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Differentiation of surface and bulk conductivities in topological insulator via four-probe spectroscopy[1] AN-PING LI, CORENTIN DURAND, SABAN HUS, XIAOGUANG ZHANG, MICHAEL MCGUIRE, Oak Ridge National Laboratory, YONG CHEN, Purdue University — The direct measurement of the topological surface states (TSS) conductivity is often hard to achieve due to the pronounced contribution from the bulk conduction channel. Here, we show a new method to differentiate conductivities from the surface states and the coexisting bulk states in topological insulators (TI) using a four-probe transport spectroscopy in a multi-probe scanning tunneling microscopy system. In contrast to conventional models that assume two resistors in parallel to count for both the TSS and bulk conductance channels, we derive a scaling relation of measured resistance with respect to varying inter-probe spacing for two interconnected conduction channels, which allows quantitative determination of conductivities from both channels. Using this method, we demonstrate the separation of 2D and 3D conduction in TI by comparing the conductance scaling of Bi_2Se_3, Bi_2Te_2Se, and Sb-doped Bi_2Se_3 with that of a pure 2D conductance of graphene on SiC substrate. We also quantitatively show the effect of surface doping carriers on the 2D conductance enhancement in TI. The method offers an approach to understanding not just the topological insulators but also the 2D to 3D crossover of conductance in other complex systems.

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