ELECTRODEPOSITION OF HIGH MAGNETIC MOMENT CoFe BASED ALLOYS

B.Y. Yoo, M. Schwartz and K. Nobe

Department of Chemical Engineering, University of California, Los Angeles, CA 90095-1592

INTRODUCTION

The high magnetic moment soft magnetic thin film is one of the important requirements for the fabrication of magnetic storage and MEMS devices. Permalloy (80Ni20Fe) thin films, one of the most successful soft magnetic materials due to its low coercivity and good corrosion resistance can be readily fabricated by electrodeposition (1). Next generation recording heads and magnetic MEMS, however, require materials with higher magnetic moment so that considerable attention has been directed to the development of new CoFe based magnetic alloys (2).

Addition of vanadium (2wt.%) to 50Co50Fe magnetic alloy (Permendur) substantially increases ductility and electrical resistivity with little degradation of magnetic properties (3). Because of magnetic properties, such as high magnetic saturation, high Curie temperature, and low coercivity, it is used for high temperature applications such as transformer cores for aircraft electric generators (4).

In this paper, the results of electrodeposition studies of high magnetic saturation CoFeV alloys are presented including magnetic properties, microstructure and surface morphology.

EXPERIMENTALS

To investigate the relationship between deposit composition and magnetic properties and microstructure, the concentration of Co(II) and Fe(II) were varied from 0.15M to 0.287M and 0.013M to 0.15M, respectively, keeping total iron group metal concentration ([Fe(II)]+[Co(II)]) at 0.3 M. The concentration of vanadyl sulfate was kept constant at 0.17 M**.** Corrosion resistance of electrodeposit in 0.5M NaCl solutions was determined by IS.

RESULTS AND DISCUSSION

Figure 1. shows the corrosion resistances of CoFeV deposits with direct current and pulse current comparing Permalloy and CoFe deposits. As shown in the figure, corrosion resistance increased in the sequence of CoFe <CoFeV(DC)<CoFeV(PC)< Permalloy. Corrosion resistance of PC CoFeV electrodeposits was 4.6 kΩcm^2, which is almost four times greater than that of DC CoFe electrodeposits (1.24 kΩcm^2). These results show that the incorporation of vanadium improves the corrosion resistance of CoFe thin films.

Electrical resistivity is an important physical property for soft magnetic materials, because of its relationship to eddy currents. Figure 2 presents the electrical resistivity of CoFe and CoFeV deposited by DC and PC compared to Permalloy. Electrodeposits were prepared at the same conditions as those for corrosion resistance measurements. The resistivity of DC CoFe electrodeposit was 30 $\mu\Omega$cm, and DC CoFeV electrodeposit was 58 $\mu\Omega$cm; incorporation of ~2wt% vanadium almost doubled the electrical resistivity of CoFe electrodeposits. Electrical resistivity of PC CoFeV was 66 $\mu\Omega$cm, slightly higher than DC CoFeV electrodeposits. Magnetic properties obtained for 2V-Permendur (49CO49Fe2V) were as follows : H_c ~6Oe, B_s ~2.3T and B_r ~ 1.5T (after annealing). These preliminary results shows the promise of CoFeV thin film electrodeposits to achieve high performance soft magnetic properties of $H_c <$ 1Oe, $B_s \geq$ 2.4T and $\rho_{elect} >$ 100$\mu\Omega$cm.

ACKNOWLEDGMENT

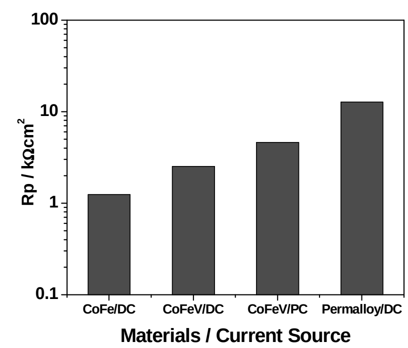

Figure 1. Corrosion resistance of CoFe, CoFeV, and Permalloy with DC, and CoFeV with PC

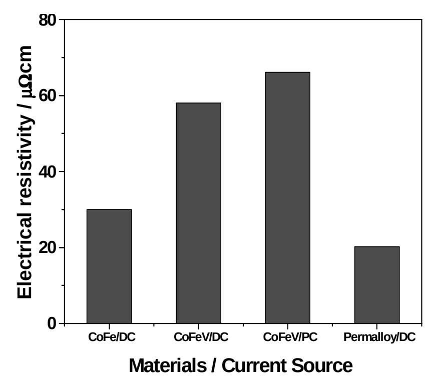

Figure 2. Electrical resistivity of CoFe, CoFeV, and Permalloy with DC, and CoFeV with PC

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