High Moment FeNi Films With Low Coercivity And Low Anisotropy Field

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To increase the areal density of hard disk drives and to achieve faster data rates, there has been a significant amount of research in developing electroplated magnetic materials for thin film heads. For magnetic materials, it is necessary to reduce coercivity (Hc) and anisotropy field (Hk) while maintaining high saturation magnetization (Bs). Iron-Nickel alloys (e.g. Permalloy [1] and $Ni_{45}Fe_{55}$ [2]) are used for the thin film head cores. Recently, higher iron NiFe alloys such as $Ni_{35}Fe_{65}$ and $Ni_{20}Fe_{80}$ [3] have been developed. This current study focuses on the electrodeposition of even higher iron NiFe films i.e. FeNi.

The alloy composition of FeNi films was varied from $Fe_{55}Ni_{45}$ up to $Fe_{95}Ni_{5}$ by changing the bath composition. The magnetic properties (Hc, Hk, Bs) and the internal stress of these films were investigated in the as-plated state and after annealing in vacuum with a magnetic field. The crystallographic structure was studied using X-Ray diffraction technique.

The lower Fe composition FeNi films were plated at pH 3.5 with bath temperature of 30C. However, it was observed that the film surface became dark and rough over 80wt% Fe. Bright and shiny FeNi films were then obtained after 80wt% Fe when the bath pH was lowered (pH< 2.0).

Fig.1 shows the change of coercivity and anisotropy field of electroplated $Fe_{88}Ni_{12}$ Films as a function of annealing time at 250C. Results show that Hc decreases rapidly within one hour of annealing and remains fairly stable after that. On the other hand, Hk becomes larger with annealing time.

Fig.2 shows the relationship between film composition and Hc in the as-plated state and after annealing. In the as-plated films, Hc is changing with the Fe composition with a maximum of 7 Oe (553 A/m) at 80wt% Fe. After annealing, Hc is reduced to 1 Oe (79 A/m) over all the alloy composition range from 55wt%Fe to 90wt%Fe.

Fig.3 shows the relationship between film composition and Hk in the as-plated state and after annealing. Hk of as plated films decreases with Fe composition and Hk increases slightly after annealing.

Fig.4 shows X-ray Diffraction patterns of electroplated $Fe_{88}Ni_{12}$ films (a) as-plated (b) after annealing. Both, as-plated and annealed films exhibit a bcc structure.

References
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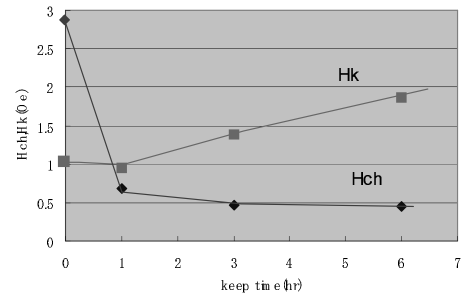

Fig.1. Relation between coercivity , anisotropy field of electroplated $Fe_{88}Ni_{12}$ films and annealing time at 250C

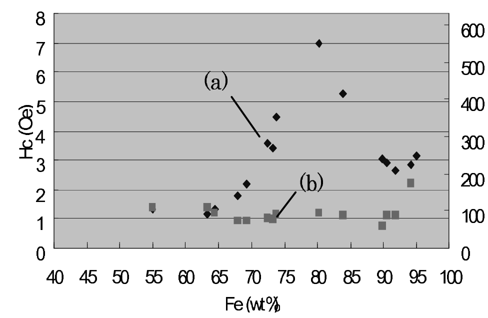

Fig.2. Coercivity of electroplated FeNi films as a function wt% Fe (a) as plated and (b) after annealing

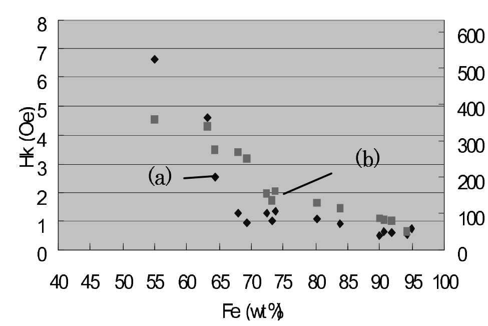

Fig.3 Anisotropy field of electroplated FeNi films as a function wt% Fe (a) as plated and (b) after annealing

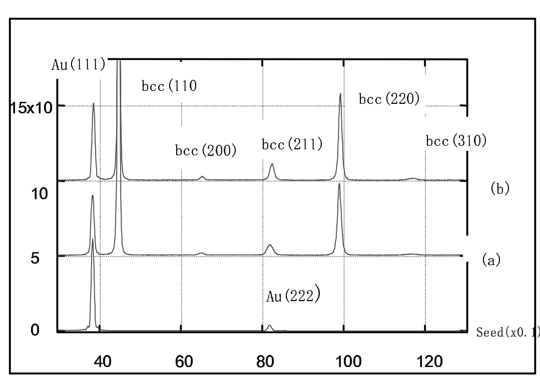

Fig.4. X-ray Diffraction patterns of Electroplated $Fe_{88}Ni_{12}$ films (a) as plated and (b) after annealing.