

Observation of surface-state transport by Mn doping into a topological crystalline insulator SnTe thin film with strain

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Topological crystalline insulators (TCIs) are topological insulators (TIs) whose surface states are protected by crystal mirror symmetry rather than time-reversal symmetry. In usual TIs, when magnetism is introduced, a gap opens in the Dirac band of the topological surface state [1], and the quantum anomalous Hall effect has been observed [2]. However, the relationship between magnetism and topological surface states in TCIs has not yet been fully elucidated.

Therefore in this study, we performed *in situ* ARPES measurements on SnTe films doped with magnetic Mn, which should be an ideal system for studying the relationship between topology and magnetism in TCIs. SnTe, a prototypical TCI material, has Dirac cones at the Γ and M points on the (111) surface [3]. In this study, a strained SnTe film was prepared on a $\text{Bi}_2\text{Te}_3(111)$ thin film, and then Mn and Te were co-deposited for magnetic doping. Figure 1 shows ARPES intensity mapping at the Fermi level (top) and the band dispersion along the Γ -M direction (bottom) for (a) pristine SnTe and (b) Mn-doped SnTe, respectively. Since SnTe is known to be *p*-doped due to the Sn vacancies, one can find circular and star-like hole pockets around Γ and hole lobes along Γ -M for the pristine SnTe. In contrast, since Mn incorporation in SnTe induces electron doping, circular Fermi surfaces of surface-state electrons and holes were observed for the Mn-doped sample. We also measured the Hall effect by *in situ* four-probe transport measurements and it was revealed that the carriers in pristine SnTe are holes while a multiple-carrier transport with hysteresis was observed for Mn-doped SnTe. These features are reflecting the Fermi surface, and we can say that we have succeeded in forming a bulk-insulating magnetic SnTe film. The details will be discussed along with the results of atomic structure analysis using TEM-EDS.

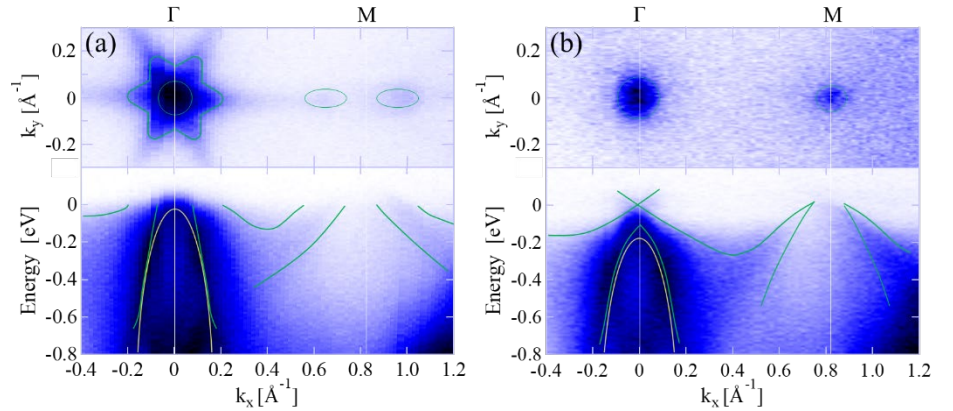


Figure 1: ARPES measurement results for (a) SnTe and (b) Mn-doped SnTe.

Color guide: Yellow represents bulk bands, while green represents surface bands.

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