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Production and Characterization of Cu-SiC Composites for Electrical Contact Materials

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Abstract: In this study, the effect of SiC reinforcement on the electrical, mechanical, physical properties and microstructure of copper matrix composite contact material was investigated. The composite materials were produced by using the powder metallurgy method. The unalloyed copper and SiC powder mixtures were shaped by using a uniaxial press after mixing for 10 minutes at 300 rpm. The shaped specimens were heat treated in graphite powder bad in a capped steel chamber and sintered at 800° C for 2 hours. Electrical conductivity, hardness, density measurements, microstructure analyzes and mineralogical analyzes of the samples were performed after sintering. The structure-property relationships of the produced monolithic and composite copper contact materials are discussed. It was determined that the value of electrical conductivity decreased with increasing amount of SiC phase, and hardness value increased compared to pure copper. Cu-SiC composites revealed better mechanical properties than monolithic copper contact materials.

Keywords: Silicon carbide, Copper, Characterization, Contact materials, Electrical conductivity, Composites.

INTRODUCTION

The electrical contact is defined as the current carrying element of the electrical/electronic device interface which maintains the continuity of the electrical circuit.Electrical contacts provide electrical connections and often perform other functions. The primary purpose of the electrical connection is to ensure that the electricity passes continuously through the contact interface. This is achieved only by establishing a good metal-to-metal interface interaction [1].

The basic requirements from electrical contacts are reliability, electrical conductivity, thermal stability, and cost. Powder metallurgy is a cost effective method for production of electrical contacts [2]. Electrical contact materials are a class of metal such as pure metal, metal alloys and metal matrix composites used in the electrical interfaces of electrical connectors and electrical switches. These materials are characterized by their superior electrical conductivity properties and can be used as bulk conductors such as, silver, silver alloys, copper, copper alloys, aluminum, aluminum alloys. Some conductors, are used as coatings on the electrical contact surfaces such as precious metals, silver alloys, tin alloys, ceramic oxide and non-oxide films …etc. Another group is a metal matrix composites where copper, silver …etc. are matrix phase and SiC, B_4C, TiB_2, ZrB_2, TiC etc. are a non-oxide and Al_2O_3, SnO_2, B_2O_3 etc. oxide reinforced phases. They have been used for ranging from low voltage to high voltage circuit application [3-13].

Cu-SiC metal matrix composites have been extensively studied due to their excellent electrical and thermal conductivity, high hardness and good wear and friction properties. Powder metallurgy is the most commonly used methods in the manufacture of these composites in a cost effective way[14-16].

MATERIALS AND METHODS

Materials

The matrix material comprises copper metal which were supplied from Sentez Bir Metallurgy, Chemical, Energy, Production and Recycling Technologies Industry Inc., Turkey. SiC reinforced phase was obtained from Ridsdale Co. Ltd., Middlesbrough, Cleveland, UK. Copper and SiC material powders were milled with a Fritsch planetary mill for twenty minutes at 200 rpm. The mixtured Copper and SiC material powders was dryied in oven at 105 ^{0}C.

After that some characterization techniques were applied to copper and SiC material powders. The true density of Copper and SiC material powders were measured by He-gas pycnometer. Optical microscopy images of Copper and SiC powders were taken with