Magneto-Transport in Bi_2Te_2Se: High Quality Surface States in Freshly Cleaved Crystals

Y. Xu, Helin Cao (Purdue, Physics & Birck Center); Jiuning Hu (Purdue, ECE & Birck Center); Ireneusz Miotkowski (Purdue, Physics); Yong P. Chen (Purdue, Physics, ECE, & Birck)

Introduction

This project aims to study the electronic properties of topological insulators (TIs) and interplay with other materials. TI is a new class of quantum matter that has attracted great interests in condensed matter physics[1,2]. They are band insulators in the bulk, however, because of the band topology and strong spin-orbit coupling, have nontrivial *metallic* states on the surface. We aim to understand the new topological matter and topologically protected surface states (SS), and hope to generate novel concepts of designing new spintronic or magnetoelectric devices.

Experimental

In 2013, we had two weeks in cell 9 (B up tp 31 T) with He-3 probe (T down to 340 mK). We continued our study on the magneto-transport properties in Bi_2Te_2Se (BTS221) crystals with low bulk carrier density[3,4].

Results and Discussion

Angle dependence study revealed that the oscillations are only controlled by perpendicular magnetic field (Fig. 1a), indicating a 2D transport behavior. Fig.1b inset shows the Fourier transform (FT) of $\Delta R_{xx}(1/B)$ at $\theta=0^O$ (perpendicular B). Two frequencies (B_{F1} = 53 T and B_{F2} = 254 T) are clearly resolved, indicating that the two sets of SdH oscillations originating from two different Fermi surfaces. We assign the maxima in ΔR_{xx} with two sets of consecutive integers according to their respective frequencies (labeled in Fig. 1a with red and green dashed lines). We plot the assigned Landau level indices against the 1/B values of the corresponding maxima in Fig. 1b. The intercept of the low (high) frequency oscillations is found to be 0.08±0.09 (0.41±0.05), providing evidence for a Schrödinger (Dirac) spectrum. We conclude that the low frequency SdH oscillations originate from trivial 2D electron gas induced by surface band bending, and the other one from topological surface states.

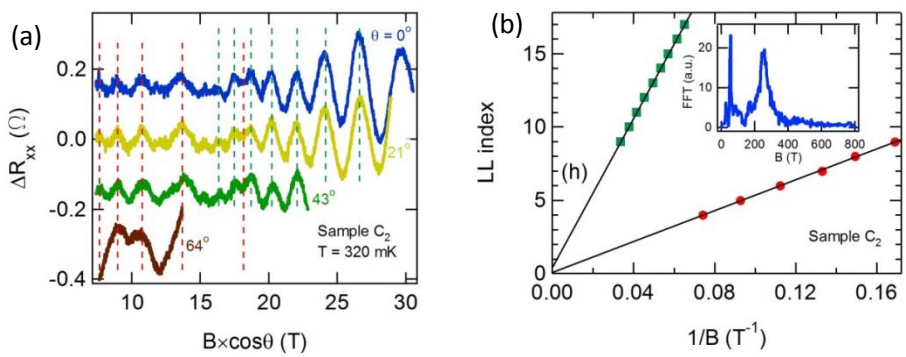

Figure 1. (a) Four terminal longitudinal resistance Rxx after subtracting a polynomial background (denoted as ΔRxx) as functions of perpendicular component of tilted magnetic field measured at 320 mK. The curves are shifted vertically for clarity. The positions of maxima and minima in the oscillations align vertically, indicating a 2D behavior. (b) Landau level Fan diagram of two sets of SdH oscillations. The solid lines are the best linear fits. The inset shows the Fourier analysis of $\Delta R_{xx}(1/B)$.

Acknowledgements

We acknowledge support from DARPA MESO program (Grant N66001-11-1-4107). The magnetotransport measurements were performed at National High Magnetic Field Laboratory (NHMFL), which is jointly supported by the NSF Cooperative Agreement No. DMR-1157490, the State of Florida, and the U.S. Department of Energy.

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