Surface and Structural Analysis of (110)-oriented $Pb_{1-x}Sn_xTe$ Topological Crystalline Insulator

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The novel class of semiconductors namely topological crystalline insulators (TCIs) is a rapidly developing research area of modern solid state physics. In these materials, surface electron states with Dirac dispersion relation are formed on certain high symmetry surfaces. $Pb_{1-x}Sn_xTe$ alloy has been experimentally discovered as a member of TCIs family in the previous decade. It exhibits topological phase transition above a critical concentration of Sn ($x \geq 0.36$ at LHe temperature) [1]. Theoretical predictions of band inversion at high symmetry L point in the Brillouin zone, and experimental evidence for topologically protected states on (001) [2] and (111) surfaces [3] of $Pb_{1-x}Sn_xTe$ alloy have already been proclaimed in literature. However, (110)-oriented $Pb_{1-x}Sn_xTe$ has not been studied experimentally in this context yet. We have grown thin layers of $Pb_{1-x}Sn_xTe$ solid solution by molecular beam epitaxy (MBE). To our knowledge the growth of $Pb_{1-x}Sn_xTe$ in the (110) orientation has not been reported so far. We have found that direct growth on epi-ready GaAs(110) substrates resulted in non-uniform layers with mixed (100) and (111) orientations. To get around this problem we have used hybrid substrates with thick CdTe(110) buffer grown in separate MBE system. The layers have been investigated by several characterization techniques such as energy dispersive X-ray fluorescence, atomic force microscope, X-ray diffraction and, high resolution transmission electron microscopy which reveals the (110)-orientation of $Pb_{1-x}Sn_xTe$. Angle-resolved photoemission experiments are underway to identify topologically protected surface states on the $Pb_{1-x}Sn_xTe$(110) surface.

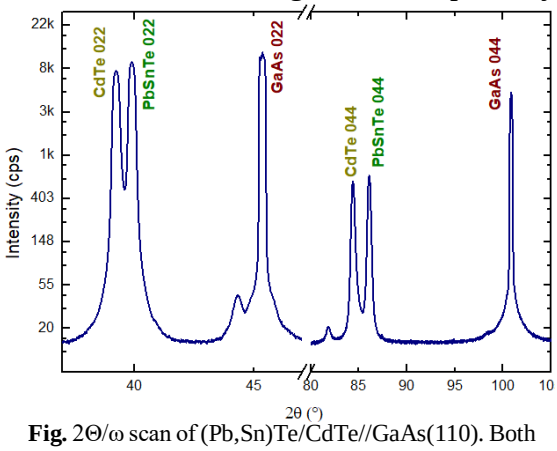

Fig. 2Θ/ω scan of (Pb,Sn)Te/CdTe//GaAs(110). Both (Pb,Sn)Te layer and CdTe buffer show same out of plane <011> growth

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