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Magnetic properties and magnetoresistance characteristics of NiFeN/Co/Cu/Co spin-valve thin films

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1. Introduction

The spin-valve films[1] reported by Dieny et al. paved the way to the application of MR head for the high areal density because spin-valve films show a large MR ratio(%) at low field. The MR behavior in spin-valve films is due to the exchange magnetic anisotropy coupling between ferromagnetic and antiferromagnetic layers. However, the MR can be also induced by antiparallel alignement between ferromagnetic layers on the basis of the difference of the coercivty in ferromagnetic layers separated by a nonmagnetic layer in the pseudo spin-valve films[2], which is applicable for the nonvolatile magnetoresistive RAM(MRAM)[3] as well as MR senser. The psedou-spin valve film gives a large MR ratio in low field even in case of sub-micrometer fabrication and unlimited read/write endurance. It has been recently reported that pseudo-spin valve FeN/Co/Cu/Co[4] structure utilizing the difference of the coercivity of two ferromagnetic layers, FeN/Co and Co layer.

In this work, we have investigated the N_2 gas effects on the magnetic properties and magnetoresistance characteristics of NiFeN/Co/Cu.Co films.

2. Experimental

The NiFeN(t Å)/Co(45 Å/Cu(15 Å)/Co(45 Å) (t=400, 230, 80 Å) films were deposited from $Nd_{81}Fe_{19}$ target onto thermal oxidized Si(100) substrates by using reactive RF magnetron sputtering method, where the reactive sputtering pressure of the mixed Ar and N_2 gas was fixed 5 mTorr and the flow rate of N_2 and Ar gas was 0.3-0.7 and 20ccm, respectively. The Co and Cu layers were fabricated by DC magnetron sputtering. The microstructure of NiFeN films was examined by TEM. Magnetic properties were measured by VSM and MR characteristics were measured with a VSM and 4 point probe method at room temperature.

3. Results and discussions

Fig.1 The *M-H* loop of NiFeN(400 Å)/Co(45 Å), Co(45 Å) and NiFeN(400 Å)/Co(45 Å)/Cu(15 Å)/Co(45 Å), when the flow rate of N_2 gas is 0.5ccm. The M-H curve of NiFeN(400 Å)/Co(45 Å) shows a small coercivity compared to that of the Co layer. The M-H curve of NiFeN(400 Å)/Co(45 Å)/Cu(15 Å)/Co(45 Å) indicates the difference of the coercivity between the Co layer(magnetically hard) and the NiFeN(400 Å)/Co(45 Å) (magnetically soft). It is a quite different state with FeN/Co (magnetically hard) and Co layer(magnetically soft)[4].

Fig.2 shows the maximum MR ratio(%) as a function of the thickness the NiFeN(t Å) layer along with the flow rate of N_2 gas in the NiFeN(t Å)/Co(45 Å/Cu(15 Å)/Co(45 Å) (t=400, 230, 80 Å). The optimum MR ratio of the NiFeN(400 Å)/Co(45 Å/Cu(15 Å)/Co(45 Å)film is at N_2 =0.5ccm.

The saturation magnetization of NiFeN films were decreased with the increase of N_2 flow rate. This is a merit to the practical application for MR devices.

4 .Reference

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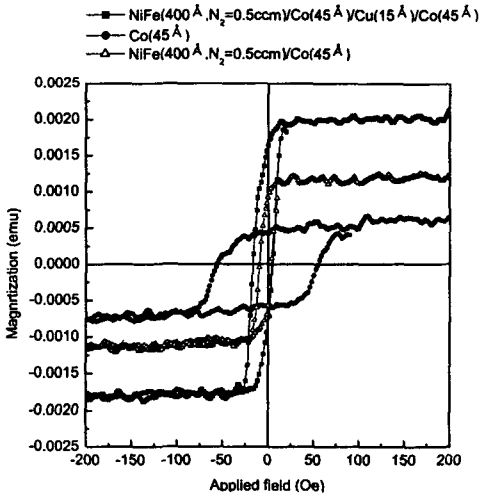

Fig.1 The *M-H* loop of NiFeN(400 Å)/Co(45 Å /Cu(15 Å)/Co(45 Å), NiFeN(400 Å)/Co(45 Å) and Co(45 Å), when the flow rate of N_2 gas is 0.5ccm.

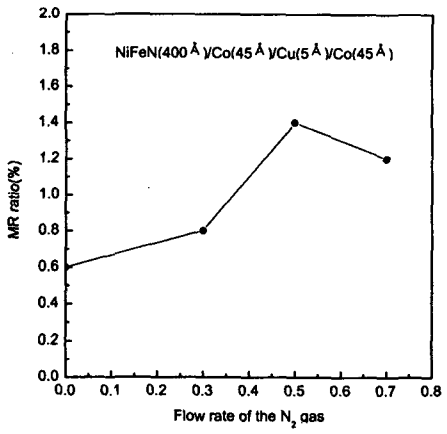

Fig.2. The maximum MR ratio(%) as a function of the flew rate of N_2 gas in the NiFeN(400 Å)/Co(45 Å/Cu(15 Å)/Co(45 Å).