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Magnetotransport properties of vertical spin valves of graphene/cobalt junctions

グラフェン/コバルト接合を用いた縦型スピンバルブ素子の磁気伝導特性

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Graphene attracts much attention as the most promising material for realizing molecular spintronic devices. In the graphene spintronic devices, the controls of the spin injection and ejection processes at the interfaces between graphene and ferromagnetic metal electrodes are crucial for the device operation. Karpan et al. theoretically demonstrated that graphene/Ni(111) and graphene/Co(0001) junctions could be a perfect spin filter due to the absence of the majority spin states on the Fermi surfaces of Ni(111) and Co(0001) near the K point of graphene [1]. Meanwhile, experimental studies have reported a small magnetoresistance (MR) effect for the vertical graphene spin valves of graphene/ferromagnetic metal junctions [2, 3].

In this work, magnetotransport properties of graphene spin valves were investigated for the vertical Co/graphene/Co devices with a current-perpendicular-to-plane configuration. The devices were fabricated by inserting layer-controlled graphene, which were grown by chemical vapor deposition, between two ferromagnetic electrodes of Co thin films. Linear current-voltage characteristics were observed for all the devices with different layer numbers of graphene, indicating that Ohmic transport in graphene is dominating rather than tunneling transport. A positive MR was commonly observed for a series of the Co/graphene/Co devices at room temperature. The MR ratios were 0.1-0.2% and 0.7-0.8% for the single-layer graphene and tri-layer graphene devices, respectively. Our previous Raman analyses [4] demonstrated that the chemical interactions between grapehene and Co at the graphene/Co interfaces are different depending on the layer number of graphene, and those at the single-layer graphene/Co interface are much stronger than those at the multi-layer graphene/Co interfaces. It is reasonably speculated that the spin injection and ejection efficiencies are reduced in the single-layer graphene device involved with the strong chemical interactions which could modify the electronic states of graphene and Co around the Fermi level, significantly different from the pristine states ideal for the spin filtering.

References

[1] Karpan et al., Phys. Rev. Lett. 99 (2007) 176602.

[2] T. M. G. Mohiuddin et al., IEEE Trans. Magn. 33 (2008) 2624.

[3] M. Z. Iqbal et al., Nano Res. 6 (2013) 373.

[4] S. Entani et al., J. Phys. Chem. C 114 (2010) 20042.