

A Study on the Characters of Co-Cr-Fe-Ni-Ti High Entropy Alloys

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Abstract

Six alloys which compositions contained the elements of Co, Cr, Fe, Ni and Ti were cast by arc melting, and examined their microstructures, mechanical properties, thermoelectric properties, analyzed the influence for property of microstructures. The results indicated that (1) increasing the elements of these alloys, atomic size of the atoms were more different, it was also easily to produce the high-entropy alloys with higher hardness; (2) the structure of CoCrFeNi high-entropy alloys was FCC, and its hardness was HV163, this revealed that the high-entropy alloys also could be designed to produce the alloys with lower hardness; (3) the microstructures of these a high-entropy alloys had nano-scale microstructures by TEM observing, and the grain sizes are about several nm. CoCrFeNi alloy also showed a microstructure of nano-grain with superlattice; and (4) the oxide resistance of high-entropy alloys were measured by TGA revealed that these six alloys all have higher oxidization resistance.

Keywords: High-entropy alloys, Microstructure, Hardness, Thermal analysis, Thermoelectric properties

Co-Cr-Fe-Ni-Ti高熵合金之特性研究

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摘要

本實驗以真空電弧熔煉技術，將Co、Cr、Fe、Ni、Ti五種金屬元素，自行製作成六組多元高熵合金，藉以探討微結構、機械性質及熱電性質的研究，並分析微結構對此性質的影響。實驗結果顯示：(1) 合金元素增多，原子尺寸差異也越大，固溶強化效應相對變強，再加上微晶強化等因素綜合表現下，使得高熵合金材料容易具有極高的硬度值；(2) CoCrFeNi四元高熵合金為FCC結構，其硬度值為HV163，說明高熵合金也可以經由合金設計而得到材質很軟的合金塊材；(3) 經由鑄造的方法將金屬元素熔煉成塊材後，再藉由TEM細微觀察其結構，可以發現其合金系統內含有許多奈米晶組織，其晶粒大小約為數個奈米至數十奈米；(4) TGA測量多元高熵合金之抗氧化情形得知，顯示本論文中六種等莫耳高熵合金，皆具備良好的抗氧化性。

關鍵詞：高熵合金，微結構，硬度，熱分析，熱電性質

1、前言

長期以來，實用合金系統之開發，主要以鐵、

銅、鋁、鎂、鈦、鉛等元素為主。而傳統合金系統絕大多數都是以一個元素為基地相，並添加其他元素使其產生固溶或第二相以改良合金之特