Influence of non-magnetic layers at $Co_2FeAl_{0.5}Si_{0.5}$/Ge interface on spin injection/detection efficiency

[1]GSES, Osaka Univ., [2]JST PRESTO, [3]GSE, Osaka Univ.,
[4]CSRN, Osaka Univ., [5]Tokyo City Univ.,
°R. Nishimura[1], T. Naito[1], M. Yamada[2,1], A. Masago[4], Y. Shiratsuchi[3,4],
R. Nakatani[3,4], K. Sawano[5], T. Oguchi[4], and K. Hamaya[4,1]
E-mail: u246369d@ecs.osaka-u.ac.jp

Recently, we reported that spin injection/detection efficiency at room temperature was significantly enhanced by inserting Fe atomic layers into $Co_2FeAl_{0.5}Si_{0.5}$ (CFAS)/Ge interface because suppression of Ge outdiffusion and efficient spin injection via band-symmetry matching effect are simultaneously demonstrated [1]. Also, we found that ferromagnetism near the interface just on top of Ge is strongly related to the spin injection/detection efficiency [2]. Here, we explore the spin injection/detection phenomena through the CFAS/Ge interface having non-magnetic metal (NM: Cr, V, Cu) layers.

Using low temperature molecular beam epitaxy (LT-MBE), we grew CFAS(~8 nm)/NM(~3 AL)/Fe(~3 AL) multilayers on an *n*-Ge layer, where Fe(~3 AL) was inserted on top of Ge to suppress the outdiffusion of Ge and to induce epitaxial growth of the CFAS layer. To measure two-terminal local (ΔR_L) and four-terminal nonlocal (ΔR_{NL}) spin signals, we fabricated lateral spin-valve (LSV) devices with various insertion layers (Cr, V, and Cu), as shown in Fig. 1(a). Although local and nonlocal spin signals are observed for all the devices at low temperatures, the value of ΔR_L for each LSV device is markedly different, as shown in Fig. 1(b). For the LSV device with Cr, the value of ΔR_L at 8 K is three orders of magnitude smaller than that for a device with Fe [1]. Therefore, even the insertion of few atomic layers of Cr, V, and Cu can drastically change the spin injection/detection efficiency at the CFAS/Ge interface. We will discuss possible mechanisms by using structural, magnetic characterizations, and theoretical calculations.

This work was supported in part by JSPS KAKENHI (Nos. 19H05616 and 17H06120), JST PRESTO (No. JPMJPR20BA), and the Spintronics Research Network of Japan (Spin-RNJ).

[1] M. Yamada *et al*., NPG Asia Mater. **12**, 47 (2020).
[2] M. Yamada *et al*., J. Appl. Phys **129**. 013901 (2021).

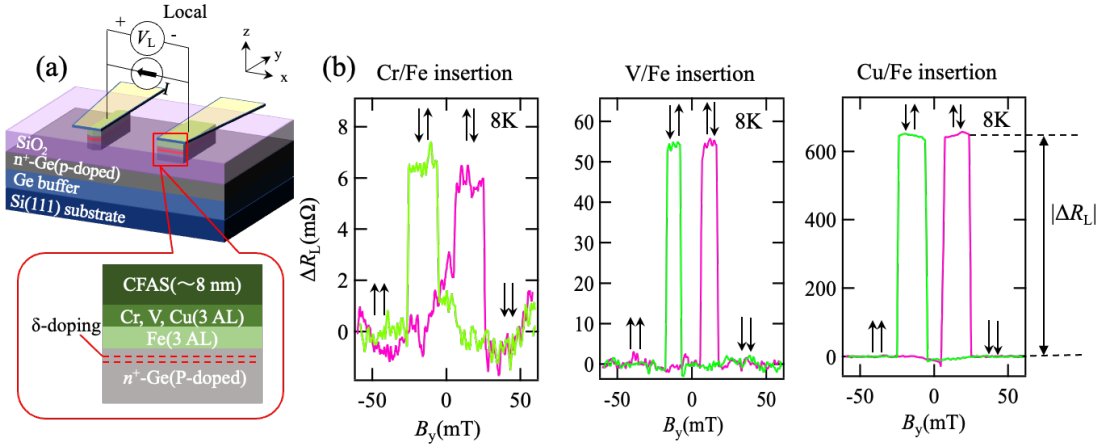

Fig. 1(a) Schematic of the fabricated LSV devices with NM insertion at the CFAS/Ge interfaces. (b) Two-terminal local spin signals measured at 8K for LSV devices with Cr/Fe, V/Fe, and Cu/Fe insertion layers.