BA09

CPP-GMR Study on Spin-Valve Films Consist of Alternate Monatomic Layered Epitaxial [Fe/Co]n Superlattices with High Spin Polarization

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To realize more high areal density magnetic recording (higher than 2Tbit/in2), it is necessary to improve the sensitivity of MR heads with low RA (Resistance Area Product). It is important to search a metallic material with the large spin asymmetry coefficients (β and γ) which should be relates to the spin polarization (P) of the ferromagnetic material in SV film. The bcc-$Fe_{50}Co_{50}$ spin valves is reported to have the large spin asymmetry coefficients (β and γ) in CPP[1], which suggests that $Fe_{50}Co_{50}$ has the advantage of a high P. On the other hand, $Fe_{50}Co_{50}$ has the B2 type ordered structure. This structure consists of the repetition of a monolayer of Fe and a monolayer of Co to <001> direction. It is considered that the periodicity of the atomic layer leads the huge spin scattering because the wave length at the Fermi level is comparable to the periodicity of the atomic layer. In this study, we focus on the P and CPP-GMR of alternate monatomic layered epitaxial (AML) $[Fe/Co]_n$ superlattices.

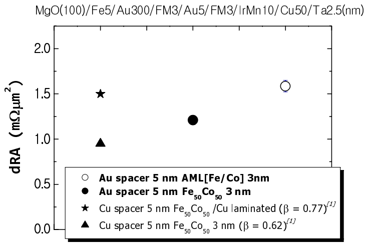

Fig. 1. Summarized ΔRA for $Fe_{50}Co_{50}$ alloy and AML $[Fe/Co]_n$ spin valves.

The P of our AML $[Fe/Co]_n$ on MgO (001) substrate (Ts=75°C) with Fe atom surface was 60% by the point-contact Andreev reflection (PCAR) relative to the pure element (bcc Fe around 43 %, Co 45 %). This value is equivalent to the reported P for half metal Heusler alloy thin films by PCAR. The highest P of metallic film was presented by AML $[Fe/Co]_n$ superlattice[2]. Then we confirmed the structural properties of trilayered full epitaxial films with AML $[Fe/Co]_n$ and $Fe_{50}Co_{50}$ alloy epitaxial film on Au electrode and spacer layer by RHEED[3] and analized the characteristic of CPP-GMR by spin valve films with IrMn layer on the top. The large ΔRA (1.50 mΩμm2) was observed in all metallic CPP-GMR with AML epitaxial $[Fe/Co]_n$/Au 5nm/$[Fe/Co]_n$. This value of ΔRA is equivalent to the CPP-GMR of $Fe_{50}Co_{50}$/Cu laminated with Cu spacer which is largest value ever reported[1]. The ΔRA of SVs with AML $[Fe/Co]_n$ is 1.2 times higher than that of SVs with $Fe_{50}Co_{50}$ alloy (Fig.1). The high ΔRA results from high P of AML $[Fe/Co]_n$ due to increasing the degree of order by AML deposition method. It should be mentioned that the elements for a low RA around 30 mΩμm^2 with same ΔRA of 1.50 mΩμm^2 show a considerably high MR ratio about 5% .

This work is partially supported by New Energy and Industrial Technology Development Organization (NEDO) Grant (Nano-Tech. Challenge for Nano-Technology Program) in Japan.

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BA10

Micromagnetic Study of Dynamic Magnetization Switching Speed in Exchange-coupled Trilayer

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An exchange-coupled trilayer, which is composed of two ferromagnetic layers separated by a thin non-magnetic spacer, is now drawing substantial attentions because of its potential advantages in advanced magnetic device applications such as high density magnetic random access memory [1,2]. Using the exchange-coupled trilayer as free layer structure, the thermal stability can be increased and the critical current density for current-induced magnetization switching can be reduced [2]. One notable disadvantage of the exchange-coupled trilayer, however, is a longer switching time compare to the single layer [3]. In this work, it was investigated the dynamic switching time of the exchange-coupled trilayer varying the external field and the damping parameter. A micromagneic simulation was performed on elliptical magnetic thin films with lateral dimensions of 200 nm × 100 nm. The total thickness of the two layers ($t_1 + t_2$) was fixed at 4 nm with the thickness asymmetry (t1 - t2) of 0.4 nm, namely, t_1= 2.2 and t_2 = 1.8 nm. The magnetic parameters used were relevant to a permalloy with a small induced anisotropy of 10 Oe in the length direction. The interlayer exchange constant and the damping constant were -0.05 erg/cm^2 and 0.003, respectively. Figure 1 shows the dynamic switching time (τ_R) dependence on the external field (H) for several values of α. Note that the time τ_R is for the coherent rotation of the magnetization. Expectedly, the magnetization was reversed fast at large external field. The time τ_R also shows the dependence on the damping parameter; as α increases τ_R increases.

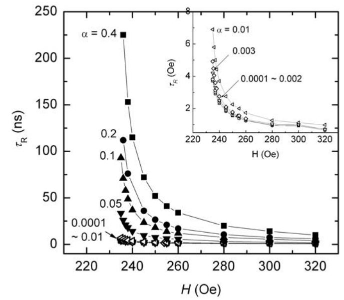

Fig. 1. Dynamic switching time τ_R as a function of the external field H for several values of α.

This work was supported by the Korea Science and Engineering Foundation (KOSEF) through the National Research Laboratory program funded by the Korean Ministry of Science and Technology (Project No. M10600000198-06J0000-19810).

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