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基于团簇+胶原子模型的[Cr-$Fe_4Co_4Ni_4$] $Cr_{2.6-x}Al_xMo_{0.4}$ 高熵合金涂层的成分设计及其抗强酸侵蚀机理

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摘要：为了延长搅拌桨叶片的使用寿命，基于团簇+胶原子模型设计了一系列[Cr-Fe4Co4Ni4] Cr2.6 - xTixMo0.4 (x = 0,0.2,0.6,0.8)高熵合金(HEAs)成分，并采用激光熔覆技术在 904L 不锈钢表面制备了高熵合金涂层。利用 XRD、SEM、显微硬度计、磨损试验机、电化学工作站和搅拌器油浴分别测定了高熵合金涂层的相结构、显微组织、显微硬度、耐磨性、耐蚀性和固体颗粒冲蚀性能。实验结果表明，当 x = 0、0.2、0.6、0.8 时，涂层中只存在面心立方(FCC)固溶体和纳米级析出相。随着 Ti 含量的进一步增加，涂层组织由柱状晶向胞状枝晶转变。在 x = 0.8 时，HEA 涂层的显微硬度最高，是 904L 的近 1.5 倍，耐磨性和耐蚀性最好，同时表现出优异的抗冲蚀性能。揭示了抗强酸冲蚀的机理。新型 HEA 涂层具有戏剧性的综合性能。

Abstract: To extend the service life of agitator blades, a series of [Cr-$Fe_4Co_4Ni_4$] $Cr_{2.6-x}Ti_xMo_{0.4}$ (x = 0, 0.2, 0.6, 0.8) high-entropy alloys (HEAs) compositions are designed based on the cluster-plus-glue-atom model, and HEAs coatings were prepared on 904L stainless steel using laser cladding techniques. The phase structure, microstructure, microhardness, wear resistance, corrosion resistance and solid-particles erosion properties of the HEA coatings were determined using XRD, SEM, microhardness tester, wear tester, electrochemical workstation and oil bath with stirrer, respectively. The experimental results show that when x = 0, 0.2, 0.6, 0.8, respectively, only face-center cubic (FCC) solid solution and a nanoscale precipitated phase exist in coatings. As further increasement of Ti content, the microstructure of the coating is transformed from columnar to cellular dendrites. At x=0.8, the HEA coating has highest microhardness, which is nearly 1.5 times than that of the 904L, and the wear and corrosion resistance become best, meanwhile the excellent erosion resistance is exhibited. The mechanism of resisting strong acid erosion is revealed. The novel HEA coating has dramatic comprehensive performance.

关键词：高熵合金涂层；团簇加连接原子模型；激光熔覆；抗强酸冲蚀性

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