Topological crystalline insulators – from crystal facets with atomic steps to nanowires

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Topological crystalline insulators (TCI) constitute a class of quantum materials exhibiting surface (2D) and edge (1D) electronic states with Dirac-like linear dispersion and spin – momentum locking. Protected by crystalline symmetry, TCI 2D states are observed in SnTe, $Pb_{1-x}Sn_xTe$, and $Pb_{1-x}Sn_xSe$ IV-VI semiconductors at (001) and (111) facets of single crystals. Experimental observations of these states cover angle- and spin-resolved photoemission (ARPES), scanning tunneling spectroscopy (STM/STS) as well as magneto-transport and magneto-optical measurements [1-3]. 1D topological edge states are observed at monolayer atomic steps at TCI (001) crystal facets [2,3]. Recent observations concern the influence of electron-electron interactions on local density of states due to electron flat band formed at atomic steps at Dirac point in resonance with Fermi energy, as controlled by surface doping with metals [3]. TCI materials are now available in the form of crystalline nanowires, including cubic SnTe [4], core-shell GaAs/$Pb_{1-x}Sn_xTe$ [5], and $Pb_{1-x}Sn_xTe$ of both square and pentagonal (composed of cubic crystalline twins) cross-sectional symmetry. Important research task is now the experimental verification of various theoretical predictions, including hinge or corned states in TCI nanowires hosting zero-energy modes [6-8].

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[1] P. Dziawa, B.J. Kowalski, K. Dybko et al., Nat. Mat. **11**, 1023 (2012).

[2] P. Sessi, D. Di Sante, A. Szczerbakow et al., Science. **354**, 1209 (2016).

[3] G. Wagner, S. Das, J. Jung et al., Nano Lett. **23**, 2476 (2023).

[4] J. Sadowski, P. Dziawa, A. Kaleta et al., Nanoscale **10**, 20772 (2018).

[5] S. Dad, P. Dziawa, W. Zajkowska-Pietrzak et al., Scientific Reports **14**, 589 (2024).

[6] G. Hussain, G. Cuono, P. Dziawa et al., arXiv: 2401.03455.

[7] N.M. Nguyen, W. Brzezicki, and T. Hyart, Phys. Rev. B **105**, 075310 (2022).

[8] S. Samadi, R. Rechciński, and R. Buczko, Phys. Rev. B **107**, 205401 (2023).