

The pH Dependence of Magnetoresistance in Cu-Co Alloy Films Formed by Electrodeposition

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Thin films of $\text{Cu}_{1-x}\text{Co}_x$ were electrochemically deposited onto aluminum substrates in a single sulfate bath. The GMR effect was investigated in the temperature range 20 to 300 K and in the magnetic field range 0 to 12 kOe. The bath pH values were selected as 5.25, 5.5, 5.75, 6, and 6.25. The compositions of the electrodeposited $\text{Cu}_{1-x}\text{Co}_x$ films were determined to be $x = 27.7, 27.4, 28.5, 37.9,$ and $28.4,$ respectively, by an atomic absorption spectrometer and an energy dispersive X-ray spectrometer. The crystal structure was FCC-Cu for all films, but a shift in the direction lines was observed with increasing Co content. All films showed a negative magnetoresistance (MR) effect. The maximum MR ratio at a magnetic field of 8.5 kOe was 1% in the pH=6 film at room temperature and 3.3% in the pH=6 film at 20 K. It was found that the composition, structure, and magnetoresistive (GMR) behaviour of the thin films exhibit a strong dependence on the pH values of the bath electrolyte.

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I. INTRODUCTION

Very intensive attention is now focused on magnetoresistive granular alloy films by researchers and technologists. The main reason for this is due to the existence of their GMR. In the presence of a magnetic field, magnetoresistive materials can exhibit a large drop in resistivity, this is the so-called giant magnetoresistance (GMR) effect [1, 2]. Heterogeneous alloy films are immiscible combinations usually prepared by electrodeposition [3–12]. In heterogeneous systems the ferromagnetic grains are distributed within a nonmagnetic matrix, whereas the GMR effect mainly originates from a spin-dependent scattering of the conduction electrons at the interface of the ferromagnetic (FM) particles [13]. Cu-Co alloy is a typical heterogeneous alloy showing GMR. This system is immiscible at room temperature, and the formation of a supersaturated Cu-Co phase is possible [14]. In the equilibrium state the solid solubility between Cu and Co is negligible at room temperature, and Co and Cu do not form solid solutions with a wide composition range. The film structure and properties are dependent closely on the preparation techniques [15–18]. The relationships between the production conditions and the magnetoresistive properties of the films are as yet unclear.

Electrodeposition is a cheap, relatively simple, and effective method of producing metastable alloy films. Moreover, electrodeposition is also an alternative to other more