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Topological phase transition according to internal strain in few layer Bi2Se3 thin film grown via a self-organized ordering process

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In a three-dimensional topological insulator Bi2Se3, a stress control for band gap manipulation was predicted but no systematic investigation has been performed yet due to the requirement of large external stress. We report herein on the strain-dependent results for Bi2Se3 films of various thicknesses that are grown via a self-organized ordering process. Using small angle X-ray scattering and Raman spectroscopy, the changes of d-spacings in the crystal structure and phonon vibration shifts resulted from stress are clearly observed when the film thickness is below ten quintuple layers. From the UV photoemission/inverse photoemission spectroscopy (UPS/IPES) results and ab initio calculations, significant changes of the Fermi level and band gap were observed. The deformed band structure also exhibits a Van Hove singularity at specific energies in the UV absorption experiment and ab initio calculations. Our results, including the synthesis of a strained ultrathin topological insulator, suggest a new direction for electronic and spintronic applications for the future.

Keywords: Topological insulator, Topological phase transition, Bi2Se3 thin film, internal strain

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Surface Analysis of Copper-Tin Thin Films Synthesized by rf Magnetron Co-sputtering

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Copper-Tin (CuSn) thin films were synthsized by rf magnetron co-sputtering method with pure Cu and Sn metal targets with various rf powers and sputtering times. The obtained CuSn thin films were characterized by a surface profiler (alpha step), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), X-ray induced Auger electron spectroscopy (XAES), and contact angle measurement. The deposition rates were calculated by the thickness of CuSn thin films and sputtering times. We observed hexagonal Cu20Sn6 and cubic Cu39Sn11 phases from the films by XRD measurement. From the survey XPS spectra, the Cu and Sn main peaks were observed. Therefore, we could conclude CuSn thin films were successfully fabricated on the substrate in this study. The changes of oxidation states and chemical environment of the films were investigated with high resolution XPS spectra in the regions of Cu 2p, Cu LMM, and Sn 3d. Surface free energy (SFE) and wettability of the CuSn thin films were studied with distilled water (DW) and ethylene glycol (EG) using the contact angle measurement. The total SFE of CuSn thin films decreased as rf power on Cu target increased. The contribution to the total SFE of dispersive SFE was relatively superior to polar SFE.

Keywords: CuSn thin films, XPS, XAES, SFE