Enhancement of room-temperature spin signals in Ge lateral spin devices by improving the quality of Heusler/Ge interfaces

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Highly efficient spin injection/detection is one of the most important technologies to achieve semiconductor spintronic devices. Recently, we have reported nonlocal (NL) and local spin signals at room temperature even in *n*-Ge lateral spin valve (LSV) devices by using Heusler-alloy $Co_2FeAl_{0.5}Si_{0.5}$ (CFAS) contacts [1,2]. However, the spin signals and magnetoresistance (MR) ratio are still small due to the fluctuation of atomic composition in CFAS near the interface [2,3]. In this study, we demonstrate a marked enhancement of spin signals by improving the quality of CFAS/Ge interfaces for spin injection/detection.

LSV devices with CFAS/Fe/n^+-Ge Schottky tunnel contacts were fabricated, where we controlled the Fe atomic-layer thickness inserted into the interface between CFAS and *n*-Ge. Figures 1 (a) and 1(b) show HAADF-STEM images of the CFAS/Ge interface with and without inserting Fe atomic layer (5ML Fe) in LSV devices. For no insertion of 5ML Fe, the fluctuation of atomic composition in the CFAS layer near the interface can be observed [Fig.1 (a)]. On the other hand, for the CFAS/Ge interface with inserting 5ML Fe, we can demonstrate homogeneous and chemically abrupt CFAS/Ge interface [Fig.1 (b)]. The inserted Fe atomic layer can suppress the Ge out-diffusion into CFAS, which can reduce the interface spin polarization [3]. Figure 1(c) shows NL spin signals at 296 K for LSV devices with and without inserting 5ML Fe. For the LSV with 5ML Fe, the NL spin signal is significantly enhanced to ~18 mΩ [4], which is ~60 times larger than that in previous one [1].

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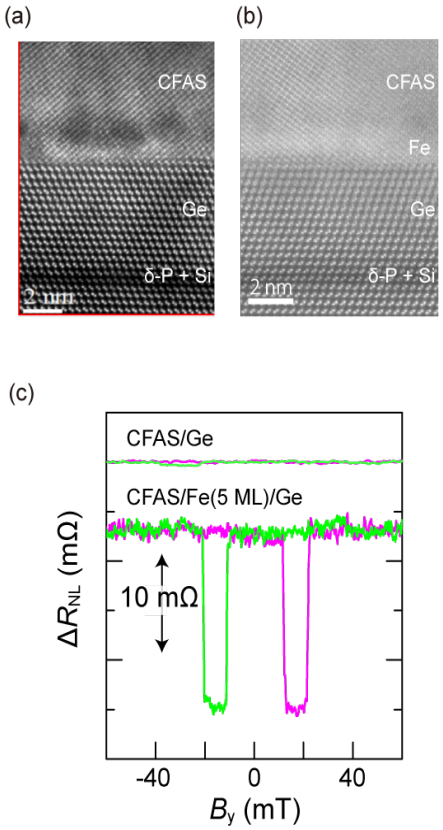

Fig. 1: HAADF-STEM images of $Co_2FeAl_{0.5}Si_{0.5}$ (CFAS)/n^+-Ge (a)with [3] and (b)without inserting 5ML Fe. (c) Nonlocal magnetoresistance curves at 296 K for LSVs with and without inserting 5ML Fe.

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