Emergent Spin-Orbit Related Phenomena in Intercalated Graphene

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Graphene is a material that has a negligible Spin-Orbit Coupling (SOC) in its pristine state. However, the intercalation of adequate metals (e.g. Pb underneath gr/Ir(111)) can transfer to graphene a giant SOC [1] of the order of 80 meV, as demonstrated by first principle calculations, STM and spin-resolved ARPES [2].

Graphene can be intercalated with ferromagnetic metals (e.g. Cobalt) becoming n-doped and with an intense electrical field at the gr/Co interface. This, rather unexpectedly, originates a giant chiral Dzyaloshinskii Moriya Interaction (DMI) at the gr/Co interface that, in addition to the SOC-induced DMI at the Co/Pt interface, creates in a chiral spin texture in gr/Co(111)/Pt(111) layered heterostructures grown epitaxially on MgO(100) [3]. The discovery of a strong DMI at the Graphene/Cobalt interface is a crucial step to promote 2D materials spin-orbitronics based on the electrical control of the transport and manipulation of topologically protected magnetic structures, such as chiral domain walls and skyrmions.

References

[1] F. Calleja et al, Nature Physics **11**, 43–47 (2015).

[2] M.M. Otrokov et al, (to be published)

[3] P. Perna et al (Nature Materials to be published)

[4] A. Fert, V.Cros and J. Sampaio, Nat. Nanotech. 8, 152–156 (2013).

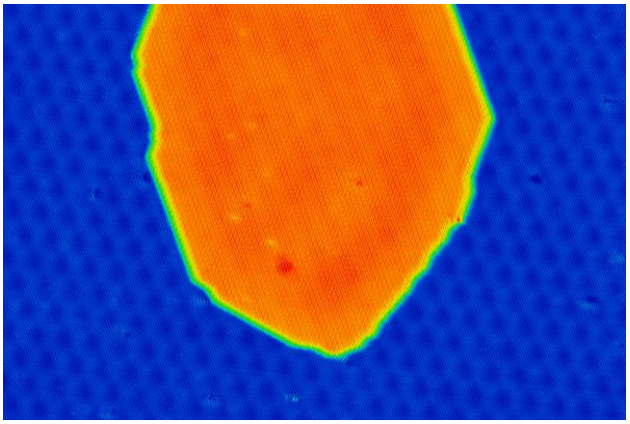

Figure 1: STM image of graphene/Ir(111) with a monolayer of Pb intercalated below graphene.

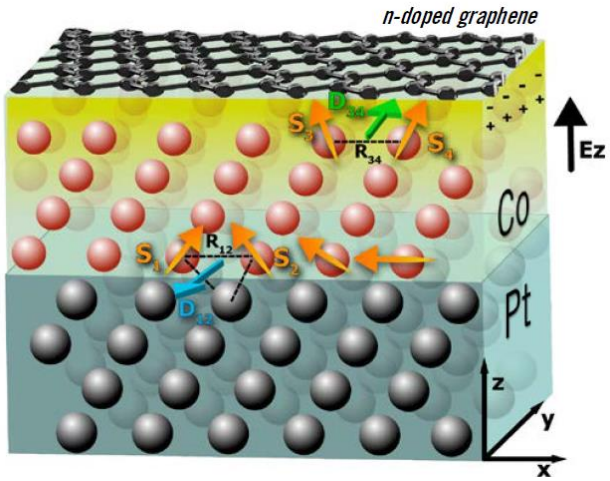

Figure 2: Sketch of the interplay between Spin-Orbit Coupling-induced Dzyaloshinskii Moriya Interaction (DMI) at the Co/Pt and opposite Rashba-type DMI at the gr/Co interfaces.