

## BA09

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

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To realize more high areal density magnetic recording (higher than 2Tbit/in<sup>2</sup>), 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 ( $\beta$  and  $\gamma$ ) which should be relates to the spin polarization (P) of the ferromagnetic material in SV film. The bcc-Fe<sub>50</sub>Co<sub>50</sub> spin valves is reported to have the large spin asymmetry coefficients ( $\beta$  and  $\gamma$ ) in CPP[1], which suggests that Fe<sub>50</sub>Co<sub>50</sub> has the advantage of a high P. On the other hand, Fe<sub>50</sub>Co<sub>50</sub> 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]<sub>n</sub> superlattices.

The P of our AML [Fe/Co]<sub>n</sub> on MgO (001) substrate (T<sub>s</sub>=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]<sub>n</sub> superlattice[2]. Then we confirmed the structural properties of trilayered full epitaxial films with AML [Fe/Co]<sub>n</sub> and Fe<sub>50</sub>Co<sub>50</sub> alloy epitaxial film on Au electrode and spacer layer by RHEED[3] and analyzed the characteristic of CPP-GMR by spin valve films with IrMn layer on the top. The large  $\Delta$ RA (1.50 m $\Omega\mu$ m<sup>2</sup>) was observed in all metallic CPP-GMR with AML epitaxial [Fe/Co]<sub>n</sub>/Au 5nm/[Fe/Co]<sub>n</sub>. This value of  $\Delta$ RA is equivalent to the CPP-GMR of Fe<sub>50</sub>Co<sub>50</sub>/Cu laminated with Cu spacer which is largest value ever reported[1]. The  $\Delta$ RA of SVs with AML [Fe/Co]<sub>n</sub> is 1.2 times higher than that of SVs with Fe<sub>50</sub>Co<sub>50</sub> alloy (Fig.1). The high  $\Delta$ RA results from high P of AML [Fe/Co]<sub>n</sub> due to increasing the degree of order by AML deposition method. It should be mentioned that the elements for a low RA around 30 m $\Omega\mu$ m<sup>2</sup> with same  $\Delta$ RA of 1.50 m $\Omega\mu$ m<sup>2</sup> show a considerably high MR ratio about 5%.

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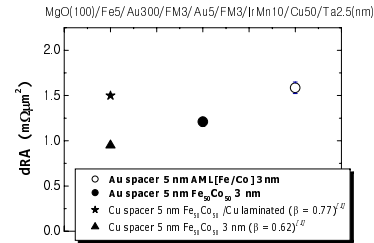


Fig. 1. Summarized  $\Delta$ RA for Fe<sub>50</sub>Co<sub>50</sub> alloy and AML [Fe/Co]<sub>n</sub> spin valves.

## 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 micromagnetic 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 ( $t_1 - t_2$ ) 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<sup>2</sup> and 0.003, respectively. Figure 1 shows the dynamic switching time ( $\tau_R$ ) dependence on the external field ( $H$ ) for several values of  $\alpha$ . Note that the time  $\tau_R$  is for the coherent rotation of the magnetization. Expectedly, the magnetization was reversed fast at large external field. The time  $\tau_R$  also shows the dependence on the damping parameter; as  $\alpha$  increases  $\tau_R$  increases.

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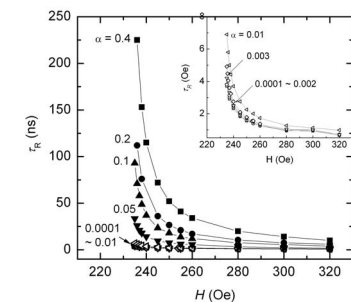


Fig. 1. Dynamic switching time  $\tau_R$  as a function of the external field  $H$  for several values of  $\alpha$ .