INVITED

Surface conduction of topological Dirac electrons in bulk insulating Bi_2Se_3

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The three dimensional strong topological insulator (STI) is a new phase of electronic matter which is distinct from ordinary insulators in that it supports on its surface a conducting two-dimensional surface state whose existence is guaranteed by topology. I will discuss experiments on the STI material Bi_2Se_3, which has a bulk bandgap of 300 meV, much greater than room temperature, and a single topological surface state with a massless Dirac dispersion. Field effect transistors consisting of thin (3-20 nm) Bi_2Se_3 are fabricated from mechanically exfoliated from single crystals, and electrochemical and/or chemical gating methods are used to move the Fermi energy into the bulk bandgap, revealing the ambipolar gapless nature of transport in the Bi_2Se_3 surface states. The minimum conductivity of the topological surface state is understood within the self-consistent theory of Dirac electrons in the presence of charged impurities[1]. The intrinsic finite-temperature resistivity of the topological surface state due to electron-acoustic phonon scattering is measured to be ~60 times larger than that of graphene largely due to the smaller Fermi and sound velocities in Bi_2Se_3, which will have implications for topological electronic devices operating at room temperature[2]. As samples are made thinner, coherent coupling of the top and bottom topological surfaces is observed through the magnitude of the weak anti-localization correction to the conductivity[3], and in the thinnest Bi_2Se_3 samples (~3 nm) in thermally-activated conductivity reflecting the opening of a bandgap[4,5].

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