Spin devices using layered topological materials

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Spintronic research has recently focused on spin-orbit torques (SOTs) to alter the magnetic state. Layered topological materials such as topological insulators (TIs) and Weyl semimetals are a new class of quantum matters with large spin-orbit coupling, and probing the spin texture of these materials is of importance for functional devices. We reveal spin textures of such materials using a new kind of magneto-resistance, the bilinear magneto-electric resistance (BMER), which depends on the relative orientation of the current with respect to the magnetic field as well as the crystallographic axes [1,2]. We also directly visualize current-induced spin accumulation in topological insulators using photocurrent mapping [3]. We identify a topological surface states (TSS) dominated effect in Bi_2Se_3 [4], and realize magnetization switching at room temperature using both Bi_2Se_3 and WTe_2 as spin current sources [5,6]. The required current density for switching is two orders of magnitude smaller than that with heavy metals. Utilizing strong spin current generation from Bi_2Se_3, we finally show magnetization switching by magnon-mediated spin torque as shown in Figure 1, in which much less Joule heat is expected compared to conventional electron-mediated switching devices [7].

References

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Figures

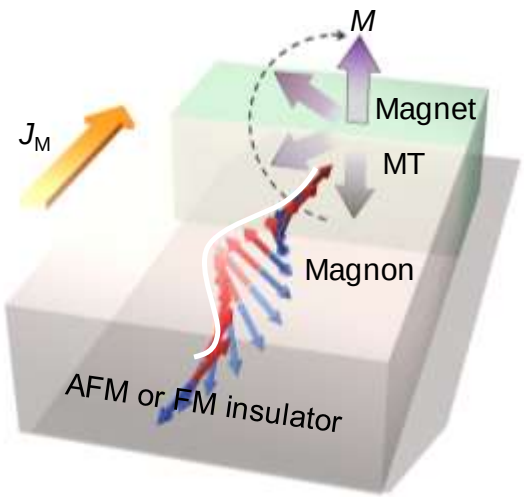

Figure 1: Magnon current based magnetization switching.