RD06

Effect of an External Magnetic Field on Magnetic Properties of Electroplated CoFeNi Alloys

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Introduction

CoFeNi alloys are some of the most well known soft magnetic materials because of their superior soft magnetic properties over FeNi alloys which applied in write head core in hard disk drives [1]. Recently, we reported that ternary CoFeNi films with high saturation magnetic flux density (Bs ;> 1.9 T) and low coecivity (12 A/m) were successfully grown by electroplating method [2]. In this work, we report the properties of CoFeNi alloys changed by external magnetic field during electroplating process.

Experiments

To analyze the effect of external magnetic field on properties of CoFeNi alloys, 140 mT magnetic field is applied in parallel to the direction of the plating sample during the thickness of 1 μm on Au/Si wafer ($1\times1cm^2$) electroplating with. The crystalline structure and magnetic properties of the CoFeNi alloys were measured by XRD and VSM, respectively and microstructure and crystallographic orientation of CoFeNi alloys were investigated by TEM.

Research results and discussion

Fig. 1 shows hysteresis loops of electroplated (a) without external magnetic field and (b) with external magnetic field of 140 mT of CoFeNi alloys.

Samples electroplated under external magnetic field show significant differences in magnetic hysteresis loops. This result shows that external magnetic field can affect the growth of crystals in soft magnetic electroplating. In addition, coercivity decrease from 12 to 10 A/m and permeability increase according electroplated with external magnetic field.

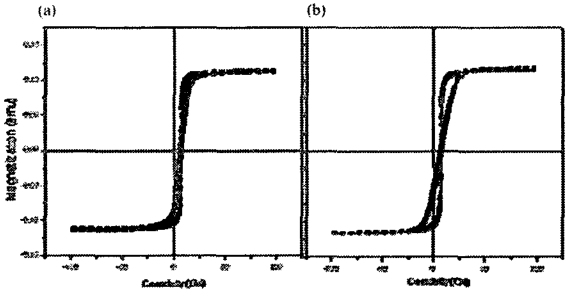

Fig 1. Hysteresis loops of electroplated (a) without external magnetic field (b) with external magnetic field of 140 mT of CoFeNi alloys.

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RD07

Order-Disorder Transition and Magnetic Properties of Fe-6.5 Si Alloy Powder cores

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Fe-6.5wt.% Si alloys havea high potential in magnetic device application due to their high electrical resistivity, very low magnetostriction, and low magnetocrystalline anisotropy. Despite of their high potential these alloys are seldom used in the magnetic application because it is almost impossible to cold-roll, extrude or machine these alloy. Magnetic alloy powder cores can overcome the demerit because the alloys powder can be easily obtained by gas atomization process. One of interesting phenomena in this alloy system is order-disorder transition which has been studied by a number of researches since DO_3 ordering structure was found. However, mostly research results were on the order-disorder effects of rapidly quenched Fe-6.5% Si melt-spun ribbons. In addition the effects of order-disorder transition on the magnetic properties was not coincident and clear.[1,2] Moreover, there have been no research results on the effects of order-disorder transition of the alloy powder cores yet. In this study gas-atomized Fe-6.5 wt.% Si alloy powder was investigated systematically with emphasis on the relation between order-disorder transition and core loss. As-atomized powder was annealed at 900°C for 2 hrs, and then rapidly cooled to room temperature. The annealed powder was mixed with coating agent, and then compacted to toroid core under a pressure of 1176 MPa. The toroid core and the rapidly cooled powder was re-annealed at 400 - 700°C for 10 - 960 min in 99.999% N_2 gas, and then furnace-cooled. The order-disorder transition was indirectly measured by micro-Vickers hardness tester. The core loss of the powder core wasmeasured by Iwatsu SY-8232 ac loop tracer under a condition of 0.1 T and 50 kHz. Minimum hardness occur very early stage of annealing and maximum hardness existed, from which optimum powder annealing condition for core compression could be inferred (Figure. 1). Core loss increased with annealing time which was due to order-disorder transition because core loss decreased if stress was relieved during the annealing (Figure.2). Decreased core loss of 960 min annealed core was thought to be due to stress relief. Permeability decresed with annealing time except a sharp increase in the early stage of 500°C annealing. More detailed experimental resultsas well as the relation between the order-disorder transition and magnetic properties will be discussed.

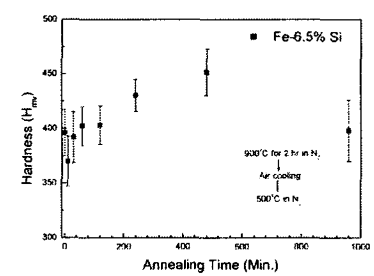

Fig. 1. Variation of micro-hardness with annealing time.

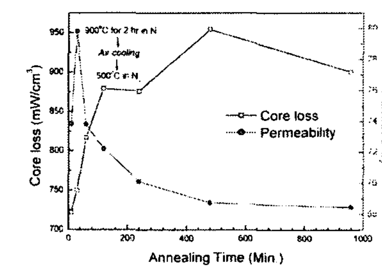

Fig. 2. Variation of core loss with annealing time.

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