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Crystallite Size and Strain Analysis of Multilayer Thin Films.

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Introduction

Giant magnetoresistive (GMR) head have attracted several theoretical and experimental works to obtain higher areal density for hard drive. The structure of the GMR sensors consists of two ferromagnetic layers and one noble metal separator with a thickness of a few nm. Their magnetic properties depend on the grain size and the strain of the magnetic layers. Therefore, the analysis of the size and the strain is important for producing good sensors.

Experiment

Samples

The layers of the samples, (anti-ferro, 1st pinned-ferro, oxide metal, 2nd pinned-ferro, Cu, free-ferro magnetic and cap layers) were deposited on underlayers in turn. The anti-ferromagnetic layer is made of MnPt and the ferromagnetic ones are fcc Co alloy. The oxide metal layer was natural oxidation of Ru, Fe, Co alloy and no oxidation sample was prepared to compare. Table 1 shows the magnetic properties, which depend on the oxide metal layer of the samples. [1]

Table 1: The MR ratio and coercivity in the easy axis (H_{ce}) of the GMR samples.

Oxide metal	MR ratio (%)	H_{ce} (A/m)	Crystallite size (nm)
Fe	18.0	416	7.9
Co alloy	17.0	576	14.5
Ru	16.1	368	7.8
No oxidation	15.3	504	8.5

Measurement

The in-plane x-ray diffraction profiles of the samples were measured by a diffractometer at BL8C2 in KEK-PF with incidence x-ray energy of 12.4 keV. To minimize the diffraction from the MnPt layer, the grazing incidence geometry was used with the incidence angle of 0.25 degree.

Results

Figure 1 shows fcc (220) and (440) in-plane XRD profiles of the samples. The diffraction peaks were fitted by a voigt function to obtain the peak width. The average crystallite size and strain were analyzed from scattering vector dependence of peak width (Hall's method). The average crystallite size of the samples is summarized in Table 1. Figure 2 shows the coercivity versus crystallite size of the free-ferromagnetic layers of the samples. The coercivity seems to relate to the average crystallite size of the free-ferromagnetic layer. However there is no correlation between the MR ratio and the average crystallite size (see Table 1).

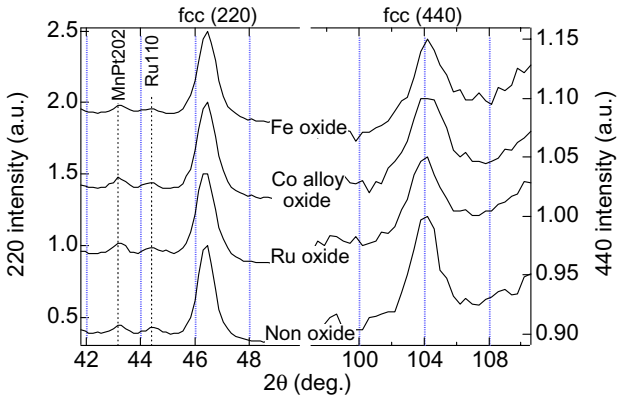

Fig. 1: In-plane XRD profiles for GMR samples.

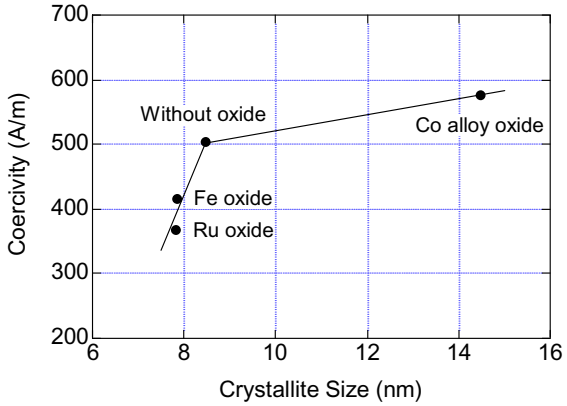

Fig. 2: Relationship between the coercivity and crystallite size for free-ferro magnetic layer. Line for the eye guide.

References

[1] K. Hoshino *et al.*, J. Magn. Soc. Jpn. 27, 311 (2003).

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