Spintronics with Topological Insulator Heterostructures

Saroj P. Dash
Chalmers University of Technology, Gothenburg, Sweden.

Topological insulators (TIs) are a new class of quantum materials that exhibit a current-induced spin polarization due to spin-momentum locking (SML) of massless Dirac Fermions in their surface states. Recently, experiments were performed to detect and utilize the spin polarized surface currents in 3D TIs by using ferromagnetic contacts [1]. For such purpose the dominance of surface state electronic transport over the bulk contribution is crucial to maximize the charge to spin conversion efficiency. Here we will show an enhancement of the magnetoresistance (MR) signal due to SML by tuning the conductivity from a bulk to a surface dominated regime in $Bi_{1.5}Sb_{0.5}Te_{1.7}Se_{1.3}$ (BSTS) [2]. Comparing the MR in BSTS to the metallic Bi_2Se_3 in a wide range of temperature (2 – 300 K) allows us to associate this strong modulation of the signal in BSTS with the tuning of the transport contributions from bulk to surface with temperature. We further exploit excellent spin transport properties of graphene [3] and high spin-orbit characteristics of 2D semiconductors [4] and topological insulators to create heterostructures with novel spin functionalities. These findings demonstrate all-electrical spintronic device at room temperature with the creation, transport and control of the spin in 2D materials heterostructures, which can be key building blocks in future device architectures.

References:

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