DS 15: Thermoelectric and Phase Change Materials

Time: Tuesday 11:45–13:00 Location: E 020

DS 15.1 Tue 11:45 E 020

Thermoelectric nanocrystalline SiGe thin films prepared by the combination of AIC and SiO2 reduction — •Marc Lindorf, Anna Zera, and Manfred Albrecht — Institute of Physics, University of Augsburg, Universitätsstraße 1, Augsburg, Germany

Classic thermoelectric materials like SiGe often face low efficiencies for practical applicability while also being held back by industrial inefficient preparation and implementation methods.

In this work, we present a thin film approach for the preparation of nanocrystalline SiGe. The process of aluminum induced crystallization (AIC) is utilized to transform sputter deposited amorphous Si80Ge20 on quartz glass (SiO2) in a polycrystalline state under the presence of Al. Parts of the Al are incorporated into the SiGe leading to p-type doping. The reduction of SiO2 by Al to Si and Al2O3 was used after the catalytic AIC process to remove the remaining metallic Al which otherwise would shortcut the thermoelectric SiGe layer [1].

The AIC processed SiGe thin films were structurally analyzed via Rutherford Backscattering Spectrometry, X-ray Diffraction, and Transmission Electron Microscopy before and after annealing. The Si atoms released by the reduction reaction were incorporated to the SiGe layer without forming a secondary phase. Furthermore, a thermoelectrically promising twin grained microstructure was found for the prepared SiGe. Electrical resistivity and Seebeck coefficient were characterized from room temperature up to 700 K revealing transport properties typical for degenerated semiconductors.

[1] M. Lindorf et al., J. Appl. Phys. 120, 205304 (2016)

DS 15.2 Tue 12:00 E 020

Intermixing of SnTe-GeTe superlattices grown by molecular beam epitaxy — •Kaminski Marvin[1], Pohlmann Marc[1], Meledin Alexander[2], Cojocaru-Mirédin Oana[1], and Wuttig Matthias[1,3] — [1]I. Institute of Physics, Physics of New Materials, RWTH Aachen University, 52056 Aachen, Germany — [2]Gemeinschaftslabor für Elektronenmikroskopie, RWTH Aachen, 52074 Aachen, Germany — [3]JARA-Insitut Energy-efficient information technology (PGI-10), FZ Jülich, 52428 Jülich, Germany

Since its first report in 2013 interfacial phase-change materials (IPCMs) attract plenty of attention. Classical phase change materials (PCM) on the one hand can be switched between the amorphous and the crystalline state. These two states can be switched by joule heating on a ns time scale and differ in orders of magnitude in resistance and up to 20 % in reflectivity. Due to this rare combination of properties PCM are one of the most promising candidates for data storage. IPCMs also switch, if a defined voltage is applied. However, experimental and theoretical results indicate that the switching in IPCMs does not rely on a transition between amorphous and crystalline states, but rather between different crystalline states. The switching in IPCMs is faster and needs less energy than classical PCM.

Here, we present superlattices of SnTe and GeTe layers on Si(111) substrate via MBE. One focus of our work lays on the intermixing of the layers and its dependence on the chosen growth temperatures. Therefore we compare results of different methods like TEM, atom-probe tomography, XRD and RHEED for different growth conditions.

DS 15.3 Tue 12:15 E 020

The Influence of Disorder on the Electrical Properties of SnTe-PbTe Alloys in the Vicinity of the Band Inversion — •Johannes Reindl[1], Zheng Zeng[1], Matteo Cagnoni[1], Alexander Rochotzki[1], Stefan Jakobs[1], and Matthias Wuttig[1,2] — [1]1. Physikalisches Institut (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]JARA-FIT, RWTH Aachen University, 52056 Aachen, Germany

Chalcogenide IV-VI compounds are well known to exhibit a plethora of intriguing physical properties, like symmetry protected topological surface states in SnTe or high thermoelectric performance in PbTe. Alloys of these two materials have been utilized for infrared applications because of the tunable small band gap. Furthermore, the combination of SnTe and PbTe yields the model system for the investigation of topological crystalline insulators.

So far research in general was focused on the study of samples with high quality to disentangle the underlying physical phenomena. However, having disorder and defects in the crystal, is not only more feasible or sometimes even beneficial for industrial application, but might also unveil new physical insight. Therefore, with a combination of conductivity, Hall and Seebeck measurements, we investigate the electrical properties of thin films with the stoichiometry being close to the band inversion.

DS 15.4 Tue 12:30 E 020

Modeling of current-voltage characteristics of BFO based memristors — •Max Huber[1,2], Andreas Zienert[3], Jörg Schuster[2], and Michael Schreiber[1] — [1]Institute of Physics, Technische Universität Chemnitz, Chemnitz, Germany — [2]Fraunhofer Institute for Electronic Nano Systems, Chemnitz, Germany — [3]Center for Microtechnologies, Technische Universität Chemnitz, Chemnitz, Germany

Memristors are one of the most promising candidates for next generation memory. They can also be used for nonvolatile logic application, neuromorphic computing and hardware based encryption.

To build high performance devices, one has to know the mechanism behind the resisitive switching. Dependent on the material, the device can show filamentary or interface resistive switching. Despite the increasing interest of the scientific community in studying resistive switching, detailed knowledge of the switching mechanism for many materials is still missing.

We study $BiFeO_3$ (BFO) based memristors which show interface resistive switching. The device is modeled as a serial connection of two head-to-head diodes. To simulate the current-voltage characteristic we solve the drift-diffusion and Poisson's equation selfconsistently and assume the doping profile is constant in time.

DS 15.5 Tue 12:45 E 020

Thermoelectric properties of (Iron) Cobalt Monosilicide — •Lauritz Schnatmann[1], Heiko Reith[1], Gabi Schierning[1], Kornelius Nielsch[1], and Alexander Burkov[2] — [1]Leibniz institute for solid state and material science, Dresden, Germany — [2]Ioffe institute, St. Petersburg, Russia

Good thermoelectric materials need a high electrical conductivity and a low thermal conductivity. Common thermoelectric materials at room temperature are for example Bi2Te3 or Sb2Te3, which are toxic and rare materials. Promising alternatives are the silicides, because they are non-toxic and abundant. They also show a relatively high thermoelectric performance and are possible candidates for Weyl materials. Co1-xFexSi Samples were grown by Bridgeman method. Structure and chemical analysis of the samples were made by XRD, TEM and EDX. Afterwards we performed temperature and magnetic field dependent measurements on different silicide-compositions. Thermal conductivity, Seebeck-coefficient and electrical conductivity were measured with the thermal transport option of a Dynacool system by Quantum Design. In the structure analysis we identified the B20 crystal structure in our sample with a [111] orientation perpendicular to our measurement direction. In the magnetic field dependent measurements we analyse the difference between parallel and perpendicular applied magnetic fields in respect to the measurement direction. In parallel applied field we observed a negative magneto resistance with a maximum at 50K. For a perpendicular applied field we see a positive magneto resistance.