Room Temperature Nonlocal Detection of Charge-Spin Interconversion in a Topological Insulator

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Topological insulators (TIs) are emerging materials for next-generation nanoelectronic devices, thanks to the non-trivial spin-momentum locking of their topological surface states. Although charge-spin conversion (CSC) has previously been reported in TIs by potentiometric measurements [1-2], reliable nonlocal detection has so far been observed only at cryogenic temperatures up to T = 15 K [3]. Here, we report nonlocal detection of CSC and its inverse effect in the TI compound $Bi_{1.5}Sb_{0.5}Te_{1.7}Se_{1.3}$ at room temperature using a van der Waals heterostructure with a graphene spin valve device (see Figure 1). The lateral nonlocal device design with graphene allows observation of both spin switch and Hanle spin precession signals for generation, injection and detection of spin currents by the TI. Detailed bias- and gate-dependent measurements in different geometries prove the robustness of the CSC effects in the TI. These findings demonstrate the possibility of using topological materials to make all-electrical room-temperature spintronic devices.

References

[1] C.H. Li et al., Nature Nanotechnology, 9 (2014) 218-224
[2] A. Dankert et al., Physical Review B, 97 (2018) 125414
[3] K. Vaklinova et al., Nano Letters, 16, 4 (2016) 2595-2602

Figures

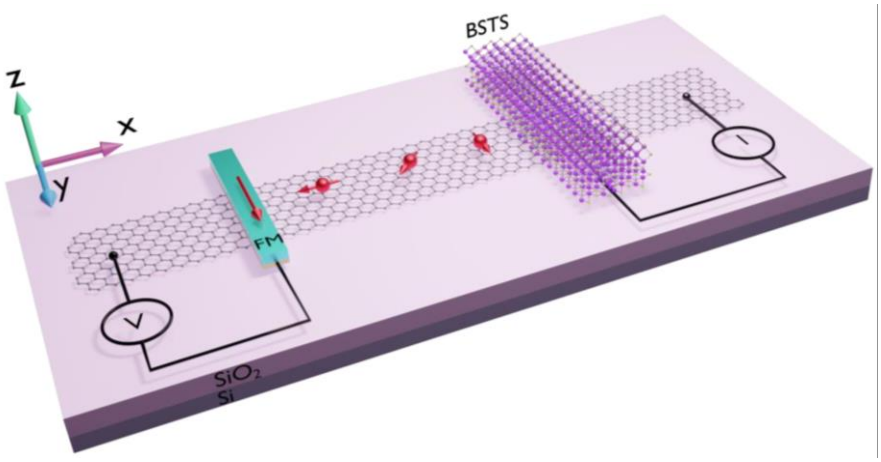

Figure 1: Schematic of the graphene/$Bi_{1.5}Sb_{0.5}Te_{1.7}Se_{1.3}$ heterostructure device with nonlocal measurement geometry, with reference nonmagnetic and ferromagnetic contacts.