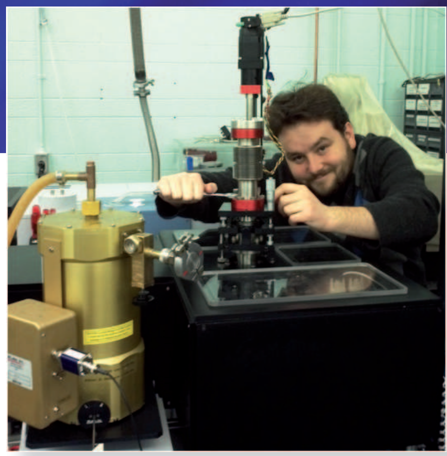
Lee-Osheroff–Richardson North American Science Prize 2012

Dr Kenneth Burch



Dr Kenneth Burch is the 2012 recipient of the Lee Osheroff Richardson North American Science Prize.

Dr. Burch is an outstanding young experimental condensed matter physicist who has made seminal contributions to the fields of spintronics, nanotechnology, and optical properties of novel materials. Recently Dr. Burch's group has developed a number of novel techniques for producing, characterizing and combining novel materials on the nanoscale. These efforts are opening new paths to the study of a wide variety of effects in high temperature superconductors and topological insulators. In particular Dr. Burch focused on the production of nanocrystals of $Bi_2Sr_2CaCu_2O_8$. The Burch group was the first to explain the apparent insulating behavior of these crystals and provide a route to avoid keeping the nanocrystals superconducting [L. J. Sandilands et. al., PRB 82, 064503 (2010)]. His group has extended this technique to topological insulators resulting in the production of the thinnest topological insulators via mechanical exfoliation. Perhaps more interestingly they were able to observe a phonon coming from the surface of these materials, suggesting a new path to study the novel surfaces of these materials[S.Y.F Zhao et al, APL 98, 141911 (2011)]. Dr. Burch joined the faculty of the University of Toronto in July 2008, following his graduate work with D.N. Basov at the University of California, San Diego and his postdoctoral work as a Director's Fellow at Los Alamos National Laboratories with A.J Taylor.

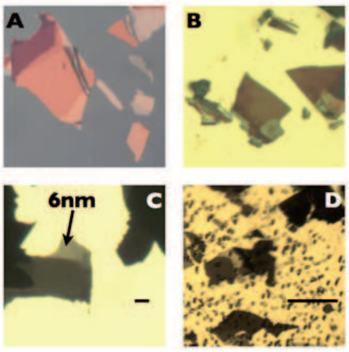


FIG 1

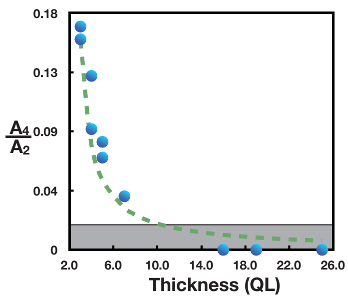


FIG 2

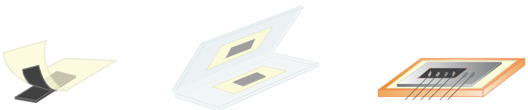


FIG 3

FIG 1: Optical microscope images of exfoliated crystals. A) $Bi_2Sr_2CaCu_2O_8$ on HfO_2 on Si; B) $Bi_2Sr_2CaCu_2O_8$ on Au; C) 6 nm thick nanocrystal of Bi_2Se_3 on Mica; D) $Bi_2Sr_2CaCu_2O_8$ nanocrystals of varying height on porous polycarbonate.

FIG 2: Ratio of the emergent peak intensity to the main peak intensity determined by Raman spectroscopy on topological insulator nanocrystals. The dashed line is a guide to the eye and shows the expected behavior for a surface mode. The gray area indicates the detection limit of our system.

FIG 3: Nanocrystal and Junction fabrication technique: Bi-2212 crystal is cleaved using scotch tape. Bi_2Se_3 is sandwiched between glass slides with double-sided tapes and the top glass slide is lifted off, cleaving a flat surface.

Topological insulators are materials where strong spin-orbit coupling produces metallic states only at their surfaces. These materials may provide a new route to spintronics and quantum computation. Since these surface states are protected by time-reversal invariance they are predicted to have a number of novel properties, including revealing new particles when placed are in proximity to magnetic or superconducting materials.

High temperature superconductors (cuprates) have challenged physicists for a quarter century, yet they also hold great promise for energy efficiency. Indeed, if they could be made to superconduct (zero electrical resistance) at room temperature these materials would provide lossless power transmission. Unfortunately, the origin of the superconductivity in these materials remains unsolved.

Mechanical exfoliation has proven to be effective for producing a variety of thin crystals. This method involves cleaving a bulk material with Van-Der Waals bonded layers and pressing it upon a substrate to produce atomically thin crystals. While this technique has primarily been applied to graphite, in principle mechanical exfoliation allows for a large variety of deposited materials and substrates.

The Lee • Osheroff • Richardson North American prize

SPONSORED BY OXFORD INSTRUMENTS

Find out more on:
www.oxford-instruments.com/scienceprize
http://www.physics.utoronto.ca/~kburch/

OXFORD INSTRUMENTS

The Business of Science®