Strain-induced topological edge states in SnTe: STM/STS signatures and a theoretical model

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2D topological crystalline insulators (2D-TCI) represent an exotic quantum state of matter characterized by metallic edges states (MES) residing within a bulk band gap [1]. Unlike 2D topological insulators where the MES are protected by time-reversal symmetry, the edge states of a 2D-TCI are protected by crystal symmetries and are characterized by the Chern mirror topological invariant. The 3D SnTe is already a known 3D-TCI [1], hosting topological protected surface states instead of edge states, but it behaves as a trivial insulator when reduced to the few layers limit (less than 10 layers) [2]. In this work we show through DFT calculations that slowly compressing the few layers of SnTe leads to a gap-closing transition, and SnTe already starts behaving as a 2D-TCI on moderate compression of 2-3%, where a clear band inversion is observed. The intrinsic ferroelectric properties of the SnTe are also investigated within this regime, where the possibility of topological and ferroelectric phases coexisting is considered. We show that such compression can be achieved when bilayers of SnTe are grown on a NbSe2 substrate due to the incommensurability between their square and hexagonal cells. The topologically protected MES are clearly observed in STS scans taken over the step edges of a bilayer to monolayers SnTe, where very clear and symmetric islands are obtained. This work opens the possibility for the engineering of such topological states by controlling the number of layers of SnTe, and by using different kinds of substrate, where its lattice parameter can then be tuned.

[1] Hsieh, T., Lin, H., Liu, J. et al., *Nat Commun* **3**, 982 (2012).
[2] Araújo, A.L., Ferreira, G.J. & Schmidt, T.M, *Sci Rep* **8**, 9452 (2018).