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Broken lattice-symmetry influence on electronic anisotropy and interface exchange-coupling-induced ferromagnetic state in TI thin films and heterostructures[1]

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Inducing an exchange gap locally on the Dirac surface states of a topological insulator (TI) is ideal for observing the predicted unique features such as the quantized topological magnetoelectric effect, half-integer quantized Hall effect, as well as to con?ne Majorana fermions. Our work experimentally demonstrated the proximity-induced interface ferromagnetism in a heterostructure combining a ferromagnetic insulator EuS layer with Bi2Se3, without introducing defects [1]. An exchange gap was observed to be induced on the surface of the TI. Extensive magnetic and magneto-transport (magnetoresistance and anomalous Hall effect) investigation of the heterostructures, including synchrotron interfacial (XAS and XMCD measurements) studies have shown the emergence of a ferromagnetic phase in TI, which is a step forward to unveiling the above exotic properties. Also, to understand the intrinsic properties of TI it is necessary to correlate structure with the exotic electronic properties as well as interaction with other materials. Molecular beam epitaxy (MBE) ideally allows us to engineer the system whereas using synchrotron and electron diffraction based experimental techniques helps us to investigate with atomic resolution. We will elucidate our studies on well-defined TI films and heterostructure, and the role of imperfections on the symmetry of the material that leads to internal atomic ordering by the decoration of the defects. Charge transport and mobility are seen to relate with film growth strain and relaxation as well as display strong directional dependence on the defect geometry. Work done in collaboration with Peng Wei, Ferhat Katmis and others.

[1] P. Wei, F. Katmis, B. A. Assaf, H. Steinberg, P. Jarillo-Herrero, D. Heiman, and J. S. Moodera, PRL, 110, 186807 (2013)

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