Magneto-transport and microstructure properties of $Co_2Fe(Ga_{0.5}Ge_{0.5})$/Cu lateral spin valves

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As the areal density of hard disk drives (HDDs) has been expected to go beyond 2 Tbit/inch^2 for the next 10 years[1)], very narrow read heads with reliable performance would be strongly desired. With regards to this issue, lateral spin valves (LSVs) have been proposed to be one of candidates for very narrow read head applications. Since the two ferromagnetic layers in LSVs are laterally separated, very narrow shield-to-shield spacing is expected to be realized in this structure. However, as for all-metallic LSVs with ohmic contacts, the output voltage is much smaller than that of vertical magnetoresistive devices such as current-perpendicular-to-plane giant magnetoresistance (CPP-GMR) and magnetic tunnel junctions (MTJ). Based on one dimensional spin diffusion model[2)], one of the recipes to effectively ehance the output voltage of LSVs is to utilize highly spin polarized ferromagnets. In this meeting we will present our recent effort on the development of all-metallic LSVs utilizing $Co_2Fe(Ga_{0.5}Ge_{0.5})$ (CFGG) Heusler alloy exhibiting high spin polarization.

The starting multilayer stack of MgO (001) sub./Cr (1nm)/Ag (10nm)/CFGG (20nm)/Cu (20nm)/ MgO (2nm) was prepared by ultra-high vacuum magnetron sputtering system. After the deposition of CFGG film, the whole stack was annealed at 500°C to promote the B2 ordered structure of the CFGG film. The multilayer stack was then microfabricated into LSV devices with sub-micron scale dimension of CFGG ferromagnetic wires and Cu metallic channels. The scanning transmission electron microscopy observation on a representative LSV device confirmed the clean interface of CFGG/Cu contacts. At room temperature, a very large non-local spin signal (ΔR_S) of 17.3 mΩ was observed for a LSV device with center-to-center CFGG wires distance of 350 nm (Fig. 1). The fitting based on one dimensional model (Fig. 2) suggests that both high spin polarizations of CFGG film (P_F) and CFGG/Cu interfaces (P_J) contribute to the large non-local spin signals observed in this system.

References
1) “Status and Outlook”, *ASTC Fall 2013 Meeting*, Biltmore Hotel, Santa Clara, California, September 27, 2013.
2) S. Takahashi and S. Maekawa, *Phys. Rev.B*, 67, 052409 (2003).

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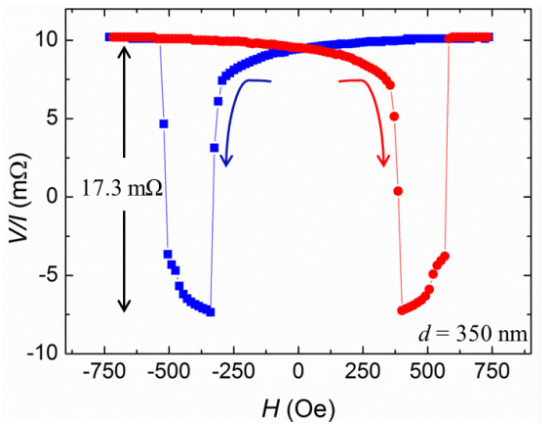

Figure 1. The non-local resistance change (V/I) of a a LSV device exhibiting spin signal of 17.3 mΩ at room temperature.

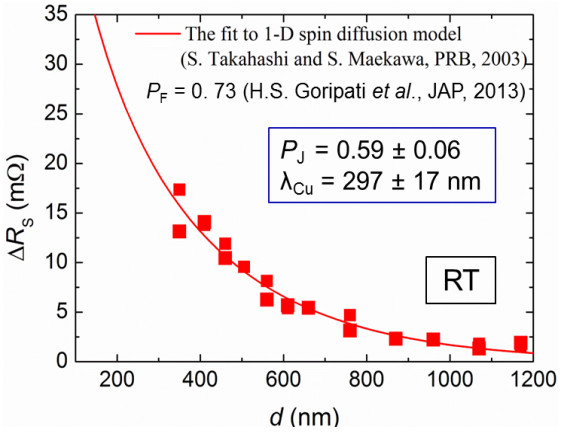

Figure 1. The non-local spin signals (ΔR_S) as a function of CFGG-wires distances measured at room temperature. The red line corresponds to the best fit based on one dimensional spin diffusion model.