Comparative reactivity of Bi_2Te_3, Sb_2Te_3, $(Sb,Bi)_2Te_3$ topological insulators

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Topological insulators with their spin-locked, gapless states on the surfaces attract an attention of physicists, chemists and material scientists. $(Bi,Sb)_2Te_3$ solid solution is one of the best candidate for the applications of its topological properties since by composition variation bulk carrier concentration can be tuned to realize bulk insulating samples providing a considerable contribution of the topological features in its electron conductance. As this material is supposed to be used in a form of thin films its stability under conditioning is an important practical issue. Besides, the behavior of mixed crystals in its connection with the properties of counterparts brings a fundamental interest.

Here we report the results of a photoemission study of the Bi_2Te_3, Sb_2Te_3, $(Bi,Sb)_2Te_3$ (111) surface oxidation in oxygen, water and humid air by *ex situ* XPS and *in situ* NAP XPS. The surface reactivity for the mixed crystals is always between that of more robust Bi_2Te_3 [1] and more reactive Sb_2Te_3 [2]. *Ex situ* studies demonstrate the non-linear dependence of surface reactivity on the composition - at the very first step, which has statistical nature, it defined by the fraction of surface Te atoms bonded to Sb. Further process is influenced by the Sb redistribution between oxide layer (enriched) and crystal surface (depleted). This redistribution is confirmed by atomic-level resolution TEM data. An underlayer Te^0 XP spectral component indicates formation of elementary Te after Sb depletion. If the oxygen is activated by X-ray beam (*in situ* NAP XPS) the activation barrier for the first step is overcome, and the reactivity of the mixed crystals does not depend on their composition.

The influence of oxygen pressure in *in situ* experiment was studied at Sb_2Te_3 in the range 0.0275-0.5 mbar. It was revealed that at lower pressures (up to 0.1 mbar inclusively) saturation is observed on curves describing the oxidation of tellurium, followed by depletion of the oxide layer by tellurium, while at higher pressures the saturation is missing.

References:
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