Spintronics with Topological-Insulator Heterostructures

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Topological insulators (TIs) are a new class of quantum materials that exhibit a current-induced spin polarization due to spin-momentum locking of massless Dirac Fermions in their surface states. This helical spin polarization in three-dimensional (3D) TIs has been observed using photoemission spectroscopy up to room temperatures. Recently, experiments were performed to detect and utilize the spin polarized surface currents in 3D TIs by using ferromagnetic contacts. I will present the room temperature spin valve signal in Bi_2Se_3 in heterostructure with spin sensitive ferromagnetic tunnel contacts [1]. A clear spin valve signal is measured at room temperature, which increases linearly with bias current, reverses sign with current direction, decreases with higher TI thickness. Recently, we also explored 3D TI with semiconducting bulk such as BiSbTeSe (BSTS) and observed even a higher magnitude of magnetoresistance, with a large enhancement of the signal at lower temperatures. We further aim to exploit excellent spin transport properties of graphene [2] and characteristics of TIs to create heterostructures with novel spin textures. These findings provide a platform for exploring novel spin functionalities in 2D crystal heterostructures and understanding the basic phenomenon that control their behavior.

[1] Room Temperature Electrical Detection of Spin Polarization in Topological Insulators; A Dankert, J. Geur, MV Kamalakar, SP Dash; Nano Letters 15 (12) 7976 (2015).

[2] Long Distance Spin Communication in chemical vapor deposited Graphene, MV Kamalakar, G. Chris, A Dankert, SP Dash; Nature Communication, 6, 6766 (2015).

BIO: Saroj Dash is leading a research group on Quantum device Physics, Nanoelectronics and Spintronics research at Chalmers. He holds a PhD degree in Physics from Max Planck Institute (2007, Stuttgart, Germany). His previous positions include postdocs at Univ. of Twente and Univ. of Groningen in Netherlands for three years. He was appointed at Chalmers in November 2010, where his group focus is on electronic charge and spin transport in graphene, semiconductor nanostructures, other two-dimensional materials and topological insulators. His group develops novel approaches for nanofabrication and design new measurement techniques that lead to fundamental physics experiments. The goal is to exploit spin degree of freedom of electrons for integration of memory and logic functionalities in nanoelectronic devices.