investigated. The phase structure, surface morphology and elemental composition of the three kinds of aluminide coatings were analyzed by XRD, SEM and EDS. The results indicate that the phase constituents of three kinds of aluminide coatings are detected to be β-NiAl. Two phases including of $Ni_{1.04}Al_{0.96}$ and $Ni_{1.1}Al_{0.9}$ are gained in the coating specimens prepared at the deposition pressure of 200 mbar. After the isothermal oxidation at 1100℃ for different dwelling times, the main phase β-NiAl transforms into γ′-Ni_3Al with formation of Al_2O_3. Differently, the peak intensity of γ′-Ni_3Al phase is the weakest for the specimens deposited at the pressure of 250 mbar. The oxidative weight gain rate of the three aluminide coatings is 0.037, 0.022 and 0.018g/(m²·h), respectively. The oxidation weight gain of the coating specimens at the deposition pressure of 150 mbar is correspondingly larger than that of the other two coating specimens. The lower deposition pressure is, the more micropores on the surface of the coating exist, and the more easily microcracks appear on the thin film of the coating surface and further form into the spllation of oxide scale after high temperature oxidation. Based on the experimental results, the coating specimens prepared at deposition pressure of 250 mbar show the best surface microstructure, elemental content and high temperature oxidation resistance.

Key words: chemical vapor deposition; aluminide coating; deposition pressure; phase structure; high-temperature oxidation

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