Spin-orbit torques in MoS_2-graphene based heterostructures

Regina Galceran[1]
Marius V. Costache[1], Juan F. Sierra[1], Subir Parui[2], Kevin Garello[2], Frédéric Bonell[3], Sergio O. Valenzuela[1]
[1] *Institut Català de Nanociència i Nanotecnologia (ICN2), Campus de la Universitat Autònoma de Barcelona, Av. de Serragalliners, s/n, 08193 Bellaterra, Spain*
[2] *IMEC, Kapeeldreef 75, 3001 Leuven, Belgium*
[3] *SPINTEC, Univ. Grenoble Alpes, CNRS, CEA, 17 rue des Martyrs 38054 Grenoble, France*
regina.galceran@icn2.cat

The reversal of the magnetization using electrical currents has great potential in applications, such as magnetic memories, to tackle the challenges of increased power consumption and the limitations in the continued miniaturization of devices. Of great promise is the use of the phenomenon known as charge-to-spin conversion through the spin-orbit torque (SOT). This consists in a charge current that is converted into a transverse spin accumulation (taking advantage of the spin-orbit coupling in materials or at interfaces), which in turn creates a torque on the magnetization. For large enough torques, the electric switching of the magnetization is achieved, opening a path for the next generation of devices with improved efficiency and much lower power dissipation.

In this work, we study the charge-to-spin conversion in heterostructures containing 2D materials. In particular, we measure the spin-orbit torque ferromagnetic resonance (SOT-FMR) in MoS_2/Al/ferromagnet stacks, with Al layers of different thickness (0 to 10nm), and also study the effect of the introduction of graphene between the MoS_2 and the Al. The introduction of a metallic or graphene layer at the interface between MoS_2 and the ferromagnet is expected to be advantageous to prevent the diffusion of volatile elements into the ferromagnet. Additionally, the proximity effect in graphene/MoS_2, already demonstrated in lateral devices [1], is expected to lead to a charge-to-spin conversion efficiency close to unity and to rich spin textures [2].

References

[1] L.A. Benítez et al., Nature Physics 14, (2018) 303
[2] M. Offidani et al. Phys. Rev. Lett, 119 (2017) 196801

Figures

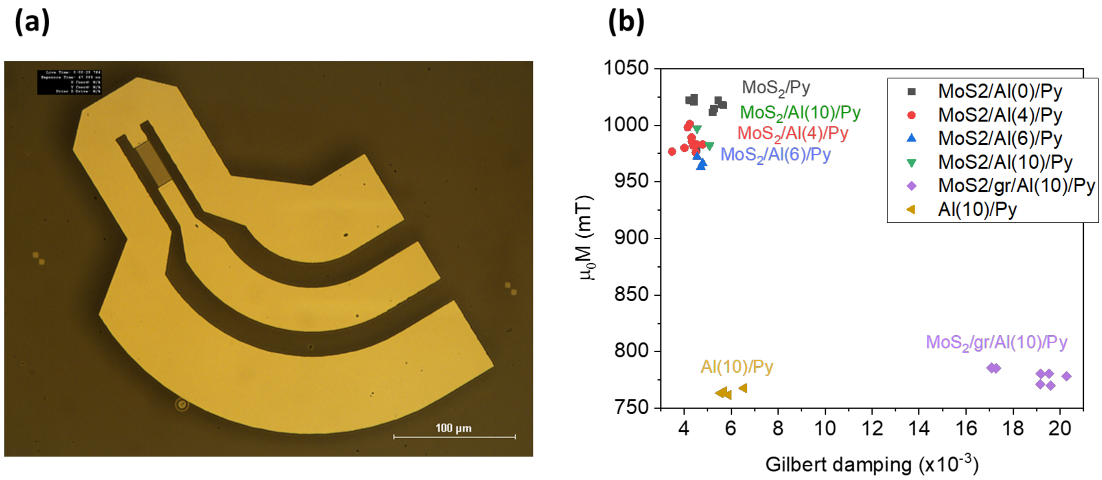

Figure 1: (a) Image of a coplanar waveguide used for SOT-FMR measurements; (b) Graph comparing the magnetization and Gilbert damping parameter of different tested devices (of different tested structures), both extracted from SOT-FMR.