Photoemission of Topological Material Epilayers Based on IV-VI Semiconductors and α-Sn

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Topological materials are promising candidates for future electronics and spintronics as well as of great interest for fundamental condensed matter physics.

In this talk, we discuss epitaxial films of topological materials produced by molecular beam epitaxy in form or orientation which is difficult to achieve in bulk. The angular resolved photoemission spectroscopy (ARPES) experiments are presented in regards to epitaxial growth, structural characterization, transport properties, etc. of the epilayers.

First, we consider (111) and (001) topological crystalline insulators (TCI) epilayers based on IV–VI semiconductors [1]. Band inversion and crystal symmetry protection in TCIs make topological surface states (TSS) very sensitive to external perturbations. We show that deposition of transition metals (TM) on the surface can drastically change the carrier's energy spectrum. Further employing spin-resolved ARPES, we show that helical spin-polarization can exist even in trivial insulator state [2].

Second, we discuss gray tin (α-Sn) epilayers synthesized on (001) insulating CdTe/GaAs substrates. Gray tin is an elemental topological material in which zego-gap semiconductor - Dirac semimetal (DSM) – Weyl semimetal (WSM) transition can be realized. We demonstrate how DSM and WSM phases are revealed by combined ARPES, magnetotransport measurements and strain characterization of obtained samples.

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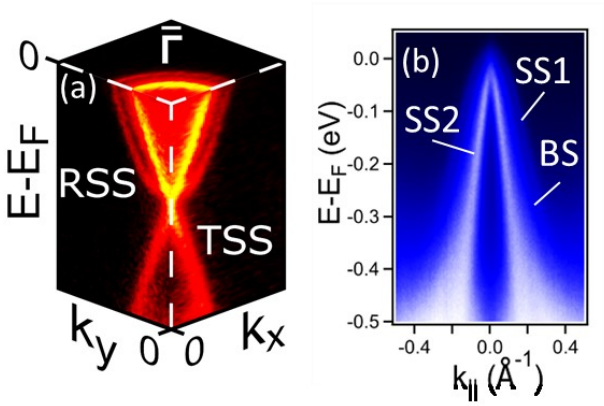

Fig. 1. ARPES spectra of a) (111) $Pb_{0.75}Sn_{0.25}Se$ epilayer demonstrating Dirac-Rashba states after transition metal deposition and b) (001) α-Sn epilayer showing bulk (BS) and surface (SS2) Dirac-like states .

[1] A. Kazakov, *et al.*, V. Volobuev, T. Dietl, Physical Review B, **103**, 245307 (2021).
[2] B. Turowski, *et al.*, V. Volobuev, Applied Surface Science, **610**, 155434 (2023).