Hinge states in topological crystalline insulators nanowires

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In recent years topological crystalline insulators (TCIs) attract much attention in condensed-matter physics. In this class of materials the inversion of the band gap leads to the existence of gapless surface states which are protected by crystalline symmetries. In IV-VI TCIs bulk crystals the band gap is inverted in 4 nonequivalent L points in the Brillouin zone (BZ) and nontrivial topology is protected by $\{110\}$ mirror plane symmetries [1,2].

In this communication we study theoretically, using tight binding calculations, the topological properties of SnTe and (Pb,Sn)Se nanowires (NWs) grown along the [001] direction. The studied NWs have a square cross-section. In this case 4 L points of the bulk BZ are projected to one $\bar{L}$ point of the NW BZ. As a consequence, we obtain many solutions in the vicinity of $\bar{L}$ in the energy region of the bulk gap. It turns out that the states with energies close to the middle of the gap are well localized at the NW hinges. We study the properties of these states. In particular, how, their localization depends on the wire thickness and bulk gap energy. We show that the hinge states are protected by (110) and $(1\bar{1}0)$ mirror plane symmetries. We also discuss the role of C_4 and time reversal symmetries.

Similar hinge states, however with protection of a different origin, have been predicted by Schindler et al in the context of higher order topological insulators [3].

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[1] T. H. Hsieh et al., *Nat. Commun.* **3**, 982 (2012)
[2] P. Dziawa et al., *Nat. mat.* **11**, 1023 (2012)
[3] F. Schindler et al., *Sci. Adv.* **4**, eaat0346 (2018)