Observation of Robust Surface States in Highly-Disordered Topological Insulator Nanotubes

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— We have studied electrical transport properties of candidate topological insulator (TI) Bismuth Telluride (Bi$_2$Te$_3$) nanotubes at low temperatures and high magnetic fields. Bi$_2$Te$_3$ nanotube samples were synthesized by solution phase method, with the outer diameters in the range of 90 ~ 200 nm and wall thickness 10 ~ 15 nm, and typical length of over 10 µm. Focused ion beam (FIB) assisted deposition and e-beam lithography were applied to fabricate Ohmic contacts. Thermal conductivity measurements show the nanotubes have similar carrier concentration to other metallic nanowires and ribbons, while the nanotubes have insulating behavior, which is due to disorder. For the highly disordered samples, strong quantum oscillations in magnetoresistance were observed in parallel field, with an h/e period associated with the outer surface of the nanotubes. Detailed analysis indicates that the oscillations are due to Anomalous Aharonov-Bohm Effect originating from Dirac-like TI surface states. The relationship between oscillation and disorder will be discussed.

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