Electron and spin properties of topological crystalline insulator $Pb_{1-x}Sn_xSe$

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Topological crystalline insulators (TCIs) constitute a new class of quantum materials with the Dirac-like metallic surface states that cross the bulk semiconductor band gap and are topologically protected by crystalline mirror plane symmetry.The TCI materials offer new ways of controlling topological states by applying perturbations lowering crystalline symmetry. The TCI states have been experimentally observed in $Pb_{1-x}Sn_xSe$, SnTe, and $Pb_{1-x}Sn_xTe$ for both (001) and (111) surfaces. These IV-VI semiconductors undergo (at a specific tin content, temperature, and pressure) a band structure inversion driven by strong relativistic effects. The investigations of the surface electronic states by angle- and spin-resolved photoemission spectroscopy will be presented for $Pb_{1-x}Sn_xSe$ (x=0-0.37) bulk monocrystals and epitaxial layers as well as $Pb_{0.65}Sn_{0.33}Mn_{0.02}Se$ crystals with magnetic Mn^{2+} ions. In the inverted band structure regime we found the Dirac-like topological in-gap states in the vicinity of four X points of the (001) surface Brillouin zone and observe a temperature-driven topological phase transition from a trivial insulator to a TCI state below the band inversion point. In crystals with Mn ions we demonstrate the tuning of the topological transition temperature by band gap engineering. The spin-resolved ARPES experiments revealed a characteristic vortical electron spin polarization texture at the Dirac points.

References:

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