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Optical conductivity of Bismuth-based topological insulators

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Topological Insulators (TI) are new quantum materials with an insulating-gap in the bulk of spin-orbit origin and metallic states at the surface. These states are chiral and show dissipation-less transport properties protected from disorder by the time-reversal symmetry. In addition to their fundamental properties, TI have potential applications in quantum computing, photonics, and spintronic devices. Materials belonging to the V2VI3 (V= Bi, Sb, S; VI = Se, Te, S) family recently emerged, due to their large bulk insulating gap (~300 meV), as the first candidates for the study of topological surface states.

However the as-grown crystals usually display, due to impurities/unstoichiometry related to the growing process, an extrinsic degenerate semiconducting behavior. Those impurities affect the low energy transport properties, rendering difficult the separation between the intrinsic 2D metallic behavior due to topological surface states and the 3D metallic conduction induced by extrinsic charges.

In this talk I will discuss the optical conductivity $\sigma 1(\omega)$ and the optical spectral weight SW of four topological insulators with an increasing chemical compensation (Bi2Se3, Bi2-xCaxSe3 x=0.005, Bi2Se2Te, Bi2Te2Se). The effect of compensation is clearly visible in the infrared spectra, through the suppression of the extrinsic Drude term and the appearance of strong peaks in the terahertz range assigned to electronic transition among impurity states. The SW of the most compensated sample (Bi2Te2Se) is still nearly two orders of magnitude higher than that expected from the surface states.

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