Spin-orbit torques in topological insulator - two-dimensional ferromagnet heterostructures

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Topological insulators (TI) have gained much interest in the field of spintronics for the generation of pure spin currents. Indeed, three-dimensional TIs are predicted to host exotic properties like topologically protected surface states (TSS), which show Dirac-like band dispersion and spin-momentum locking [1]. One of the main strategies is to take advantages of the spin polarization of the TSSs to manipulate the magnetization of an adjacent ferromagnetic thin film (FM) using the spin-orbit torque (SOT) mechanism [2]. In the past few years, the community attempted to replace the traditional heavy metals by a TI in order to enhance the SOT efficiency with limited success. It now appears that the interface sharpness and the high chemical affinity between Bi-based TIs and classical *3d* FMs is a major hurdle to reach the predicted breakthrough in magnetization switching power-efficiency [3]. The emergence of ferromagnetism in two dimensions in 2017, which started a new field in condensed matter physics, could bring a solution to this issue. The van der Waals (vdW) nature of the interaction between the TI and the 2D-FM should limit chemical reactions, interface intermixing and hybridization of state between the two layers.
Our approach focuses on stacking and growing 2D-FM (Fe_3GeTe_2) onto high-quality compensated TIs ($(Bi_{0.4}Sb_{0.6})_2Te_3$) grown by molecular beam epitaxy. We use both low and high field second harmonic magnetotransport measurement to characterize the SOT generation, finding a very large SOT with a strong temperature dependence. The observation of large SOT is promising to realize current-induced magnetization switching operation at low critical current density ($J_c < 10^{10}$ A/m^2).

References

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Figures

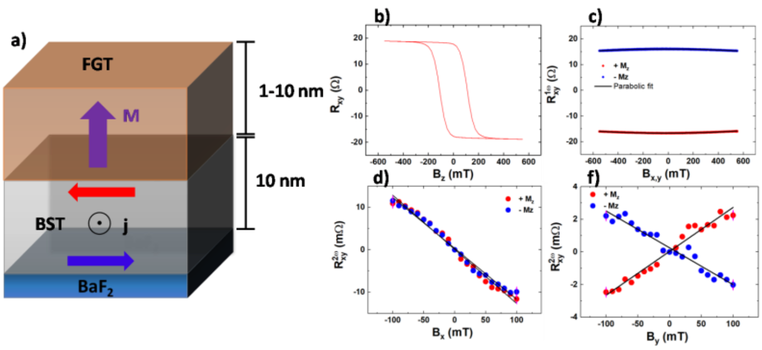

Figure 1: Second harmonic spin-orbit torque measurement in BST/FGT bilayers. a) Measurement geometry. b) Anomalous Hall effect (AHE) recorded by applying the magnetic field along z. c) AHE recorded by sweeping the field along *y*. d) Second harmonic AHE measurements acquired by sweeping the external magnetic field along x, reflecting the symmetry of the damping-like SOT field. e) Second harmonic AHE measurements acquired by sweeping the external magnetic field along *y*, reflecting the symmetry of the field-like SOT field. The sample temperature is 70 K and the applied current density is 1.3 × 10^{10} A.m^{-2}.