(111) $Pb_{1-x}Sn_xSe$ TCI epilayers across band inversion point probed by magnetotransport and spin-resolved ARPES

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Topological surface states (TSSs) of 3D topological insulators have a linear Dirac dispersion and are suitable for spintronic applications due to spin-momentum locking. Topological crystalline insulators (TCIs) based on narrow-gap IV-VI lead-tin chalcogenide semiconductors also have these peculiar properties. In these compounds, gap inversion can be induced by both temperature changes and changes in tin content. Here we studied TCI $Pb_{1-x}Sn_xSe$ epilayers grown by molecular beam epitaxy in the (111) orientation. By varying the Sn content we investigated the evolution of their magnetotransport properties and spin-resolved photoemission (SR-ARPES) spectra in the band inversion region. The high surface quality of the obtained samples was confirmed by RHEED and AFM. The Sn content was determined by XRD and EDX-SEM. The samples with compositions corresponding to trivial and topological phases were investigated and similar properties were found in both phases. Although ARPES measurements proved that the surface gap closes after the topological transition is induced, weak anti-localization (WAL) [1] and spin texture in the reciprocal space [2] remain unchanged. SR-ARPES measurements indicated 30% spin-polarization for the in-plane spin component in both phases. Behaviour of magnetoresistance showed that WAL effect depends on the symmetries present in the system, rather than on topology. These results agree with the theoretical calculations predicting π Berry phase for both trivial and topological phases, and with the importance of the symmetries present. The results pave the way for the application of surface states of not only topological but also trivial IV-VI semiconductors in spin-charge conversion devices.

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References

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