Magnetic properties of Graphene/Cobalt and Gold/Cobalt interfaces

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The coupling of a ferromagnet (FM) with 2D materials appears as a promising route for future spintronic [1]. Interface effects in FM/2D materials can occur through interfacial interactions such as for perpendicular magnetic anisotropy (PMA) which is one of the most important properties of magnetic materials [2]. Indeed, its tunability is essential to enhance the performance of spintronic devices [3].

We studied the coercive field H_c and magnetic anisotropy behaviors in Co/Gr interface (CoGr) compared to the reference Au/Co (AuCo) interface. The Gr is prepared by chemical vapor deposition, then transferred to Si/SiO_2 substrates and recovered by Co film with thickness (t_{Co} = 2 and 3 nm) and Au capping layer using physical vapor deposition. The quality of synthesized graphene was controlled by Raman spectroscopy. We observed the G and 2D bands characteristics of graphene and the D band related to defects and disorder [4]. The intensity ratio I_D/I_G was found to be sensibly lower than 0.1, for all the samples, indicating very low concentration of defects in graphene. Moreover, the ratio I_{2D}/I_G was found larger than 1.3 indicating that graphene is monolayer [5]. The Gr domain sizes were found to decrease when the t_{Co} increases, that could indicate modification of optical properties by Co deposited layer. From Magneto-Optic Kerr Effect hysteresis loops, we observed, for a given thickness, an increase of H_c in presence of graphene. This could be indication that the reversal of magnetization in cobalt is dominated by domain wall propagation, with pinning at Gr domains boundaries.

The effective magnetization, $\mu_0(M_s - H_a)$, M_s being the saturation magnetization and H_a the anisotropy field, was studied by means of Brillouin light scattering (BLS) technique that allows investigating the spin waves (SWs) thermally excited and propagating within the samples. The SWs frequencies are found higher for the GrCo interfaces comparing to the AuCo ones, indicating that the effective magnetization is higher in presence of graphene. One can conclude, at first glance, that the magnetic anisotropy for the GrCo interfaces is a little smaller but comparable to the AuCo ones. Such behavior is encouraging for research in graphene spintronic.

[1] W. Han, R. K. Kawakami, M. Gmitra, J. Fabian, Nat. Nanotech. 9, (2014) 794.
[2] N. Rougemaille, A.T. N'Diaye, J. Coraux, C. Vo-Van, O. Fruchart, A.K. Schmid, Appl. Phys. Lett. 101, (2012)142403.
[3] S. S. P. Parkin, M. Hayashi, L. Thomas Eason, Science 320, (2008)190.
[4] M.S. Poorali, M.M. Bagheri-Mohagheghi. J. Mat. Sci: Mat. Elect. 28, (2017) 6186.
[5] Y. Bleu, F. Bourquard, A-S. Loir, V. Barnier, F. Garrelie, C. Donnet, J. Raman Spectrosc. 50, (2019)1630.