

CrAlN 抗冲蚀涂层制备及性能研究 *

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摘 要: 为提高钛合金材料抗冲蚀性能, 利用真空阴极电弧沉积技术在 TC11 钛合金上沉积 CrAlN 涂层, 研究靶电流、偏压和气压对涂层结构及性能的影响。采用扫描电镜观察膜层表面和截面形貌, 金相显微镜对表面的大颗粒进行定量分析; 显微硬度计测量膜层的维氏显微硬度; 采用喷砂试验机对涂层的抗冲蚀性能进行测试, 通过三维表面轮廓仪测量涂层厚度和侵蚀坑的深度; X 射线衍射仪表征涂层中的晶体结构。结果表明: 靶电流从 70A 增大到 110A, 虽可提高涂层的沉积速率, 但会导致涂层表面大颗粒增加, 从而降低涂层的抗冲蚀性能; 气压从 1Pa 增大至 4Pa, 可有效地减少涂层表面颗粒的尺寸及数量, 但也会一定程度降低沉积速率及硬度; 偏压对 CrAlN 涂层的结构及性能影响最大, 偏压在 -50V 时涂层呈 (200) 择优取向, -100V 涂层呈 (111) 择优取向, -200V 时, 涂层择优取向不明显; 且随着偏压的增加, 涂层的硬度及抗冲蚀性能增大, 在高冲蚀角下, 冲蚀的失效机理为脆性失效。结论: 工艺参数中靶电流对表面质量的影响最大; 涂层的生长取向与偏压密切相关; CrAlN 涂层的表面质量及硬度直接影响其抗砂粒冲蚀性能, 偏压对涂层抗冲蚀性能影响最大。最终优化的工艺参数为: 靶电流 90A、偏压 -100V、气压 4Pa。

关 键 词: 钛合金; CrAlN 涂层; 抗冲蚀; 靶电流; 偏压; 气压

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Study on Preparation and Properties of CrAlN Anti-erosion Coating

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Abstract: In order to improve the erosion resistance of titanium alloy material, CrAlN coating was deposited onto TC11 titanium alloy by vacuum cathodic arc deposition technique. The effects of target current, bias voltage and furnace pressure on the structure and properties of the coating were investigated. Scanning electron microscopy was used to observe the surface and cross-section of the film layer. Metallographic microscope was used to quantitatively analyze the large particles on the surface. Microhardness tester was used to measure the Vickers microhardness. The sandblasting tester was used to resist the erosion of the coating. The properties were tested by measuring the thickness of the coating and the depth of the etch pit by a three-dimensional surface profilometer. The X-ray diffractometer characterizes the crystal structure in the coating. Increasing the target current from 70A to 110A, although increasing the deposition rate of the coating, it will increase in the number of large particles on the surface of the coating to decrease the erosion resistance of the coating. The furnace pressure is increased from 1 Pa to 4 Pa, which is effective to reduce the size and quantity of particles on the surface of the coating, but also reduce the deposition rate and hardness to a certain extent. The bias has the greatest influence on the structure and properties of the CrAlN coating. When the bias voltage is -50V, the coating has a preferred orientation of (200). The 100V coating has a (111) preferred orientation.

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