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ABSTRACT

Copper–iron alloys (CFAs) are a much anticipated class of materials for electrical contacts, magnetic recordings, and sensors. In this study, $Cu_{100-x}Fe_x$ alloys (x = 10, 30, or 50, representative of the Fe content in at%) were prepared via gas atomization, followed by sintering and heat treatment in vacuum. The electrical conductivity of the alloys was determined as a function of the grain size. The substitutional solid solution formed between copper and iron during alloy synthesis is decomposed during the subsequent heat treatment, followed by sluggish grain growth in samples of all compositions, but it was highest in the sample consisting of 10 at% of iron. In the samples with the other two compositions, grain growth was very slow and the grain boundaries were pinned by the Fe-rich phase. Bulk samples of all compositions with powder particles measuring ~24 μm exhibited higher electrical conductivity with longer durations of heat treatment.

Keywords:

Copper–iron alloy (CFA), Gas atomization, Microstructural evolution, Heat treatment, Electrical conductivity.

1. Introduction

A copper-iron alloy (or copper-ferro alloy, CFA) is known for its good combination of high electrical conductivity and good mechanical strength [1]. It has great potentials to be used as material for magnetic recording, optical devices, electrical contact materials and sensors [1]. As materials with high strength and high conductivity, CFAs can potentially be applied in many industrial fields and have become popular subjects of research in materials science [2]. Other alterative alloys like Cu-Nb [3] and Cu-Ag [4] have much better combination of electrical conductivity and strength than CFA but the advantage of CFAs lies in the cheap cost of Fe as compared to both Nb and Ag. CFAs can be produced by various methods, by casting [5], mechanical alloying [6], or rapid solidification processes such as melt spinning [7] and gas atomization [8]. The application of CFA has, however been limited because generally serious segregation of components takes place during solidification [9]. Research indicated that rapid solidification has great potential in the manufacturing of this alloy with expected microstructure because in rapid solidification, it is possible to produce solid-