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论文

Si和Y掺杂对(Ti, Al)N涂层结构和性能的影响

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摘要： 分别在未施加偏压和施加-100 V偏压条件下, 利用磁控溅射技术在压气机叶片用 1Cr11Ni2W2MoV热强不锈钢基体上沉积了$Ti_{0.3}Al_{0.7}N$和$Ti_{0.39}Al_{0.55}Si_{0.05}Y_{0.01}N$硬质涂层. 实验结果表明, 施加偏压及Si和Y掺杂明显改变了涂层的相结构, 提高了涂层致密度, 施加-100 V偏压且添加Si和Y的涂层为非晶结构, 表面更加均匀致密. 950 ℃氧化实验表明: $Ti_{0.39}Al_{0.55}Si_{0.05}Y_{0.01}NN$涂层表面形成极薄且致密的 Al_2O_3保护性氧化膜, 大大降低了氧化速率. 施加-100 V偏压的(Ti, Al)N和(Ti, Al, Si, Y)N沉积态涂层与未施加偏压的相应涂层相比, 硬度均降低, 尤其是(Ti, Al, Si, Y)N涂层变化显著. 经950 ℃热处理, 施加偏压的(Ti, Al, Si, Y)N涂层硬度略有降低, 这是由于形成了硬度较低的B4相, 而未施加偏压的(Ti, Al, Si, Y)N涂层硬度显著提高, 这归因于B1相固溶体的分解. 划痕测试结果表明, 在实验载荷(50 N)下, 所有涂层均未出现连续性的剥落.

关键词： 磁控溅射 (Ti, Al)N Si和Y掺杂 抗氧化性能 硬度 结合力

INFLUENCE OF DOPING WITH Si AND Y ON STRUCTURE AND PROPERTIES OF (Ti, Al)N COATING

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Abstract: Composite metastable $Ti_{0.3}Al_{0.7}N$ and $Ti_{0.39}Al_{0.55}Si_{0.05}Y_{0.01}NN$ hard coatings were deposited on a wrought martensite steel 1Cr11Ni2W2MoV for aero-engine compressor blades by the magnetron sputtering system with the bias voltage of 0 and -100 V respectively. Detailed microstructure, chemical composition, crystal structure, hardness and adhesion were examined by means of FESEM, EDS, XRD, Micro hardness tester and scratch tester. The influence of doping with Si and Y and bias on structure, oxidation-resistance and mechanical properties of (Ti, Al)N coatings were investigated. Pulsed bias and the doping with Si and Y gave rise to the change of phase structure and improvement of density. Doping with small amounts of Si and Y into (Ti, Al)N significantly improved the oxidation resistance at 950 ℃. The oxidation-resistance of (Ti, Al, Si, Y)N is based on the formation of dense protective Al_2O_3 layer. The application of negative pulse led to decreased hardness for (Ti, Al)N while remarkable decrease of hardness for (Ti, Al, Si, Y)N. For (Ti, Al, Si, Y)N prepared under -100 V\linebreak bias, annealing 10 h at 950 ℃ slightly decreased it's hardness because of the formation of B4 structure. And for which deposited at 0 V bias, heat-treatment of 950 ℃ for 10 h improved the hardness from 26 GPa to 35 GPa. The hardness change of the coating may be ascribed the transition of B1 phase structure. Scratch tests show that the continuous spall is not occurred for all the coatings under the critical load of 50 N.

Keywords: magnetron sputtering (Ti, Al)N doping with Si and Y oxidation-resistance hardness adhesion

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