Materials Science & Engineering Master's Defense

Electronic excitations in Topological Insulators studied by Electron Energy Loss Spectroscopy

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abstract

Topological insulators with conducting surface states yet insulating bulk states have generated a lot of interest amongst the physics community due to their varied characteristics and possible applications. Doped topological insulators have presented newer physical states of matter where topological order co-exists with other physical properties (like magnetic order). The electronic states of these materials are very intriguing and pose the problems and the possible solutions to understanding their unique behaviors.

In this work, we use Electron Energy Loss Spectroscopy (EELS) – an analytical TEM tool to study both core-level and valence-level excitations in Bi_2Se_3 and Cu(doped)Bi_2Se_3 topological insulators. We use this technique to retrieve information on the valence, bonding nature, co-ordination and lattice site occupancy of the undoped and the doped systems. Using the reference materials Cu(I)Se and Cu(II)Se we try to compare and understand the nature of doping that copper assumes in the lattice. And lastly we present results obtained using the state of the art monochromated Nion UltraSTEM 100 to study electronic/vibrational excitations at a record energy resolution from sub-nm regions in the sample.

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