Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

Scanning tunneling spectroscopic (STS) studies of the bulk magnetic doping effects on the surface state of Bi_2Se_3[*1] C.-C. CHEN, M.L. TEAGUE, N.D. WOODWARD, N.-C. YEH, Dept. of Physics, Caltech, Pasadena, CA 91125, L. HE, X. KOU, M. LANG, K.-L. WANG, Dept. of Electrical Engineering, UCLA, Los Angeles, CA 90095 — We report STS studies of MBE-grown undoped and Cr-doped Bi_2Se_3 bi-layers on InP (111) and as a function of the up-doped layer thickness and the Cr-doping level (x). Our studies reveal *gapless* Dirac spectra at all temperatures (T) for samples with an undoped top layer larger than 5 QLs, implying that the interlayer magnetic correlation length $\xi_\perp$ is $<\sim$ 5-QL. For samples with an undoped top layer smaller than 5 QLs, STS reveals *gapped* spectra at $T < T_c = (260 \pm 20)$ K. The gap is spatially inhomogeneous and increases with decreasing T, reaching an x-independent maximum $\Delta = (0.8 \pm 0.2)$ eV at $T << T_c$. Further, the gap inhomogeneity increases with decreasing x, showing magnetic clusters separated by gapless regions and an in-plane magnetic correlation length $\xi_{||} \sim$ 8-QL. We also find spatially localized double and single resonance peaks in the gapless regions, and their areal densities peak near T_c. We attribute the resonance sites to isolated Cr impurities, which couple with the spins of surrounding Dirac electrons and form localized topological spin textures of a long lifetime. With increasing interlayer magnetic field, the resonance sites diminish and the gap distribution becomes more homogeneous.

[1]Work supported by DARPA.

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Date submitted: 15 Nov 2013 Electronic form version 1.4