Pulsed Field Torque Measurements of Topological Insulators

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Introduction

Topological insulators [1] (TIs) are quantum materials with bulk insulating and topologically protected metallic surfaces. Understanding and control of non-trivial bulk states and surface Dirac electrons transport in TI is essential to the further applications as well as the realization of proposed exotic topological effects. However, the transport of TI is challenging due to the dominated bulk transport. To minimize the bulk contribution and let the surface dominate transport, chemical doping is introduced to tune the quantum oscillation in the pulsed magnet.

Experimental

We performed transport, torque and TDO measurements on single crystal in pulsed magnetic fields up to 60 T. $Bi_2(Te,S)_3$ single crystal are grown in China. The bulk contribution can be significantly reduced by tuning the ratio of Te/S. Angle dependence of torque measurements are carried out in the 60 T short pulse magnet of NHMFL-PFF, LANL.

Results and Discussion

We investigate the torque properties of two TI single crystals in the 60 T pulsed magnet. Quantum oscillations are observed in the $Bi_2Te_{2.3}S_{0.7}$ single crystal, which is consistent with the transport measurement. By contrast, no oscillation is shown in the $Bi_2Te_{2.3}S_{0.4}$ single crystal.

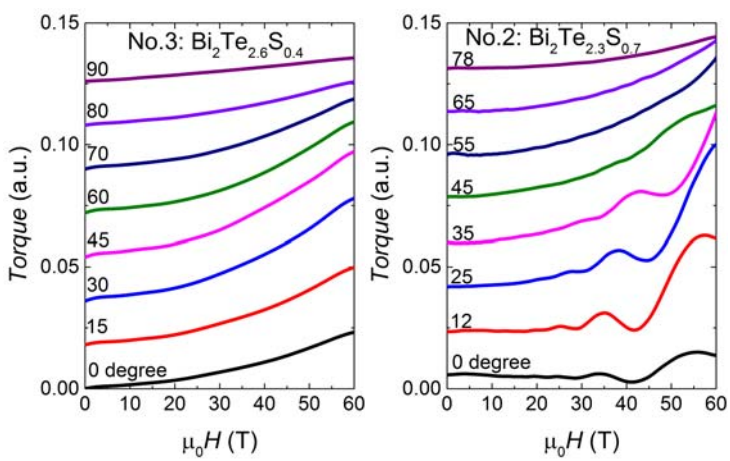

Fig 1. Angle dependence of torque measurement in two different doping single crystals. Left: $Bi_2Te_{2.3}S_{0.4}$; Right $Bi_2Te_{2.3}S_{0.7}$.

Conclusions

Torque measurements are a volume sensitive probe of the magnetic anisotropy. The oscillations observed in $Bi_2Te_{2.3}S_{0.7}$ are consistent with previous transport measurement, indicating the oscillations originate from bulk carriers in $Bi_2Te_{2.3}S_{0.7}$ single crystal. The lack of oscillations in the torque measurement of $Bi_2Te_{2.3}S_{0.4}$, suggest that the transport oscillations observed for this composition arise from the surface state.

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References

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