Electrical Control of Magnetoresistance in Topological Insulator Thin Film in 60 T Pulsed Magnet

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

Introduction

The discovery of quantum Hall effect in the 2D electron gas has broadened the understanding of the topology in condensed matter physics. Topological insulators (TIs), as a newly discovered quantum material, is known for its topological surface states with helical spin texture [1]. In the quest for understanding the nature of spin-polarized Dirac surface state, the main experimental goal is to reveal the intrinsic quantum transport of such topology protected surface states.

Experimental

The sample is fabricated into a field effect transistor (FET). The device is mechanically scratched into a Hall bar geometry for magneto transport measurements with a magnetic field applied perpendicular to the film plane. Due to the high resistance of the thin film, the standard DC method is used for the transport measurement in pulsed magnetic field.

Results and Discussion

By applying a back gate voltage through the insulating $SrTiO_3$ (111) substrate, we find that the MR behaviour of Sb_2Te_3 can be electrically driven into three regimes: bulk dominated parabolic MR, surface quantum Hall effect induced negative MR and linear MR originated from the interaction between the bulk and surface carriers.

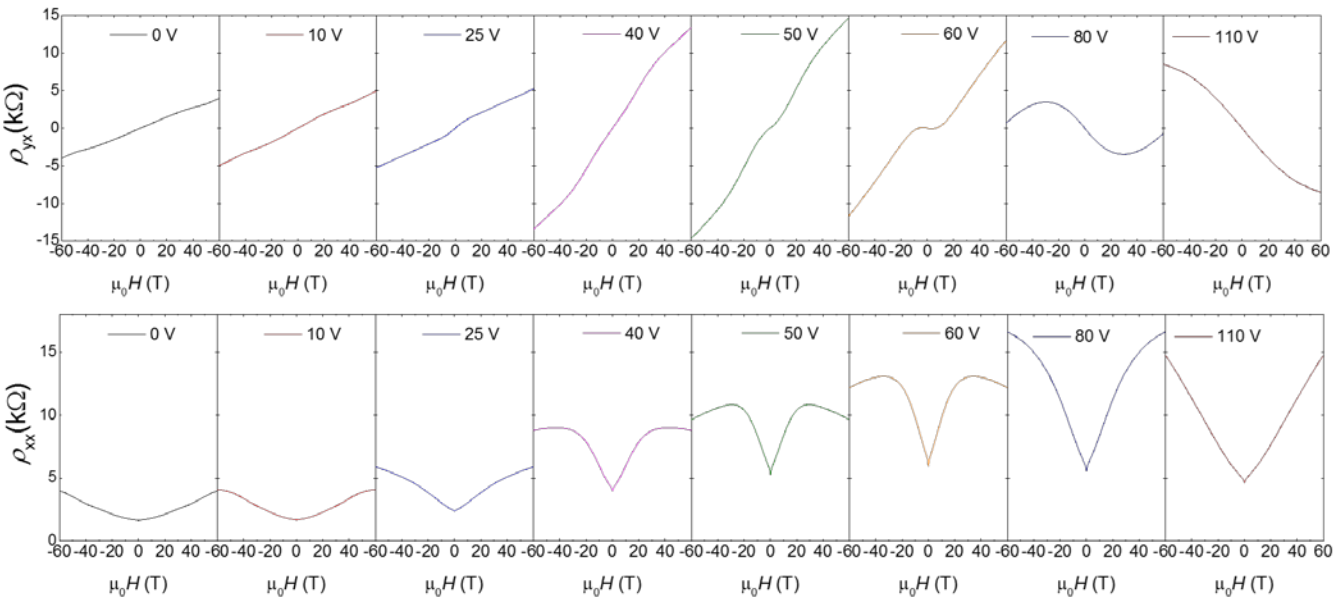

Fig.1 Magnetoresistance and Hall effect under various gate voltages.

Conclusions

The MR behavior of topological insulator thin film evolves smoothly from conventional parabolic MR to surface quantum Hall effect induced negative MR, indicating the crossover from bulk dominated transport to the surface dominated transport.

Acknowledgements

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References

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