DS 10: Thermoelectric and Phase Change Materials

Time: Monday 16:45–18:00 Location: H39

DS 10.1 Mon 16:45 H39

Switching behaviour of epitaxial Ge2Sb2Te5 thin films — •Mario Behrens, Andriy Lotnyk, Jürgen W. Gerlach, and Bernd Rauschenbach — Leibniz Institute of Surface Engineering (IOM), Permoserstraße 15, 04318 Leipzig, Germany

Phase change materials represent a promising material class with applications in various fields such as photonics, data storage and neuromorphic computing. The unique characteristic of these materials is a pronounced electrical and optical property contrast between different phases combined with the possibility to switch between these phases fast and reversibly. One of the most prominent phase change materials is the Te-based chalcogenide Ge2Sb2Te5 which has been intensively studied due to its well-balanced switching properties. A promising approach to gain deeper knowledge of the material properties is to employ epitaxially grown thin films, since it enables precise control of the structure and the phase and furthermore allows studies presupposing single-crystalline orientation. In this work, the switching behaviour of epitaxial Ge2Sb2Te5 thin films grown on Si(111) substrates by pulsed laser deposition is investigated. X-ray diffraction and aberration-corrected high-resolution scanning transmission electron microscopy studies of the thin films before and after switching demonstrate that phase transitions between different crystalline phases can be achieved without losing the epitaxial framework of the structures. These results therefore offer valuable insights into the switching processes of epitaxial phase change materials and might help to advance the design of phase change memories by employing highly textured structures.

DS 10.2 Mon 17:00 H39

Controlling Disorder and Disorder-Related Physical Properties in the Phase Change Material $Sn_1Sb_2Te_4$ — •Nikita Polin, Stefan Maier, Brigitte Baumkötter, and Matthias Wuttig — I. Physikalisches Institut (IA), RWTH Aachen University, D-52056 Aachen, Germany

Phase-change materials (PCMs) possess physical properties suited for a wide range of applications from non-volatile data storage, data processing to thermoelectrics. The recently investigated PCM-material $Sn_1Sb_2Te_4$ (SST) displays a high amount of atomic disorder attributed to intrinsic vacancies. From the fundamental research perspective SST is one of the few experimentally observed realizations of an Anderson insulator. From the applicational point of view the vacancy disorder plays an important role in shaping electronic properties. These observations make SST a promising candidate for a multilevel data storage device.

The microscopic understanding of the underlying physical phenomena is therefore of interest. The aim of this work is to get insights into interplay between disorder, transport and bonding. For this purpose optical, structure determination and electronic transport measurements shall be employed.

DS 10.3 Mon 17:15 H39

Phonon modes and thermal conductivity in Si/SiO_2 multishell nanotubes — C. I. Isacova[1], A. I. Cocemasov[1], D. L. Nika[1], O. G. Schmidt[2], and •V. M. Fomin[1,2] — [1]E. P. Pokatilov Laboratory of Physics and Engineering of Nanomaterials, Moldova State University, Chisinau MD-2009, Republic of Moldova — [2]Institute for Integrative Nanosciences, Leibniz IFW Dresden, Dresden D-01069, Germany

Theoretical atomistic study of thermal transport is conducted for Si/SiO_2 multishell nanotubes, which model rolled-up Si/SiO_2 nanostructures. Phonon modes are obtained within Lattice Dynamics Theory. Thermal conductivity in Si/SiO_2 nanotubes, as calculated using Boltzmann Transport Equation within the relaxation-time approximation, is lower than that in Si nanowires with the same lateral dimensions due to the acoustical mismatch of the materials and a stronger phonon confinement. A large number of phonon modes are scattered on Si/SiO_2 interfaces, what enhances the effect of the boundary scattering mechanism on thermal conductivity of multishell nanotubes. Thermal conductivity is found to decrease almost linearly as a function of the number of Si/SiO_2 bilayers in multishell nanotubes. The present work is supported by the DFG grant no. FO 956/4-1.

DS 10.4 Mon 17:30 H39

Resistive switching in optoelectronic III-V materials based on deep traps — •Michael Schnedler, Verena Portz, Ulrich Semmler, Marco Moors, Rainer Waser, Rafal E. Dunin-Borkowski, and Philipp Ebert — Peter Grünberg Institut, Forschungszentrum Jülich GmbH, Jülich, 52425, Germany

Resistive switching random access memories (ReRAM) are promising candidates for energy efficient, fast, and non-volatile universal memories that unite the advantages of RAM and hard drives. Unfortunately, the current ReRAM materials are incompatible with optical interconnects and wires. Optical signal transmission is, however, inevitable for next generation memories in order to overcome the capacity-bandwidth trade-off. Thus, we present here a proof-of-concept of a new type of resistive switching realized in III-V semiconductors, which meet all requirements for the implementation of optoelectronic circuits. This resistive switching effect is based on controlling the spatial positions of vacancy-induced deep traps by stimulated migration, opening and closing a conduction channel through a semi-insulating compensated surface layer. The mechanism is widely applicable to opto-electronically usable III-V compound semiconductors.

DS 10.5 Mon 17:45 H39

Absolute Seebeck coefficient of thin platinum films and individual silver nanowires — •Maximilian Kockert[1], Danny Kojda[1], Rüdiger Mitdank[1], Anton Zykov[2], Stefan Kowarik[2,3], Johannes Ruhhammer[4], Zhi Wang[4], Michael Kröner[4], Peter Woias[4], Toni Markurt[5], and Saskia F. Fischer[1] — [1]Novel Materials Group, Humboldt-Universität zu Berlin, D-10099 Berlin — [2]Nanoscale processes and growth, Humboldt-Universität zu Berlin, D-10099 Berlin — [3]Bundesamt für Materialforschung und -prüfung (BAM), D-12203 Berlin — [4]Laboratory for Design of Microsystems (IMTEK), University of Freiburg, D-79110 Freiburg — [5]Leibniz-Institute for Crystal Growth (IKZ), D-12489 Berlin

Thermoelectric properties of as sputtered and tempered thin platinum films and single crystalline silver nanowires were investigated and compared to bulk. Structural properties like film thickness, grain size and nanowire diameter were correlated with the thermoelectric properties. Furthermore, we present a model to describe the temperature dependence of the absolute Seebeck coefficient S of thin films, nanowires and bulk, which consists of a thermodiffusion and phonon drag part. S of thin platinum films is reduced compared to the bulk and we find that the film thickness and grain size by means of the electron mean free path influence S. Silver nanowires exhibit a reduction of the thermodiffusion part and a shift of the phonon drag peak towards higher bath temperatures compared to the bulk, but without changing the maximum value of S. In addition, a discussion of the influence of the electron-phonon and phonon-phonon interaction on S is given.