Study of spin injection into few-layer graphene

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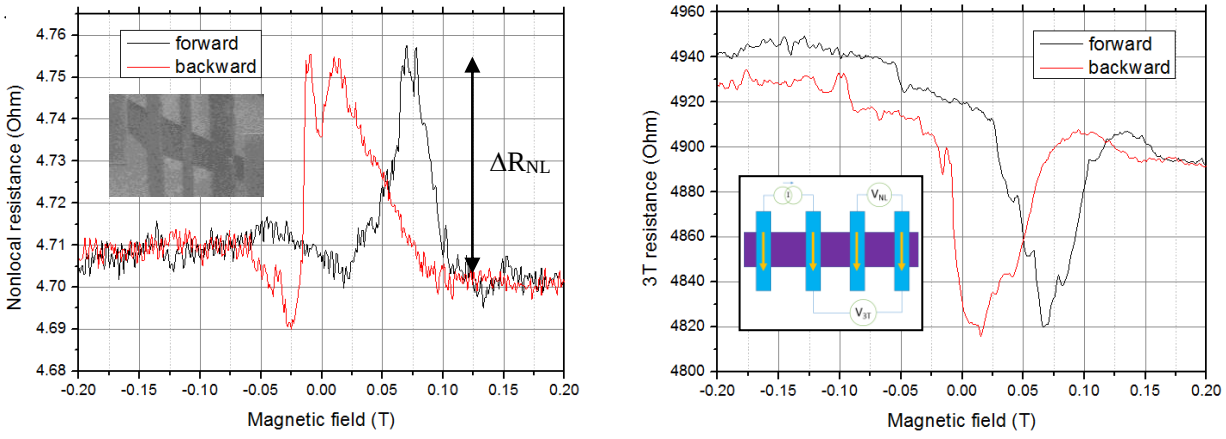
Recently, spin injection from ferromagnetic electrodes to a high quality graphene layer is shown to be a promising approach for spintronics [1]. However, the spin injection efficiency, the quality of the FM/graphene interface etc. remain as critical issues due to the fact that an observed spin life time is still short compared to theoretical predictions (~2 orders shorter) [2]. In fact, the spin injection from ferromagnetic (FM) metal into graphene strongly depends on the spin relaxation rate because of the backflow of spin currents into ferromagnetic electrodes. In order to increase the spin injection, the spin backflow into electrodes needs to be controlled by alternating the tunnel resistance very precisely. Therefore, this study focuses the spin injection into few layer graphene by controlling the tunnel resistance.

Following the most standard configurations of spintronic devices used to evaluate the spin injection from FM/Graphene and spin transport in the graphene channel have been proposed so far in literature, we employed the so-called nonlocal and three-terminal measurement geometries to fabricate devices (the inset to Fig. 1 (b)). We report the tunneling spin injection from Co into tri-layer graphene via the TiO_2 seeded Al_2O_3 barrier. A high-quality tunnel barrier Al_2O_3 was grown by atomic layer deposition (ALD). The TiO_2 seed significantly improves the uniformity of ALD Al_2O_3. A nonlocal magnetoresistance (ΔR_{NL}) of nearly 50 mΩ was observed at 1.5K (Fig. 1a). A three-terminal magnetoresistance (R_{3T}) was also observed at 1.5K (Fig. 1b). A comparison of spin injection into tri-layer graphene with various tunnel barrier resistances will also be discussed.



(a) (b)

Fig. 1 a) Nonlocal spin-valve signal measured at 1.5K using the injection current of I = 1 μA. The sweep directions of the in-plane magnetic field are indicated by black (forward) and red (backward). Inset: the SEM image of a multi-terminal spin-transport device showing a graphene flake contacted by TiO_2/Al_2O_3/Co electrodes. b) 3T – anisotropic magnetoresistance measured at 1.5K. Inset: nonlocal and 3T measurement configurations.

[1] P. Seneor, et al, MRS Bulletin, 37, 1245-1254, 2012.

[2] Wei Han, et al, PRL, 105, 167202, 2010.