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Magnetic Topological Insulators and Their Heterostructures

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Abstract

When magnetic order is introduced into topological insulators (TIs), the time-reversal-symmetry is broken, and the non-trivial topological surface is driven into a new massive Dirac-fermions state. By adjusting the Fermi level position, quantum anomalous Hall effect (QAHE) emerges in the Cr-doped $(BiSb)_2Te_3$ samples where dissipationless chiral edge conduction is realized in the macroscopic millimeter-size devices without the presence of an external magnetic field, and the stability of the dissipationless chiral edge conductance is well-maintained as the film thickness varies across the 2D hybridization limit. By further manipulating the topological surface gap, we realize the metal-to-insulator quantum phase transition in the system.

In addition to the uniform magnetic TIs, our recent work on several magnetic TI based heterostructures will be presented. First, in the TI/Cr-doped TI system, we demonstrate that the spin-orbit torque is highly efficient that the critical charge current density required for the magnetization switching is three orders of magnitude smaller than that of heavy metals. In addition, by constructing novel AFM/TI heterostructures, we realize emergent interfacial magnetic effects, which can be tailored through artificial structural engineering. Finally, by introducing additional superconductivity (SC), we observe the presence of the chiral Majorana edge mode in the QAHE-SC hybrid system. All these exotic magnetic TI-based phenomena will serve as fundamental steps to further explore the TRS-breaking TI systems.