Transport Behaviour of Topological Insulator Nano Device in The 60 T Pulsed Magnet

Zhang, Z.; Wang, Y. (Tsinghua U, Physics); Zhu, Z.; McDonald, R. (NHFML-PFF, LANL)

Introduction

Topological insulators (TIs) possess topologically protected boundary states enclosing an insulating bulk with topologically nontrivial band structure induced by strong spin orbit coupling. The metallic surface states (SSs) of the three dimensional TIs exemplified by the Bi_2Te_3 family compounds have a single Dirac cone with helical spin-momentum texture. In the presence of strong magnetic field, the energy spectrum of the topological SSs will quantize into discrete Landau Levels (LLs). The linear dispersion of the topological SSs guarantees that there is a LL pinned at the Dirac point, which is protected by the particle-hole symmetry as demonstrated by scanning tunneling microscope (STM) experiment. This so-called zeroth LL has been actively pursued because it may exhibit remarkable quantum transport phenomena such as the half quantum Hall effect.

Experimental

$Bi_2(Te,S)_3$ single crystal is grown in China. The bulk contribution can be significantly reduced by tuning the ratio of Te/S, and reducing the thickness of the sample. Transport measurement are carried out in the 60T short pulse magnet of NHMFL-PFF, LANL.

Results and Discussion

With decreasing thickness the resistivity becomes larger due to the reduced bulk conduction. The quantization of surface states is further demonstrated by the gate-tuned SdH oscillations in the 75 nm sample, where the two surfaces are totally decoupled and only one surface can be tuned effectively by gate voltages. Therefore the metallic topological surface states can be tuned effectively by the gate voltage while the bulk contribution is nearly intact. The bulk quantum oscillations is insensitive to the gate voltage as displayed in the Fig. 1.

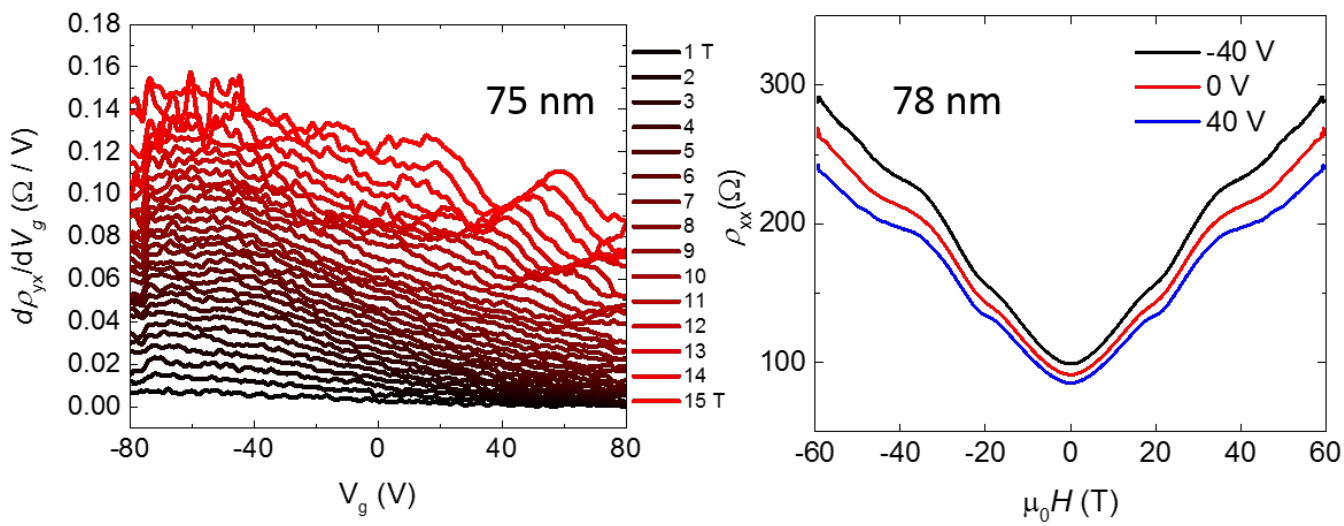

Fig.1 Gate tuned quantum oscillations in strong magnetic field

Conclusions

In summary, by applying an ultra-high magnetic field, we simultaneously observe the quantum oscillations from the bulk and SSs of the $Bi_2Te_{3-x}S_x$ TI single crystal.

Acknowledgements

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References

[1] Hasan, M.Z., *et al*., Review of Modern Physics, **82**, 3045-3067 (2010).