I. Institute of Physics
Physics of New Materials

RWTH AACHEN UNIVERSITY

Institute of Physics IA
Phase Change Materials Group
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Master Thesis in Physics (German/English)

Tuning of Transport Properties in PbTe-Sb_2Te_3 Phase Change Materials by Gating and Vacancy Control

Phase change materials (PCMs) are renowned for their pronounced optical and electrical property changes upon crystallization and have played an important role for optical storage devices in the past. Recently they enjoy renewed interest for their potential applications in novel electronic storage devices.

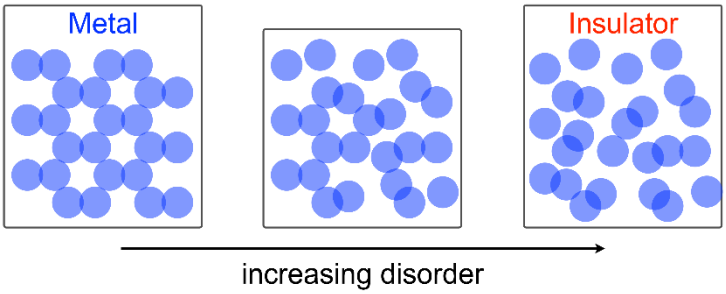

Figure 1: Disorder-induced metal-insulator transition

The electrical properties of PCMs, consisting primarily of group IV-VI elements, show a unique dependence on the disorder of the system. This can be used to effectively tune the transport properties and even lead to a metal-insulator transition. Replacing the commonly used Ge by the isoelectric but heavier Pb reveals several interesting effects like an n-p-transition, topological properties and a reduction of carrier concentration. For PbTe some of the effect can be explained by the varying formation energies of different vacancy types. However, no extensive studies were reported for systems with increased intrinsic vacancies, present in materials of the PbTe-Sb_2Te_3 line.

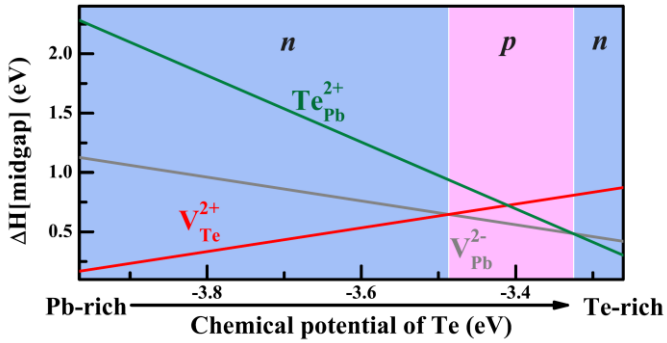

Figure 2: Vacancy formation energies in PbTe. [3]

In the scope of this thesis several materials of the PbTe-Sb_2Te_3 line will be examined with regards to their transport properties and band structure. The impact of vacancies are tested by changing the constituent concentration and by thermal annealing. Microscopic analysis of the transport properties can be obtained by electric field gating, Fourier transform infrared spectroscopy (FTIR) and tunneling experiments. Both, experimental and theoretical aspects of this work are equally important.

We are looking for a motivated student with good communication skills that is interested in working with unique materials and electronic devices.

Resources:

[1] Disorder-induced localization in crystalline phase-change materials, *Nature Materials*, T. Siegrist et al., 2011

[2] Candidates for topological insulators: Pb-based chalcogenide series, *Physical Review B*, H. Jin et al., 2011

[3] Microscopic origin of the p-type conductivity of the topological crystalline insulator SnTe and the effect of Pb alloying, *Physical Review B*, N Wang et al., 2014

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