High Field Magnetoresistance Measurements of the Surface States of Topological Kondo Insulator Samarium Hexaboride

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Introduction

The recent conjecture of a topologically-protected surface state in SmB_6 and the verification of robust surface conduction below 4 K have led to a large effort to understand the surface states. There has been a recent surge of research activity in SmB_6 and in this new field of correlated topological insulators. In the last year our research has focused on the important goal of understanding fundamental properties of electrical transport and surface states in SmB_6 [1],[2].

Experimental

The SmB_6 crystals needed for this project are provided by Prof. Zachary Fisk's group from University of California, Irvine. We heavily rely on Corbino measurements to characterize the surface conduction in this material. The Corbino geometry allows us to extract diagonal conductivity of the two-dimensional layer from the measured resistance using a known geometric constant.

Results and Discussion

We measured conductivity in high magnetic fields at various angles. At each angle, both (011) and (001) samples show a strong negative magnetoresistance. The raw magnetotransport data obtained from a (110) Corbino sample is shown in Fig. 1. Even though we do not fully understand the origin of the negative magnetoresistivity obtained for the parallel magnetic field, we were able to extract electron mobility of 122 cm^2/Vs by fitting the ratio of the perpendicular and parallel magnetoresistance traces to a the quadratic function $(1+\mu^2B^2)$ [1]. The carrier density is determined from the zero field resistance value of the Corbino sample; the carrier density thus extracted is 2.5×10^{13} cm^{-2}.

The low mobility values that we have extracted from the Corbino experiments explain why we have not observed SdH oscillations using these samples. It is critically important to understand how the preparation of the surfaces affects the carrier mobility. We are currently working on strategies to enhance the carrier mobility. If we can enhance the mobility even by a factor of 3, we should be able to observe SdH oscillations. These experiments would then complement quantum oscillations seen in magnetization measurements [3].

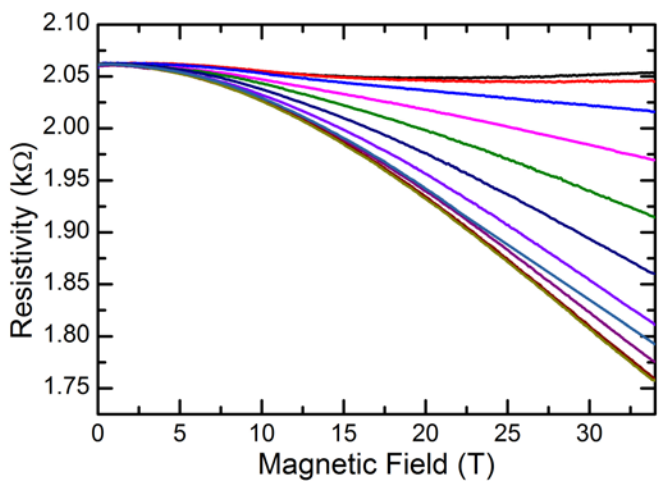

Fig. 1. Resistance versus magnetic field traces at T = 0.3 K obtained from a (110) Corbino sample for different orientations of the sample with respect to magnetic field. Perpendicular and parallel magnetic fields corresponds to upper and lower traces respectively.

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References

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