NUS Graduate School for Integrative Sciences and Engineering
Research Project Write-up

Title of Project : **Spintronic Devices based on Topological Insulators**

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Short Description

The emerging research field of topological insulator is growing rapidly. Spin orbital coupling (SOC) is the crucial ingredient of a topological insulator. Driven by the strong SOC, band inversion between two orbits with opposite parity leads to the helical gapless states crossing the bulk bandgap. Moreover, the spin up electrons and spin down electrons in the gapless states experience opposite effective magnetic field and flow in opposite directions along the boundary, exhibiting quantum spin Hall effect which has attracted great attention in possible spintronics applications. We try to understand the electronic structures of topological insulator as well as their phonon dispersion relation using sophisticated approaches, such as tight-binding approach and density functional theory, in order to capture their intrinsic material properties appropriately. We will systematically investigate the effects of doping, vacancy, interface, strain and contact on the electronic structures of topological insulator. Next, we will develop a universal approach based on quantum transport theory to investigate the electron and phonon transport properties in a topological insulator.