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Bulk Transport in Strongly Correlated Topological Insulator Samarium Hexaboride Using Hall Effect and Inverted Resistance Methods

Authors : Alexa Rakoski, Yun Suk Eo, Cagliyan Kurdak, Priscila F. S. Rosa, Zachary Fisk, Monica Ciomaga Hatnean, Geetha Balakrishnan, Boyoun Kang, Myungsuk Song, Byungki Cho

Abstract : Samarium hexaboride (SmB6) is a strongly correlated mixed valence material and Kondo insulator. In the resistance-temperature curve, SmB6 exhibits activated behavior from 4-40 K after the Kondo gap forms. However, below 4 K, the resistivity is temperature independent or weakly temperature dependent due to the appearance of a topologically protected surface state. Current research suggests that the surface of SmB6 is conductive while the bulk is truly insulating, different from conventional 3D TIs (Topological Insulators) like Bi_2Se_3 which are plagued by bulk conduction due to impurities. To better understand why the bulk of SmB6 is so different from conventional TIs, this study employed a new method, called inverted resistance, to explore the lowest temperatures, as well as standard Hall measurements for the rest of the temperature range. In the inverted resistance method, current flows from an inner contact to an outer ring, and voltage is measured outside of this outer ring. This geometry confines the surface current and allows for measurement of the bulk resistivity even when the conductive surface dominates transport (below 4 K). The results confirm that the bulk of SmB6 is truly insulating down to 2 K. Hall measurements on a number of samples show consistent bulk behavior from 4-40 K, but widely varying behavior among samples above 40 K. This is attributed to a combination of the growth process and purity of the starting material, and the relationship between the high and low temperature behaviors is still being explored.

Keywords : bulk transport, Hall effect, inverted resistance, Kondo insulator, samarium hexaboride, topological insulator
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