Seminar

Surface conduction of topological Dirac electrons in bulk insulating Bi_2Se_3

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Time: 16:00pm, Jul. 31, 2014 (Thursday)
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Venue: Room 607, Science Building 5
地点： 理科五号楼607会议室

Abstract

The three dimensional strong topological insulator (STI) is a new phase of electronic matter which is distinct from ordinary insulators in that it supports on its surface a conducting two-dimensional surface state whose existence is guaranteed by topology. I will discuss experiments on the STI material Bi_2Se_3, which has a bulk bandgap of 300 meV, much greater than room temperature, and a single topological surface state with a massless Dirac dispersion. We study the evolution of doping in films of Bi_2Se_3 grown by molecular beam epitxay (MBE), using *in situ* transport measurements to probe the carrier concentration and mobility during film growth in UHV on $SrTiO_3$ substrates[1,2]. We find that Bi_2Se_3 is *n*-doped before exposure to atmosphere, doping is largely interfacial in origin, and largely independent of growth temperature. Mobility however can be optimized with growth temperature through increased structural quality of the films. We employ molecular surface charge transfer doping using F4-TCNQ or MoO_3 to move the Fermi energy into the bulk bandgap to access the topological regime, and we demonstrate that air-stable doping can be achieved[3,4]. Field effect transistors consisting of thin (3-20 nm) Bi_2Se_3 reveal the ambipolar gapless nature of transport in the Bi_2Se_3 surface states, and are used to study the minimum conductivity[4], the intrinsic electron-phonon resistivity[5], the thickness-dependent weak anti-localization behavior[6], and the thermopower[7] of the topological surface state.

[1] Jack Hellerstedt et al., in SPIE 8923, Micro/Nano Materials, Devices, and Systems; p. 89230P (2013).
[2] J. Hellerstedt et al., ArXiv :1405.5692.
[3] M.T. Edmonds et al., *ACS Nano* **8**, 6400 (2014).
[4] D. Kim et al., Nature Physics 8, 460 (2012).
[5] D. Kim et al., Phys. Rev. Lett. 109, 166801 (2012).
[6] D. Kim et al., *Nature Communications* **4**, 2040 (2013).
[7] D. Kim et al., *Nano Lett.* **14**, 1701 (2014).

About the Speaker

Michael S. Fuhrer received his B.S. in Physics from the University of Texas at Austin in 1990, and Ph. D. in Physics from the University of California at Berkeley in 1998 after doing research on electronic and thermal transport in high-Tc and fullerene superconductors with Prof. Alex Zettl. Prof. Fuhrer remained at Berkeley as a postdoctoral researcher with Profs. Alex Zettl and Paul McEuen, working on electronic transport in carbon nanotube devices. Prof. Fuhrer joined the faculty at the University of Maryland as an Assistant Professor in 2000, and from 2009-2012 was Professor, and Director of the Center for Nanophysics and Advanced Materials. In 2012 Fuhrer was awarded an ARC Laureate Fellowship, and moved to Monash University as Professor of Physics in 2013. Fuhrer's current research interests lie in atomically-thin two-dimensional materials such as graphene and transition-metal chalcogenides. Fuhrer is a Fellow of the American Physical Society and the American Association for the Advancement of Science.