Voltage-controlled inversion of tunnel magnetoresistance in epitaxial Nickel/Graphene/MgO/Cobalt junctions: a signature of the hybridized Graphene|Ni interface.

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Abstract

The large spin filtering effect predicted at graphene/Nickel(111) interface [1] has recently driven major effort to build and characterize current perpendicular to plane (CPP) spin valve based on graphene [2,3]. Here, we will report the fabrication of epitaxial CPP spinvalves based on CVD graphene directly grown on top of Nickel electrode [4], and we will present a detailed study of their electrical and spin filtering transport properties.

Epitaxial growth of electrodes and *tunnel barriers* on *graphene* is one of the main technological challenge for graphene spintronics. We will first report recent results of our group, demonstrating that Molecular Beam Epitaxy can be used to grow (111) oriented MgO tunnel barrier and ferromagnetic electrodes over CVD and also epitaxial graphene [4,5]. We will then focus our attention on.oriented epitaxial stack made of a 2.6 nm thick (111)MgO barrier covered by a (111) Cobalt top electrode. X-Ray Diffraction (XRD) characterizations were performed to confirm the (111) orientation of MgO and ferromagnetic layers and their crystalline quality (Fig.1.a). XPS measurements (Fig.1.b) also reveal the absence of oxidation of the bottom Nickel electrode, confirming its passivation by the protecting graphene layers, and doing so, the unique properties offered by Graphene Protected Ferromagnetic Electrode (GPFE) for spintronics applications [3].

Finally, we present detailed transport measurements performed on epitaxial (111)-oriented GPFE/MgO/Co magnetic tunnel junctions. We observe efficient magnetoresistance signals on junctions of active area ranging from 1µm^2 up to 1000µm^2, with a resistance-area product in the range of 10-100 MΩ.µm^2 confirming the good quality of the barrier. By the variation of the applied bias voltage across the junction, a reproducible, robust and scalable bias dependence is observed. These findings are explained by a model of phonon-assisted transport mechanisms that relies on the peculiarity of the band structure and spin density of states at the hybrid graphene|Ni interface [1,4]. More generally, our work demonstrates that tailoring the tunneling spin polarization of well-known transition metals through hybridization with two-dimensional overlayers provides opportunities for realizing new spin injectors with unique bias-dependent properties.

References

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