Abstract for an Invited Paper
for the MAR15 Meeting of
the American Physical Society

Electron and spin properties of topological crystalline insulator \((\text{Pb,Sn})\text{Se}\)^1

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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 states have recently been experimentally observed in \((\text{Pb,Sn})\text{Se}, \text{SnTe}, \text{and} (\text{Pb,Sn})\text{Te for both (001) and (111)}\) crystal 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 bulk \((\text{Pb,Sn})\text{Se} \) monocrystals with tin content up to 37 at. %, also doped with magnetic \( \text{Mn}^2+ \) 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 very efficient tuning of the topological transition temperature by band gap engineering effect. The spin-resolved ARPES experiments revealed a characteristic vortical electron spin polarization texture at the Dirac points. Based on spectroscopic observation we construct the composition - temperature topological phase diagram of \((\text{Pb,Sn})\text{Se} \) and compare it with tight-binding band structure calculations. P. Dziawa et al., Nat. Mat. 11, 1023 (2012); B.M. Wojek et al., Phys. Rev. B 87, 115106 (2013); C.M. Polley et al., Phys. Rev. B 89, 075317 (2014); B.M. Wojek et al., Phys. Rev. B 90, 161202 (R) (2014).

^1Supported by NCN (Poland) research project 2011/03/B/ST3/02659.