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EPITAXIAL GROWTH AND CHARGE-TO-SPIN CONVERSION STUDIES OF BI_2TE_3 TOPOLOGICAL INSULATOR

ABSTRACT

As a novel class of materials, topological insulators (TI) have been intensively studied since the first theoretical prediction in 2006[1]. Bi2Te3, Sb2Te3 and Bi2Se3 compounds were theoretically predicted and experimentally observed as 3D topological insulators, which have a large bulk band-gap, but possess metallic surface states. These spin-polarized surface states have a number of exciting properties such as the spin/momentum locking and suppression of backscattering. The field of TIs leads to potential applications in spintronics and quantum computing, and lots of research efforts are being made.

This dissertation explores the charge-to-spin conversion in topological insulator thin films of Bi2Te3 grown by molecular beam epitaxy (MBE). It shows a thickness- dependent spin torque ratio in ultrathin thickness range (3 QL - 10 QL), where QL refers to quintuple layer.

In the first part, we focus on the growth of high quality Bi2Te3 thin films by employing MBE technique. Using in-situ electron diffraction method for structural characterization, the growth of Bi2Te3 thin films is optimized. Then we performed electrical measurement on Bi2Te3 thin films to explore the electronic transport properties, and disentangle contributions from the bulk and surface states.

In the second part, we use spin torque ferromagnetic resonance (ST-FMR) to measure spin torques generated by the topological insulator Bi2Te3 onto a magnetic layer (Permalloy) and calculate the spin torque ratio. We find the value of spin torque ratio reaches maximum at 8 QL Bi2Te3 in a thickness range from 3 QL to 10 QL. The ST-FMR measurements are performed both at 300K and at 4K, yielding a larger spin torque ratio at low temperature. The observations suggest significant contributions of the surface states of the TI to the charge-to-spin conversion.

[1] B. A. Bernevig, T. L. Hughes, and S.-C. Zhang, Science, 314, 5806, 2006

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