Topological Insulator Thin Film Research for Spintronic

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時間：2015年5月26日(二)
14：00～16：00
地點：電機二館142室

Abstract

A new research direction in the current era of *"beyond Si CMOS"* is the pursuit of emergent quantum matters in realization of exotic quantum phenomena, thus to develop a "*paradigm shift*" technology in pushing computer speed and power consumption beyond current limitations. The new states of low-D quantum matters, typified by topological insulators (TI), have recently drawn unparalleled attentions worldwide due to their extraordinary physical properties and potential applications in dissipationless spintronics and quantum computing. The helical spins of the TI surface states plus the unique spin-momentum locking feature may be exploited in giving rise to a host of novel spintronic devices with much higher spin-charge conversion efficiency, crucial for effective pure spin current generation to realize spin logics and circuits in future.

In light of the exciting prospect, we have recently undertaken investigations of TI thin films and heterostuctures intended for spintronic applications. High quality 3-D TI films of Bi_2Se_3 and Bi_2Te_3 were obtained by van der Waals epitxy and the surface states displayed distinct Dirac cone features confirmed by ARPES, STS, along with weak antilocalizations. TI/FM and TI/FI magnetic heterostructures were fabricated to generate pure spin current by the dynamical spin pumping method, and detected by the inverse spin Hall effect. Very strong spin-charge conversion was observed, with a typical charge current density J_c about 3-5 times higher than those of Fe_3Si/NM and Fe_3Si/GaAs bi-layers. In addition, we demonstrated a large electrical field effect via a back gate device, thus paving new ways of exploiting this new quantum matter for dissipationless spin transport and applications.

* The work is done in collaboration with H. Y. Lin, C. Y. Wang, C. N. Wu, Y. T. Fanchiang, Yuchi Liu, Mandy Chen, Dept. of Physics, National Tsing Hua University, Hsinchu; Prof. Minghwei Hong, Dept. of Physics, National Taiwan University, Taipei; Dr. Jau Yin Lin, CCMS, NTU; Dr. Shang-fan Lee, Institute of Physics, Academic Sinica, Nangkang; and Dr. T. W. Pi of NSRRC, Hsinchu, Taiwan.

主辦單位：台積電-臺灣大學聯合研發中心