XPS study of Te-protected surface of $Sn_{1-x}Mn_xTe$ topological crystalline insulator

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In past few years a great focus was put on SnTe, $Pb_{1-x}Sn_xTe$ and $Pb_{1-x}Sn_xSe$ IV-VI compounds and alloys due to the observation of topological crystalline insulator (TCI) states at the (001) and (111) surfaces of bulk crystals [1,2]. The original experimental discovery was done with angle-resolved photoelectron spectroscopy (ARPES) method applied to atomically clean surfaces obtained by cleaving the crystals in ultrahigh vacuum [3]. This simple and versatile method cannot be used for important topological systems like layered heterostructures or poorly cleaving materials like lead and tin tellurides. Therefore, developing the methods of analysing, modifying and protecting the surface of TCI thin layers is vital for future development of this field towards electronic and optical heterostructures.

In the light of the above, we present the findings of conventional X-ray Photoelectron Spectroscopy (XPS) study where tellurium protecting cap layer was employed to prevent the surface contamination and to preserve the surface quality of the $Sn_{1-x}Mn_xTe$ layers sufficient for future surface sensitive measurements of topological effects. The $Sn_{1-x}Mn_xTe$ layers covered by either amorphous (a-Te) or crystalline (c-Te) thin capping layer were grown by molecular beam epitaxy on GaAs (001) substrate with a thick CdTe buffer. Prepared samples were transferred in ambient air environment into ultra-high vacuum system of XPS before being treated by annealing procedure. The XPS, atomic force microscopy, and X-ray diffraction methods were used to investigate the electronic structure, chemical composition, and structural properties of the (001) surface of $Sn_{1-x}Mn_xTe$ layers. It was found that sample annealing for at least 20 min at 250 - 290 ^{0}C successfully removed the oxidized cap tellurium layer and provided atomically clean surface of $Sn_{1-x}Mn_xTe$. That finding makes it possible to perform "surface sensitive" measurements such as ARPES. Authors believe that proposed method can be an effective pathway to obtain clean surfaces of IV-VI TCI materials expected to exhibit both TCI properties and carrier-induced ferromagnetism.

[1] Y. Tanaka et al., *Nat. Phys.* **8,** 800 (2012).
[2] P. Dziawa et al., *Nat. Mat.* **11**, 1023 (2012).
[3] P Richard et al., *J. Phys.: Condens. Matter*, **27**, 293203 (2015).