Electrical spin injection in Co_2MnGa based all-metallic lateral spin valves

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Co-based Heusler alloys have been intensively investigated in the recent years due to their promising properties desired to a spintronic devices application, such as the half-metallic nature of their electronic structure, the high Curie temperature and a low damping parameter [1]. In particular, Co_2MnGa is a ferromagnetic compound predicted to be a type III half-metal [2], where the majority and minority spin electrons are itinerant and localized, respectively. It also has a special feature of high resistance to oxidation [3], which is important for a device application. Although some studies about spin injection using this material have been reported [4], none of them implemented electrical spin injection using a spin-valve-structure.

In this work, all-metallic lateral spin valve devices using Co_2MnGa as a spin injector are investigated. The spin valve devices shown in Fig. 1 were fabricated starting from Co_2MnGa thin films epitaxially grown on MgO crystalline substrates. The Cu/Co_2MnGa interface quality was clarified to be critical and was carefully optimized in the fabrication process. The spin transport properties were studied through a non-local 4-four-terminal voltage measurement with in-plane application of an external magnetic field and Hanle effect measurements with an out-of-plane application of the magnetic field. The temperature (Fig. 2) and channel length dependence of spin signals were characterized and analyzed using the one dimensional spin diffusion model, estimating the spin polarization of the Heusler alloy and the spin diffusion length and diffusion constant for the Cu channel. Final results and further detail will be discussed in the presentation.

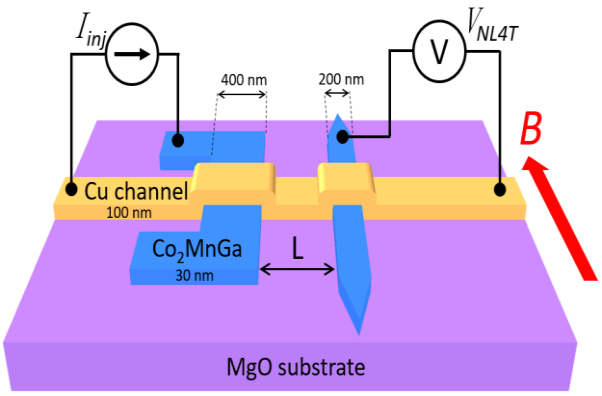

Figure 1: Scheme of the metallic lateral spin valve devices using non-local 4 terminal voltage measurement with in-plane-field configuration.

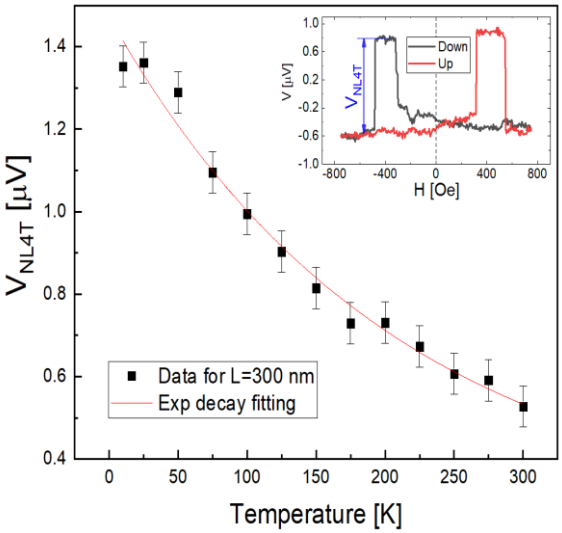

Figure 2: Temperature dependence of non-local spin signal amplitude for a channel length of 300nm. Inset graph shows a typical measurement of voltage as a function of in-plane magnetic field, where the spin signal amplitude V_{NL4T} can be identified.

References:

[1] T. Kubota, S. Tsunegi, M. Oogane, S. Mizukami, T. Miyazaki, H. Naganuma, and Y. Ando, Appl. Phys. Lett. **94**, 122504 (2009)

[2] Spintronics: From Materials to Devices, edited by C. Felser and G. H. Fecher (Springer Science & Business Media, 2013), p. 136.

[3] B. M. Ludbrook, B. J. Ruck, and S. Granville, Appl. Phys. Lett. **110**, 062408 (2017)

[4] C. D. Damsgaard, M. C. Hickey, S. N. Holmes et al., Journal of Applied Physics **105**, 124502 (2009)