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THE MAGNETIC PROPERTIES AND MICROSTRUCTURES FOR Fe-B-N NANOCRYSTALLINE SOFT MAGNETIC THIN FILMS

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Fe-B-N 나노 결정 연자성 박막의 자기적 특성 및 미세구조에 관한 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 [1-3]. 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. For developing new materials, which meet the above requirement, as-sputtered Fe-B-N thin films were prepared by a reactive rf magnetron sputtering method.

In this paper, the magnetic properties and microstructures of as-deposited Fe-B-N thin films have been investigated with the variation of nitrogen partial pressure.

2. EXPERIMENT

As-deposited Fe-B-N thin films were prepared by a reactive rf magnetron sputtering method using a composite target. The nitrogen partial pressure (P_{N2}) was controlled in the range of 0 ~ 10 % keeping the total pressure of 1 mTorr constant The rf input power was 450 W. The films with 0.5μm thickness were deposited on Si (100) substrates. The composition of the films was analyzed using auger electron spectroscopy (AES) and Rutherford backscattering spectro- scopy (RBS). When analyzed by AES, the composition was calibrated with the standard sample analyzed by RBS. The saturation magnetization ($4\pi M_s$) and coercivity (H_c) of the films were measured by vibrating sample magnetometer (VSM). Using a B-H loop tracer, the magnetic anisotropy direction of the films was characterized. The frequency dependence of the 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) using CuK_α radiation.

3. RESULTS AND DISCUSSION

The magnetic properties of Fe-B-N films fabricated by Ar + N_2 reactive sputtering showed strongly dependence on nitrogen partial pressure (P_{N2}). Fig. 1 shows $4\pi M_s$ and H_c values of Fe-B-N films with the increment of P_{N2}. The $4\pi M_s$ value slowly decreases with the increment of P_{N2} from 1 % to 6 %, but there is an abrupt decrease over 6 % P_{N2}. In the case of low P_{N2}, the $4\pi M_s$ shows about 22.3 kG similar to pure Fe films, and falls off to about 8.6 kG at 10 % P_{N2}. The

H_c drops from 40 Oe at 0 % to about 0.8 Oe at approximately 3.5 % and rises to about 110 Oe at 10 % P_{N2}. Also, the μ_{eff} of these films gradually increases with the increment of P_{N2} from 1 % to 3.5 % and reaches the maximum permeability of about 4200 (100MHz) at 4 % P_{N2}. However, the further increment of P_{N2} deteriorates the μ_{eff}. Therefore, the best soft magnetic property in as-deposited Fe-B-N films is obtained at 4 % P_{N2}.

In this results, as-deposited $Fe_{89.4}B_{3.0}N_{7.6}$ film exhibited excellent magnetic properties of $4\pi M_s \sim 19.2$ kG, $H_c \sim 0.8$ Oe, and $\mu_{eff} \sim 4200$ at 100MHz. Therefore, they are attractive for high frequency write head pole applications.

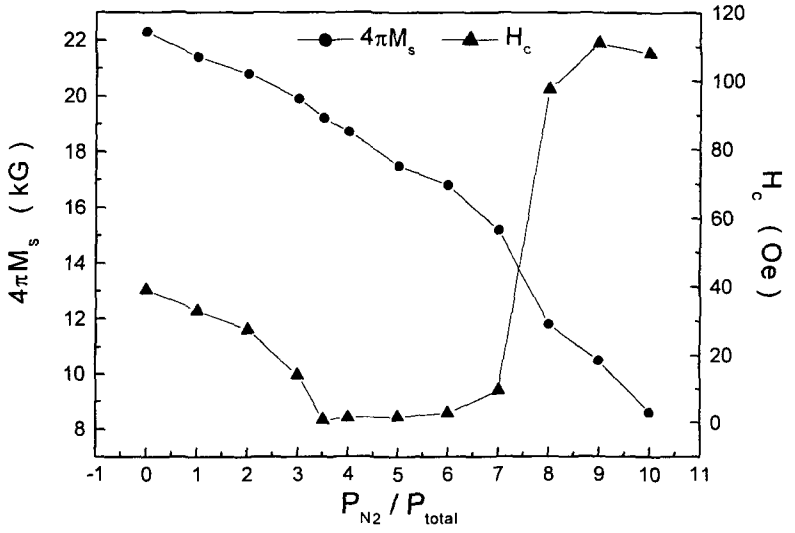

Fig. 1 Saturation magnetization (4πMs) and coercivity (Hc) for Fe-B-N films with the increment of P_{N2}.

4. REFERENCES

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