THE LANDAU LEVELS OF TOPOLOGICAL CRYSTALLINE INSULATOR $Pb_{1-x}Sn_xTe$ PROBED BY MAGNETOOPTICAL ABSORPTION

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Topological materials have recently emerged as systems that hold the prospect for future high mobility electronic applications, spintronic devices and platforms to study exotic quantum effects. This mostly owed to their Dirac surface electron states. In particular, the recently discovered topological crystalline insulating state in $Pb_{1-x}Sn_xTe$ is known to exhibit such topological states that are protected by crystalline symmetry. As a result, the Dirac states are valley degenerate, and the band topology is sensitive to crystalline deformations [1]. This motivates us to characterize the band structure of such systems using magneto-optical absorption experiments. In this work, we, thus, examine the Landau level spectrum of the bulk and surface states of high mobility topological crystalline insulator $Pb_{1-x}Sn_xTe$ film using far- and mid- infrared magneto-optical absorption at T=4.5K and up to B=15T.

Epilayers of $Pb_{1-x}Sn_xTe$ (1-2µm, x=0.46) are grown on BaF_2 (111). Mobilities that are close to $1m^2/Vs$ and carrier densities of at most $2\times10^{18}cm^{-3}$ are achieved. As a result, the onset of Landau quantization occurs close to 1T and allows a reliable mapping of the band parameters (Fermi velocity, band gap, effective mass) of the bulk and surface states in $Pb_{1-x}Sn_xTe$. A number of strong interband transitions that vary as $B^{1/2}$ are identified and attributed to the valley degenerate bulk bands, known to have massive Dirac dispersions.

Additionally, two intraband transitions are observed at lower energies. A strong transition, that satisfies a massive Dirac model is associated with a bulk longitudinal valley, while a second weaker transition is seen to unambiguously satisfy a massless Dirac model and is attributed to a topological surface state occurring at the $\overline{\Gamma}$-point of the (111) surface. The Fermi velocity of the $\overline{\Gamma}$-surface state and longitudinal bulk states are found to be equal. The experimental value of the Fermi velocity is in agreement with the theoretical value calculated from the **k.p** matrix element for $Pb_{1-x}Sn_xTe$, thus confirming our interpretation [2].

Our results provide reliable quantitative information about the surface and bulk band structure of $Pb_{1-x}Sn_xTe$, and are of great use to future work in magneto-optics and magnetotransport on such topological materials.

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