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Topological Insulator Nanoribbons and Nanocrystals

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Following the discovery of two-dimensional topological insulator edge states in HgTe quantum wells at cryogenic temperatures, three dimensional (3D) topological insulators were recently discovered in Bismuth Selenide (Bi_2Se_3) and related compounds. Theoretical prediction and angle resolved photon emission spectroscopy studies show quantum spin Hall surface states in these 3D topological insulator materials. However, all the studies thus far have been on bulk size materials and it is challenging to observe directly the surface topological state conduction since its effects are masked by the residue bulk carrier. Here I present our study on topological insulator nanostructures, which can manifest the surface conduction states due their large surface-to-volume ratios. We show unambiguous transport evidence of topological surface states through periodic quantum interference effects in layered single-crystalline Bi_2Se_3 nanoribbons. Pronounced Aharonov-Bohm oscillations in the magnetoresistance clearly demonstrate the coverage of two-dimensional electrons on the entire surface. I will discuss our recent exciting study on topological insulator nanocrystals. Our results suggest that topological insulator nanoribbons and nanocrystals afford novel promising materials for future spintronic devices.