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Magnetotransport studies of new topological insulators: Bi_2Te_2Se and others[1]

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A topological insulator (TI) is a material that has a gapped insulating bulk and a gapless metallic surface. However, presently available TI materials are not truly insulating, making surface transport measurements to be a challenge. The second generation of TIs, Bi_2Se_3 and related compounds, turned out to be more suitable for the experimental studies of the topological 2D states than the first discovered Bi-Sb alloys, due to a much larger bulk gap and a simpler surface state consisting of a single Dirac cone. Unfortunately, near-stoichiometric Bi_2Se_3 is always a metallic n-type material owing to a finite amount of Se vacancies. We searched for new TI materials that are better suited for achieving a bulk insulating state and found that Bi_2Te_2Se, which has an ordered tetradymite structure with the Te-Bi-Se-Bi-Te layer sequence, is a very promising material. It was found that high-quality single crystals of Bi_2Te_2Se show a high resistivity exceeding 1 Ωcm, together with a variable-range hopping behavior which is a hallmark of an insulator; yet, they present Shubnikov-de Haas oscillations which signify the 2D surface state consistent with the topological one observed by photoemission spectroscopy. Moreover, we are able to clarify both the bulk and surface transport channels, establishing a comprehensive understanding of the transport in this material. Our results demonstrate that Bi_2Te_2Se is the best material to date for studying the surface quantum transport in a topological insulator. Transport properties of other new TI materials are also presented.

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