ABSTRACT

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SnTe and PbTe oxidized semiconductor compounds and components: cluster formation and speciation

Understanding the nano-scale processes provides the important information on fundamental properties of a material surface. Issues regarding both the theory and application of clusters have become of current importance due to the most recent accomplishments including the development of topological insulators which are a new type of semiconductor materials.

This doctor thesis focuses on the analysis of clusters and molecular speciation of SnTe and PbTe semiconductors and their components. The surface of SnTe and SnTe semiconductor crystals, tellurium and selenium oxidized by different methods, metallic bismuth, tin and zinc were investigated. The realization of key goals, i.e. mutually complementing research on the cluster formation and speciation of materials under consideration has been made possible through joint using TOF SIMS, Raman spectroscopy, AR XPS, Angle-resolved XPS.

The analyses of Se and Te surface mass spectra over a wide mass range has allowed making suggestions regarding how clusters are formed in these materials under the influence of primary beam ions. For clusters implanted with chalcogenides the detection level was increased due to the use of a special technique to investigate high mass clusters. Additionally the speciation analysis was made to determine the types of elements and oxides. The Plog's model is used to determine the oxidation level of materials. It has been found that a multilayer depth non-uniform structure is formed in naturally oxidized SnTe. Main components of this structure are SnO_2 and tellurium in three chemical states: elemental Te, tellurium dioxide TeO_2 and tellurium complex TeO_x ($0<x<2$). The oxidation kinetics has been investigated within the time periods from 10 minutes till 2 years. It has been found that SnTe oxidation under room temperature is a long process. The comparison of TOF SIMS spectra made for Te, SnTe and PbTe proves that SnTe is oxidized faster than PbTe.