Cu-Cr 二元合金为复合材料的金属基体

摘　要

Cu 是一种具有优秀的导电导热性能，良好的耐腐蚀性能以及工艺性的金属材料，因此 Cu 在电子行业、电力行业、汽车运输行业以及机械冶金方面有广泛的应用。但是 Cu 较差的耐腐蚀性能限制了 Cu 的发展。Cu-Cr 合金是具有导电导热性能好、塑性好和强度高的经典的时效强化合金。在生产生活中应用前景非常广泛，比如制备插头、高铁导电弓、电触头、集成电路引线框架、电动工具的转向器等。因此以 Cu-Cr 二元合金为金属基体的纳米增强铜铬复合材料有很重要的研究意义。本文使用电化学实验测试不同成分比例纳米增强 Cu-Cr 复合材料在 5%氯化钠溶液中，处于 50℃以及 75℃时的极化曲线、淡水-开路电位以及电化学阻抗谱，通过所得到的电化学测试实验结果分析纳米增强 Cu-Cr 复合材料的腐蚀行为、腐蚀机理以及耐腐蚀性能。

纳米增强 Cu-Cr 复合材料由 Cu、Cr、氧化铝晶须和石墨烯组成，样品中氧化铝晶须和石墨烯含量分别为 1%和 0.5%，三组样品中铬含量分别为 2%、3%、4%还有一个作为对照的纯铜样品。在工艺方面，采用粉末冶金法制备成分不同的样品，这种方法能更容易得到我们需要的成分比例的样品。要研究材料的耐腐蚀性能我们主要通过电化学工作站对材料的开路电位、极化曲线和阻抗图谱来分析，同时用金相和扫描电镜来对其表征分析。

加入适量的 Cr、氧化铝和石墨烯会明显增强材料的耐腐蚀性能。加入的 Cr 会在材料表面形成氧化物薄膜保护复合材料，温度较低时不易形成氧化物薄膜，温度较高时，Cr 含量越高越容易形成保护膜，复合材料的耐腐蚀性能越强。在 50℃时，随着 Cr 含量的增加，材料的腐蚀速率是先降低后升高，而腐蚀敏感度先降低后增加，材料耐腐蚀性能先增加后降低。在 75℃时，随着 Cr 含量的增加，材料腐蚀速率逐渐降低，腐蚀敏感度逐渐降低，材料耐腐蚀性能逐渐增加。在不容易形成氧化物保护膜的时候，材料的腐蚀主要以形成众多微型原电池的方式进行。在较低温度环境中，低 Cr 含量的 Cu-Cr 复合材料更适用。在较高温度环境中，高 Cr 含量的 Cu-Cr 复合材料更适用。Cu-Cr 复合材料的腐蚀敏感度主要受到材料表面的氧化膜的影响。

关键词：纳米增强 Cu-Cr 复合材料；粉末冶金法；电化学工作站；耐腐蚀性能；腐蚀机理

Abstract

Cu is a metal material with excellent conductive thermal resistance, good corrosion resistance and process, so Cu is widely used in the electronics industry, power industry, automobile transportation industry and mechanical metallurgy. But Cu's poor corrosion resistance limits Cu's development. Cu-Cr alloy is a classic aging-reinforced alloy with good conductive thermal conductivity, good plasticity and high strength. In the production and life of the application of a wide range of prospects, such as the preparation of plugs, high-speed rail conductive bow, electric contacts, integrated circuit lead frame, power tools of steering. Therefore, the nano-enhanced copper-chromium composite material with Cu-Cr binary alloy as a metal substrate is of great significance. In this paper, the corrosion behavior, corrosion mechanism and corrosion resistance spectrum of nano-reinforced Cu-Cr composite materials were analyzed by electrochemical experiments to analyze the corrosion behavior, corrosion mechanism and corrosion resistance spectrum of nano-enhanced Cu-Cr composite materials in 5% sodium chloride solution, in 50 ℃ and 75 ℃.

Nano-enhanced Cu-Cr composite materials consist of Cu, Cr, alumina whiskers and graphene, alumina whiskers and graphene content in the samples of 1% and 0.5%, respectively, the three groups of samples with chromium content of 2%, 3%, 4% and a pure copper sample as a control. In terms of process, it is easier to obtain samples with different components using powder metallurgy. To study the corrosion resistance of materials, we mainly through electrochemical workstations to the material open potential, polarization curve and impedance map to analyze, while using gold phase and scanning electron lenses to analyze its characterization.

Adding the right amount of Cr, alumina and graphene will significantly enhance the corrosion resistance of the material. The added Cr will form oxide film protection composite material on the surface of the material, the lower temperature is not easy to form oxide film, the higher the temperature, the easier the formation of protective film, the more corrosive corrosion resistance of the composite material. At 50 °C, with the increase of Cr content, the corrosion rate of the material is reduced and then increased, while the corrosion sensitivity is reduced and then increased, and the corrosion resistance of the material can be increased and then reduced. With the increase of Cr content, the corrosion rate of the material decreases gradually, the corrosion sensitivity decreases gradually, and the corrosion resistance of the material is gradually increased. When it is not easy to form oxide protective film, the corrosion of the material is mainly carried out by forming a large number of miniature primary batteries. Cu-Cr composites with low Cr content are more suitable in