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Control and characterization of the metallic surface state of bulk insulating Bi_2Se_3[1]

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Bi_2Se_3 is a three dimensional strong topological insulator with a conducting two-dimensional surface state whose existence is guaranteed by topology. The bulk Bi_2Se_3 has a 300 meV bandgap, but is often a degenerately n-doped metal in as-grown material. I will discuss our efforts to remove this doping in thin crystals and films to achieve surface-dominated conduction. Electrochemical gating (using PEO+LiClO4 electrolyte) or molecular doping (using F4-TCNQ) is shown to effectively bring the Fermi energy of thin (3-20 nm) exfoliated Bi_2Se_3 crystals to the conduction band edge, where it can be further modulated at low temperature using field-effect gating. These techniques allowed us to reveal the gapless ambipolar transport in the topological surface, and measure the minimum conductivity,[2] electron-acoustic phonon scattering,[3] thermopower,[4] and inter-surface coupling of the topological surfaces.[5] Recently we have developed techniques to measure the transport properties of Bi_2Se_3 in situ during growth in ultra-high vacuum, enabling better understanding of the doping mechanisms.[6] We have also studied vacuum-deposited MoO_3 as a highly effective acceptor dopant which remains stable on air exposure for time scales of days.[7]

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[2]D. Kim et al., *Nature Physics* **8**, 460 (2012)

[3]D. Kim et al., *Phys. Rev. Lett.* **109**, 166801 (2012)

[4]D. Kim et al., *Nano Lett.* **14**, 1701 (2014)

[5]S. Cho et al., *Nano Letters* **11**, 1925 (2011); S. Cho et al., *Nano Letters* **12**, 469 (2012); D. Kim et al., *Nature Comm.* **4**, 2040 (2013)

[6]J. Hellerstedt et al., *APL* **105**, 173506 (2014)

[7]M.T. Edmonds et al., *ACS Nano* **8**, 6400 (2014)