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Topological surface state in the Kondo insulator Samarium Hexaboride[1]

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Topological invariants of electron wave functions in condensed matter reveal many intriguing phenomena. The most exotic one is the topological insulator (TI) characterized by the Z2 group where an insulating bulk coexists with a metallic boundary state. Possible novel quantum states supporting coherent qubits using Majorana fermions with their potential for technological application have led to intense research into Bi based TIs with large band gap. However, the main complication concerning these Bi based materials is their considerable residual conductivity in the bulk, and only experimental techniques distinguishing bulk and surface clearly such as ARPES or STM can be used to explore the surface properties of these materials properly. Theories predict that a Kondo insulator SmB6, which evolves from a Kondo lattice metal to an insulator with a small gap as the temperature is lowered, could be a topological insulator. Although the insulating bulk and metallic surface separation has been demonstrated in recent transport measurements, these were not able to prove that the metallic surface state is topologically protected. we report careful thickness dependence transport measurements on doped SmB6 which show that magnetic and non-magnetic dopants in SmB6 exhibit clearly contrasting behavior supporting that that SmB6 is the first perfect 3D topological insulator with virtually zero residual bulk conductivity. We anticipate our results to be a starting point to explore the details of topological Kondo insulators and their potential applications toward scalable quantum information processing.

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