Magnetotransport properties of graphene directly grown on permalloy in CPP configuration

パーマロイ上のグラフェン成長および磁気伝導特性

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Graphene attracts much attention as the most promising material for realizing molecular spintronic devices. In the graphene spintronic devices, the control 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 were studied for the vertical spin valve devices with two junctions of permalloy electrodes and a few-layer graphene interlayer. The graphene layer was directly grown on the bottom permalloy electrode by chemical vapor deposition. X-ray photoelectron spectroscopy showed that the permalloy surface fully covered with a few-layer graphene is kept free from oxidation and contamination even after dispensing and removing photoresist. This enabled fabrication of the current perpendicular to plane spin valve devices with a well-defined interface between graphene and permalloy. Spin-dependent electron transport measurements revealed a distinct spin valve effect in the devices (Fig.1). The magnetotransport ratio was 0.8% at room temperature and increased to 1.75% at 50 K. Linear current-voltage characteristics and resistance increase with temperature, indicating that ohmic contacts are realized at the relevant interfaces.

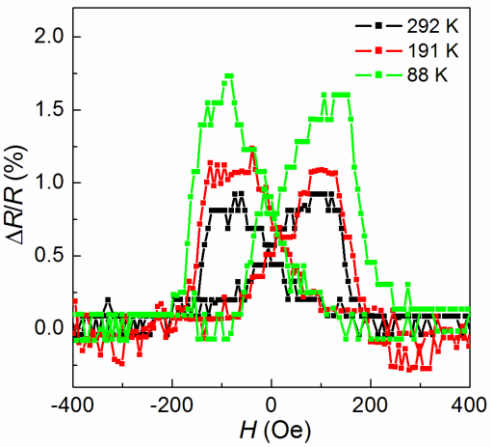

Fig.1: Magnetoresistance ratio of the few-layer graphene spin valve as a function of magnetic field at 88 K, 191 K and 292 K.

[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. Iabal et al., Nano Res. 6 (2013) 373.