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IMPROVEMENT OF CORROSION RESISTANCE FOR Fe-M-N (M=Ti, Hf) NANOCRYSTALLINE SOFT MAGNETIC THIN FILMS

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Fe-M-N (M=Ti, Hf) 나노 결정 연자성 박막의 부식 저항 향상에 대한 연구

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1. INTRODUCTION

Fe-M-N (M=Hf,Ti,Ta,Al) thin films have been studied for writing head materials of high density magnetic recording [1][2]. Good soft magnetic properties with high saturation magnetization are required for pole materials of writing head. Additionally, thin film head materials must possess good corrosion resistance and thermal stability. Corrosion resistance of Ni based Permalloy and Fe based alloys depends to a great extent on the nature and stability of passivating oxide films formed on their surfaces [3]. The FeMN films exhabit excellent soft magnetic properties, but corrosion resistance worse than those of the permalloy ($Ni_{81}Fe_{19}$) film. To improve the corrosion resistance of FeMN films, Cr added to FeMN films

This work investigates the magnetic properties, the thermal stability and the corrosion resistance for as-deposited FeTiN, FeHfN, FeTiCrN, and FeHfCrN thin films with comparison to Fe and Permalloy films.

2. EXPERIMENT

As-deposited Fe-Ti-N, Fe-Hf-N, Fe-Ti-Cr-N, and Fe-Hf-Cr-N thin films were prepared by a reactive rf magnetron sputtering method. The input power and the working pressure are maintained at 450W and at 1mTorr, respectively. The magnetic properties of the films were measured by vibration sample magnetometer (VSM). The frequency dependence of effective permeability (μ_{eff}) was measured by using an 8-figure coil method. The electrical resistivity of the films was measured by a four-point probe method. The microstructure was investigated by transmission electron microscopy (TEM) and x-ray diffraction (XRD) with CuK_{α}. To observe the thermal stability, annealing was performed with a 100 Oe dc field applied along the hard axis for transverse field annealing (TFA) at 150 °C in 5×10^{-6} Torr increasing the annealing time. Electrochemical corrosion data were obtained using an EG&G Par 273A electrochemical test system.

3. RESULTS AND DISCUSSION

The magnetic properties of as-deposited Fe and FeMN (M=Ti, Hf, CrTi, CrHf) thin films with 1μm thickness are summarized in Table 1. The film compositions on Table 1 are selected to represent the typical soft magnetic properties. $Fe_{92.3}Ti_{2.1}N_{5.6}$ and $Fe_{72}Hf_9N_{19}$ films show excellent soft magnetic properties. However, corrosion resistance behaviors of the FeTiN and FeHfN films are much worse than those of the permalloy ($Ni_{81}Fe_{19}$) film. To improve the corrosion resistance of the FeTiN and FeHfN films without the deterioration of soft magnetic properties, Cr added to the FeTiN

and FeHfN films.

The anodic polarization curves for FeMN (M=Ti, Hf, CrTi, CrHf), Fe, and permalloy films are shown in Fig. 1. It shows that the corrosion resistance of $Fe_{90.3}Cr_{1.2}Ti_{1.1}N_{5.6}$ and $Fe_{69.7}Cr_{2.0}Hf_{9.2}N_{19.1}$ films are improved with comparison to $Fe_{92.3}Ti_{2.1}N_{5.6}$ and $Fe_{72}Hf_9N_{19}$ films. Also, the corrosion resistance of these films is as good as permalloy film. From this result, the addition of Cr in the FeTiN and FeHfN films would result in the improvement of the corrosion resistance by the formation of a passivation layer. Conclusively, an addition of Cr in FeTiN and FeHfN films improved the corrosion resistance without the deterioration of soft magnetic properties.

Table 1 Magnetic properties of Fe, permalloy, FeTiN, FeHfN, FeCrTiN, and FeCrHfN films

Sample	$4\pi M_s$ (kG)	H_c (Oe)	μ_{eff} (at 100MHz)	ρ ($\mu\Omega$cm)
Fe	20.9	18	300	17
$Ni_{81}Fe_{19}$	8.6	0.5	2300	27
$Fe_{92.3}Ti_{2.1}N_{5.6}$	19.5	1.2	2000	62
$Fe_{90.3}Cr_{1.2}Ti_{1.1}N_{5.6}$	18.6	1.5	2700	74
$Fe_{72}Hf_9N_{19}$	15.8	0.6	4080	121
$Fe_{69.7}Cr_{2.0}Hf_{9.2}N_{19.1}$	14.6	0.5	4150	134

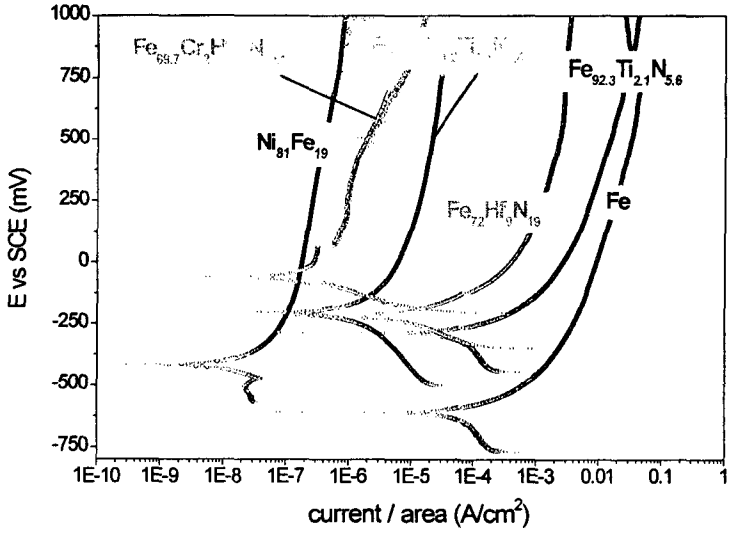

Fig. 1 Comparison of the anodic polarization curves of Fe-Ti-N, FeCrTiN, FeHfN, and FeCrHfN films with NiFe and Fe films in 0.5 M NaCl at pH = 6.

4. REFERENCES

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