ABSTRACT

Topological Insulator Growth and Characterizations

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Topological insulators are a new class of materials that have recently received a lot of attention due to many novel properties that they have been predicted to possess. A topological insulator is a material that is electrically insulating in the bulk while possessing highly conductive and spin-polarized massless Dirac surface states that are protected against disorder by time-reversal symmetry, allowing for near dissipationless transport of spin on the surface. Additionally, time-reversal symmetry can be broken in a topological insulator by, for example, using elemental doping to induce a ferromagnetic phase in the material. The broken time-reversal symmetry allows for the formation of an energy gap on the surface and is important for many interesting properties in these materials. Currently, much work is being done to improve the ability to study the surface states in these materials by, for instance, improving material quality to lower bulk conduction and by using experimental techniques that can distinguish surface transport from bulk transport. In this work, the foundations and properties of topological insulators will be discussed along with many possible applications of these materials for electronics and spintronics devices. Next, the synthesis and material properties of many kinds of topological insulator materials, both nanostructures and thin films, will be presented. Then, experimental techniques used to study the surface states and differentiate them from the bulk states will be explained. Finally, the results from electronic transport experiments in topological insulator nanostructures of Bi_2Se_2Te and in thin films of Bi_2Te_3 with broken time-reversal symmetry will be presented and analyzed.