Effect of post annealing on spin accumulation and transport signals in Co_2FeSi/MgO/n^+-Si on insulator devices

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In order to realize the Spin-MOSFET, highly efficient spin injection and detection in ferromagnetic metal (FM)/insulator (I)/semiconductor (S) junction are necessary. The efficiency of spin injection and detection depends on the spin polarization of the FM, the spin selectivity of the tunnel barrier, and the conductivity matching condition [1]. It is also predicted that spin injection efficiency must increase with increasing spin polarization of FM electrodes [2]. Recently, our group reported that Heusler alloy (Co_2FeSi) shows better spin polarization as compared with CoFe ferromagnet [3]. To confirm the robustness of our device, the post annealing temperature (T_A) dependence on spin accumulation and transport signals in Co_2FeSi/MgO/n^+-Si on insulator were investigated. The 4-terminal devices with Co_2FeSi/MgO electrodes on phosphorous-doped (~1.5×10^{19} cm^{-3}) (100)-textured Si on insulator substrates were prepared [4] and T_A dependences of local-MR and nonlocal-MR and Hanle signals were investigated.

Figure 1 shows the resistivity changes of ΔR_{Local} and $\Delta R_{Nonlocal}$ observed by measuring local-MR and nonlocal-MR signals, respectively. As shown in Fig. 1, both signals have slight maximum at around 350°C. The changes in spin signals with annealing temperature are very small. The 3-terminal narrow Hanle signals also follows the same behavior (not shown), whereas in the case of spin signals using GaAs substrates with half metallic system, inconsistent behavior between nonlocal-MR and 3 terminal Hanle signals was reported [4]. This indicates the 3-terminal narrow Hanle signals are intrinsic signals in the case of Si. In this study, we would like to show the details of the experimental data and to discuss about the reason of the maximum observed in the T_A dependences of the spin signals.

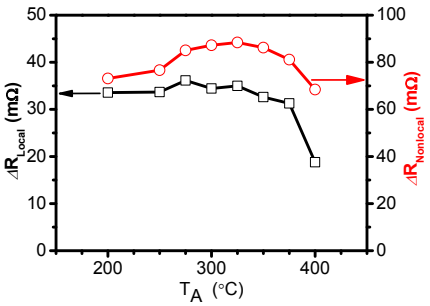

Fig. 1. The ΔR_{Local} and $\Delta R_{Nonlocal}$ as function of annealing temperature (T_A) measured at 20 K.

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References

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