Abstract Submitted
for the MAR13 Meeting of
The American Physical Society

Coherent Topological Transport on the Surface of Bi_2Se_3[1] DOHUN KIM, PAUL SYERS, Department of Physics, University of Maryland, NICHOLAS P. BUTCH, Condensed Matter and Materials Division, Lawrence Livermore National Laboratory, JOHNPIERRE PAGLIONE, MICHAEL S. FUHRER, Department of Physics, University of Maryland — We report weak anti-localization (WAL) measurements in gate-tuned, bulk insulating Bi_2Se_3 thin crystals with thicknesses varying between 5 and 17 nm. The gate-voltage dependent WAL behavior shows systematic variation as a function of crystal thickness. For the thickest samples, we observe two decoupled surfaces exhibiting perfect WAL as expected for the symplectic class. As the films are made thinner, we observe a gate-voltage tuned crossover from two decoupled surfaces to a single coherently coupled 2D system exhibiting WAL. The observed crossover is governed by competition between the phase coherence time and inter-surface tunneling time associated with the hybridization gap. In contrast to classical transport in which the signature of the hybridization gap appears only in the ultrathin limit ($\leq$ 3nm), phase coherent transport is extraordinarily sensitive to sub-meV coupling between top and bottom topological surfaces, and the surfaces of a TI film may be coherently coupled even for thicknesses as large as 12 nm. On further thinning, the WAL behavior is suppressed altogether at small carrier density, which we associate with the opening of a sizable gap on order the Fermi energy and destruction of topological protection.

[1]The authors acknowledge support from Center for Nanophysics and Advanced Materials (CNAM).

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Date submitted: 12 Nov 2012 Electronic form version 1.4