Template synthesis and characterization of Bi_2Te_3 and Sb_2Te_3 nanowires

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Topological insulators (TIs) are a new quantum state of matter which has gapless surface states. Currently known TI materials can possibly be classified into two families, the HgTe family and the Bi_2Se_3 family. It has been found that excellent thermoelectric materials can be also topologically trivial. Bismuth, antimony and tellurium compounds (Bi/Sb/Te) are known as the best thermoelectric materials for room temperature operation. However 2D quantum matter is a challenge, due to the difficulty of separating surface contributions from the non-conductivity of the bulk. Nanostructured synthesis/growth, doping, compositional tuning, or band-gap engineering via device gating, has not yet completely suppressed bulk conduction in the TIs.
Nano-scale topological insulators have a large surface-to-volume ratio that can manifest the conductive surface states and are promising for devices. Electronic transport of nanostructured TI's exhibit novel quantum effects. The main obstacle for future developement of TI based devices is growth of high quality TI structures.

Growth of nanowires with high surface to volume ratio can be realized by two methods, chemical vapour transport and electro-deposition. The second method used in the presented work and allows fabrication of structures such as p-n junctions, intercalation of magnetic or superconducting dots.

We report the fabrication of high quality TI thermoelectric single crystal nanowire (Bi_2Te_3, $Sb_2Te_{3)}$ via electro-deposition (ED). The morphological structure of nanowires was studied by SEM. Crystalline properties were investigated by TEM. Mono-crystal structure was confirmed for all nanowires. ED growth parameters such as substrate, substrate annealing, deposition potential and solution composition have been optimized for growth of mono crystal nanowires of Bi_2Te_3 and $Sb_2Te_{3.}$ Preliminary results show that electronic transport of electrodeposited nanowires is dominated by surface states as testified by weak antilocaliation.

Keywords: Template synthesis, electro-deposition, nanowires.