Surface states of topological crystalline insulators

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The discovery of topological insulators is one of the most important recent developments in condensed-matter physics. In these quantum materials the band structure is inverted due to strong relativistic (spin-orbit) effects. The band gap inversion and the time-reversal symmetry requires that the bulk insulating states are accompanied by metallic Dirac-like electronic states on the surface of the crystal. These surface states are encoded in topologically non-trivial wave functions of valence electrons and robustly resist non-magnetic disorder. They are non-degenerated and have helical spin structure, which leads to conduction channels insensitive to back-scattering.

Recently it has been predicted theoretically that in rock-salt IV-VI crystals the role of time-reversal in the topological protection of the metallic surface states can be replaced by crystalline mirror plain symmetry, [1]. This prediction has led to the discovery of a new class of materials with similar to topological insulators properties, i.e., topological crystalline insulators (TCIs). Namely, in 2012 it has been shown by angle-resolved photoelectron spectroscopy (ARPES) studies that SnTe and IV-VI substitutional alloys, $Pb_{1-x}Sn_xSe$ and $Pb_{1-x}Sn_xTe$ with Sn content *x* higher than a critical value, have topologically protected surface states, which present Dirac dispersion, [2-4].

During the talk I will discuss the predicted theoretically properties of surface Dirac-like electrons in the IV-VI TCIs. In particular, it has been shown, using tight binding approach for the band structure calculation, that the energy spectra and the spin textures of the surface states strongly depend on the surface orientation [2, 5-7]. For example, in contrast to the surface states observed on the (100) surface, the Dirac cones of (111) surface states are well separated and no interacting [6]. I will describe ARPES [2] and spin-resolved ARPES [5,7] experiments performed on the bulk as well as thin $Pb_{1-x}Sn_xSe$ layer, which confirm the theoretical predictions. Finally, I will also discuss how the reduced dimensionality in TCIs thin layers and quantum wells affects the surface/interface states and hence their topological properties.

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