Enhancement of spin-dependent interfacial scattering by inserting thin NiAl layer at $Co_2Fe(Ge_{0.5}Ga_{0.5})$/Ag interface in current-perpendicular-to-plane pseudo spin valves

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All-metallic current-perpendicular-to-plane giant magnetoresistance (CPP-GMR) device have attracted much interest recently for potential applications as magnetic sensors that require low device resistance, e.g., the read sensors of high density hard disk drives. However, the main drawback of the current CPP-GMR devices is their low magnetoresistance (MR) outputs compared with those of tunneling magnetoresistance devices. A possible way to increase the MR output is to use a good band structure matched nonmagnetic (NM) spacer with half-metallic ferromagnetic (FM) layers that can generate a high spin-dependent interfacial scattering. Nakatani *et al*. reported a better band structure matching for the majority of spin electron transmittance at interface between NiAl and the $Co_2Fe(Al_{0.5}Si_{0.5})$ Heusler alloy compared to that between Ag and the Heusler alloy. However, its short spin diffusion length limited the application as a spacer layer. [1)] In order to overcome the problem of the short diffusion length, we used thin NiAl as a thin insertion layer between the Heusler alloy and spacer layers.

The pseudo spin valve (PSV) films $Co_2Fe(Ge_{0.5}Ga_{0.5})$ (10 nm)/NiAl (t_{NiAl})/Ag (5 nm)/NiAl (t_{NiAl})/$Co_2Fe(Ge_{0.5}Ga_{0.5})$ (10 nm) were prepared on Cr (10 nm)/Ag(100 nm) buffer layer that were grown on MgO (100) substrates. The thickness of the NiAl insertion layer (t_{NiAl}) was varied in the range of $0 \leq t_{NiAl} \leq 2$ nm. Fig. 1 shows the t_{NiAl} dependence of *RA*, Δ*RA*, and observed MR ratio (MR_{obs}). We confirmed a monotonic enhancement of the Δ*RA* and *RA* with increasing $t_{NiAl} \leq 0.8$ nm. However, the insertion of the NiAl layers with $t_{NiAl} \geq 1$ nm did not improve the MR output due to their short spin diffusion length. Interestingly, the insertion of 0.21 nm-thick NiAl layers at $Co_2Fe(Ge_{0.5}Ga_{0.5})$/Ag interfaces effectively improved the MR output. The highest Δ*RA* and MR ratio of 31 mΩ μm^2 and 82% at room temperature and 78 mΩ μm^2 and 285% at 10 K were obtained.[2)] These values are 2-3 times higher than those without NiAl insertion. Therefore, the $Co_2Fe(Ge_{0.5}Ga_{0.5})$/NiAl interface proposed here is expected to have a much improved spin-dependent interfacial scattering, yielding a high MR output.

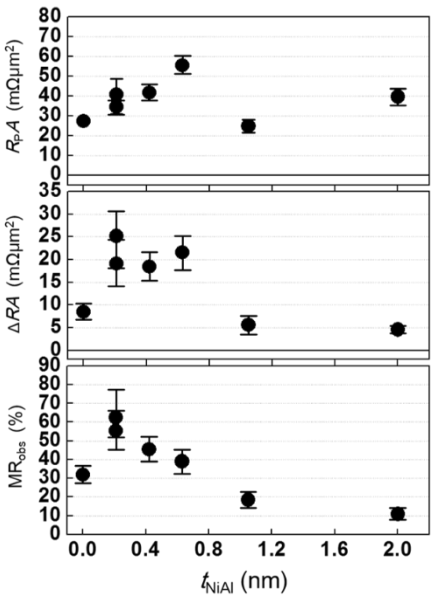

Fig. 1. The t_{NiAl} dependence of *RA*, Δ*RA*, and observed MR ratio (MR_{obs}).

Reference

1) T. M. Nakatani. *Spin-dependent scattering in CPP-GMR using Heusler alloy and the selection of the spacer material*. Ph. D. Thesis. University of Tsukuba (2011).
2) Jung *et al*., Appl. Phys. Lett. **108**, 102408 (2016).