SES17-2017-000004

Abstract for an Invited Paper
for the SES17 Meeting of
the American Physical Society

High-Temperature Interfacial Magnetic Order in Topological Insulator - Ferromagnetic Insulator Heterostructures[1]

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Realization of proximity-induced magnetism on a topological insulator (TI) surface with a ferromagnetic insulator (FMI) provides a rout for device applications with novel quantum functionality. We demonstrated a fundamental step towards realization of a high temperature magnetization in a TI-FMI heterostructure. Employing strong TI-FMI exchange coupling we have induced uniform long-range ferromagnetic order onto the surface of epitaxial Bi_2Se_3 films. Depth-sensitive polarized neutron reflectometry (PNR) discriminates the magnetism at the surface of TI from the FMI layer and directly measures proximity-induced interfacial magnetism in the top 2 QL (˜2 nm) layer of Bi_2Se_3 that is generated by the short-range exchange interaction at the interface with EuS. The interfacial spin polarized state persists up to room temperature, above the Tc of the FMI (EuS). The interfacial magnetism resulting from the large spin-orbit interaction and spin-momentum locking property of the TI surface is found to greatly enhance the magnetic ordering temperature. Due to the short-range nature of the ferromagnetic exchange interaction, the time-reversal symmetry is broken only near the surface of the TI, while leaving its bulk states unaffected [1]. The TI ferromagnetism is observed reproducibly in a variety of bi-layer samples with different combinations of thicknesses, providing a mechanism to control this effect. The analysis of polarized neutron off-specular scattering (OSS) that arises from lateral in-plane inhomogeneities, probes correlations of lateral inhomogeneity with a length scale of ˜0.1-10μm. These findings of locally-induced ferromagnetic order on the TI surface extending over macroscopic areas without impurity doping open the door for an energy efficient topological control mechanism for future spin-based technologies.

F. Katmis, V. Lauter, et al "Achieving high-temperature ferromagnetic topological insulating phase by proximity coupling", *Nature 2016,* ***533****, 513*

[1]Work supported by the Scientific User Facilities Division, Office of Basic Energy Sciences, and the US Department of Energy, by the Laboratory Directed Research and Development Program of Oak Ridge National Laboratory