Agnieszka Wolos, J Material Sci Eng 2015, 4:3
http://dx.doi.org/10.4172/2169-0022.C1.031

OMICS International
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International Conference and Exhibition on
Mesoscopic & Condensed Matter Physics
June 22-24, 2015 Boston, USA

# Three-dimensional topological insulators-a new phase of quantum matter; growth issues and the properties of bismuth chalcogenides

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It has been recently discovered that bismuth chalcogenides, previously recognized for its thermoelectric properties, hide a surprise in the band structure - topologically protected surface states. They are so-called three-dimensional topological insulators constituting a new state of quantum matter. They possess a band gap in the bulk and metallic surface states resulting from the change of the topological invariant at the interface with other material (could be the vacuum). The crystal structure of bismuth chalcogenides hosts considerable amounts of lattice defects, which results in highly conducting bulk covering the surface electric transport. In order to investigate properties of both the bulk and the surface states, $Bi_2Te_3$, $Bi_2Se_3$, and $Bi_2Te_2Se$ were grown by the vertical Bridgman method at the Institute of Electronic Materials Technology, Warsaw. Undoped $Bi_2Te_3$ is p-type due to bismuth anti-sites while $Bi_2Se_3$ is n-type due to selenium vacancies. The structure of $Bi_2Te_2Se$ prevents formation of both types of defects, resulting in the lowest conductivity of all the three materials. The conductivity of $Bi_2Se_3$ was reduced by varying the stoichiometry and applying calcium acceptor doping. The limits for the reduction of the bulk concentration will be discussed. Bulk and surface states were investigated using the contactless microwave spectroscopy (with the use of a standard electron paramagnetic resonance spectrometer). Properties of the bulk conduction electron spin resonance will be presented, while the presence of the surface states is manifested in the cyclotron resonance and weak anti-localization phenomena.

## Biography

Agnieszka Wolos has completed her PhD in 2005 from the University of Warsaw, Faculty of Physics. In 2005-2006 she was a Post-Doc at the Johannes Kepler Universität Linz, Institut für Halbleiter- und Festkörperphysik. She is now an Assistant Professor at the Institute of Physics Polish Academy of Sciences and at the University of Warsaw. She is interested in electron paramagnetic resonance, in particular in the application to studies of the electron transport phenomena. She currently works on topological insulators.

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