Spin-orbit torques in topological insulators of the Bi_2Te_3 family of materials

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Van der Waals (vdW) heterostructures, including those comprising topological insulators (TIs) of the Bi_2Te_3 family of materials, have disruptive potential for magnetic random access memory applications [1]. The boundary states of a TI can generate a non-equilibrium spin density that can be used to control the magnetization of a ferromagnet (FM) by means of the spin-orbit torques (SOTs), and recent reports have demonstrated large SOT efficiencies. However, to identify the microscopic mechanisms at play, as well as to maximize the SOT, a deep understanding and control of the properties of the TI/FM interface is needed. In this talk, I will first introduce the potential advantages of vdW heterostructures and, in particular, of TIs for non-volatile spintronics memories. I will then describe the relevance of their boundary states and of preserving the quality of the TI/FM interface. I will show that the introduction of a (non-magnetic) metallic [2] or graphene [3] interlayer between the TI and the FM, when FM is a transition metal, can notably suppress Te diffusion into the FM and change the nature of the SOT and its efficiency [2]. Finally, I will argue that the discovery of vdW FMs, which can be grown as high-quality thin films [4,5], can further improve the TI/FM interface, as the weak vdW interaction beween the TI and the vdW FM can limit chemical reactions, intermixing and electronic hybridization. Our recent results using Fe_3GeTe_2 demonstrate large SOTs and magnetization switching with currents densities about 10^{10} A/m^2 [6].

References

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