Electric-field controlled giant spin-injection efficiency and local spin-valve effect in hBN/graphene/hBN van der Waals heterostructures

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We describe a new means for enhancing electrical spin-injection efficiency and demonstrate local spin-valve effect with a large giant-magnetoresistance (GMR) ratio in graphene, at room temperature. We studied spin transport in fully hexagonal boron nitride (hBN) encapsulated graphene van der Waals heterostructure with ferromagnetic cobalt electrodes[2]. Our state-of-the-art device structure consists of monolayer-graphene, completely encapsulated between a top layer of bilayer-hBN, which also acts as a tunnel barrier for spin injection into graphene from the ferromagnetic cobalt electrodes, and a bottom layer of thick-hBN as a substrate. Here, we present electric-field controlled spin-injection in cobalt/bilayer-hBN/graphene contacts with a giant polarization (P) up to ±40 % at the positive bias of +0.3 V and up to ∓80 % at the reverse bias of -0.3 V, which unveils the potential of bilayer-hBN tunnel barriers for graphene spintronic applications. With the enhanced spin-injection polarization, we demonstrate two-probe local spin-valve effect up to an about 800 Ω spin signal and 3 % GMR ratio, which has significant implications for future spin-valve devices. The observed modulation and inversion of polarization is interpreted via a possible electric-field control of spin-filtering across the cobalt/bilayer-hBN/graphene interfaces.

References

[1] M. Gurram *et.al.*, to be submitted.
[2] M. Gurram *et.al.*, *Phys. Rev. B* 93, (2016) 115441.

Figures

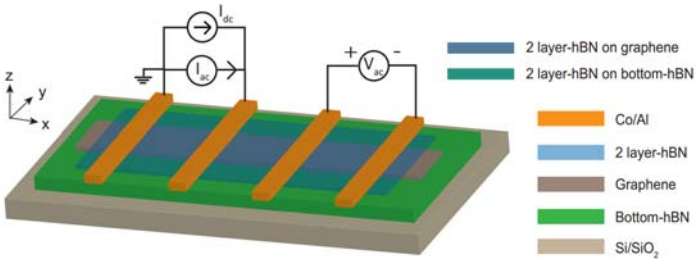

Figure 1: Schematics of the van der Waals heterostructure and the non-local spin-transport measurement geometry.

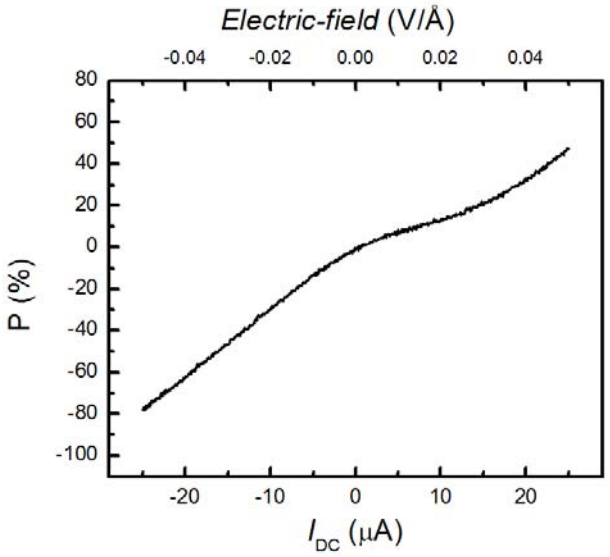

Figure 2: Change in the magnitude and sign of the spin-injection polarization of a cobalt/bilayer-hBN/graphene contact as function of the applied bias current (bottom x-axis) and the corresponding electric field across the contact (top x-axis), showing giant spin-injection efficiency.