

Influence of external temperature on interface spin polarization of ferromagnet-semiconductor heterostructures

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Understanding an influence of external temperature on the magnetoresistance effect in spintronics devices is essential for practical applications above room temperature. Unfortunately, there are few reports on the verification of the temperature dependence of interface spin polarization of ferromagnet (FM)-semiconductor (SC) heterostructures because of the relatively small spin signals in SC-based device structures. In this study, we investigate the temperature dependence of the interface spin polarization of FM/SC heterostructures for SC-based lateral spin-valve (LSV) devices with various FM/SC interface conditions.

To examine the spin polarization of FM-SC heterointerfaces, we fabricated LSV devices with $\text{Co}_2\text{FeAl}_{0.5}\text{Si}_{0.5}$ (CFAS)/Fe/Ge Schottky tunnel junctions [1], where the number of the inserted Fe atomic layers was changed to zero (Fe_0), two-three (Fe_2), five-six (Fe_5), and ten (Fe_{10}), as shown in Figs.1(a) and (b). Figure 1(c) indicates that the controlled interface condition enables us to change the magnitude of local spin signals. Figure 1(d) shows temperature dependence of the interface spin polarization (γ) for the LSVs with various Fe atomic layers. The decay of γ is improved for the LSV device with Fe_5 and Fe_{10} and can be well fitted by the $T^{3/2}$ law. Thus, for the high-quality FM-SC interfaces, the temperature evolution of γ can be interpreted in terms of a model of the thermally excited spin waves in FM electrodes [2], similar to the case of magnetic tunnel junctions [3].

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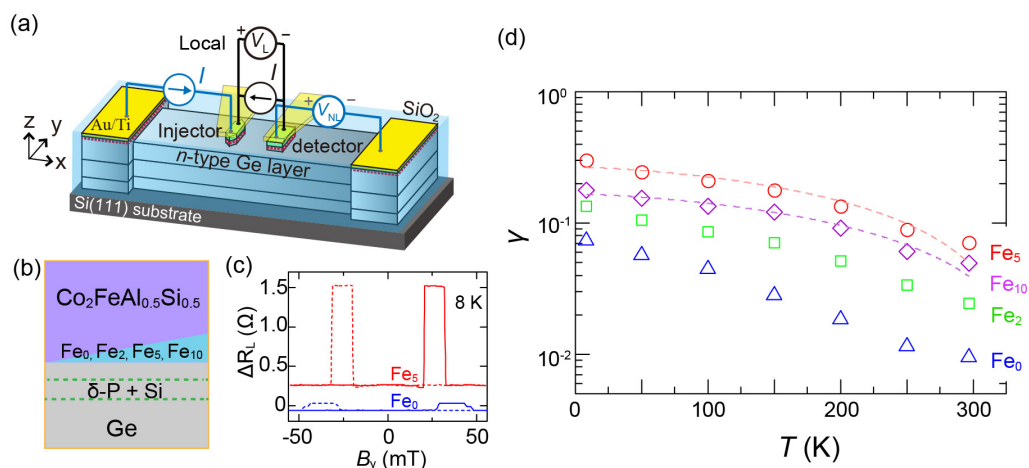


Fig. 1 (a) Schematic of a fabricated lateral spin-valve (LSV) device. (b) Illustration of the cross-section of the injector and detector for $\text{Co}_2\text{FeAl}_{0.5}\text{Si}_{0.5}/\text{Ge}$ with various Fe atomic layers. (c) Local spin signals for the LSV devices with Fe_0 and Fe_5 . (d) Temperature dependence of the interface spin polarization (γ) of FM-SC heterointerfaces.

References

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