DS 9: Poster: Synthesis of Nanostructured Films by Self-organization, Thermoelectric Thin Films and Nanostructures, High-k and Low-k Dielectrics, Layer Deposition Processes, Layer Growth, Layer Properties, Application of Thin Films, Surface Modification, Hard and Superhard Coatings, Metal Layers

Time: Monday 15:00–17:30 Location: Poster D1

DS 9.1 Mon 15:00 Poster D1

Nanocomposite thin films prepared by co-sputtering and via deposition from a cluster source — •Tilo Peter[1], Sven Bornholdt[2], Matthias Wolter[2], Thomas Strunskus[1], Vladimir Zaporojtchenko[1], Holger Kersten[2], and Franz Faupel[1] — [1]Institute for Materials Science, Kiel, Germany — [2]Institute of Experimental and Applied Physics , Kiel, Germany

Nanocomposites consisting of metal clusters embedded in a dielectric thin film exhibit very interesting functional properties [1]. Relying on surface diffusion during co-deposition for generating clusters may cause problems since it depends not only on the deposited material but also on the substrate. To obtain clusters independent of the substrate and with tunable size, we use a self-built cluster source that creates clusters from magnetron sputtered metal atoms. In this process the plasma parameters are controlled via a helium/argon mix. Test materials were Ag, Au and Cu.

Samples prepared by co-deposition of plasma polymerized HMDSO and metal clusters are compared to samples prepared by co-sputtering of Ag and SiO2. In-situ characterization is done by visible/uv optical emission spectroscopy. XPS is used for chemical characterization, and HRTEM serves to measure the cluster size and density distribution. In addition, visible/ uv optical emission spectroscopy is used to investigate the optical properties and plasmonic resonance of the clusters.

[1] Deposition of nanocomposites by plasmas F. Faupel, et al. Contributions to Plasma Physics (2007), 47(7), 537-544

DS 9.2 Mon 15:00 Poster D1

Spatially and time-resolved optical emission spectroscopy of mid-frequency pulsed PECVD — •Marcus Günther, Siegfried Peter, and Frank Richter — Institute of Physics, Chemnitz Univ. of Technol., 09107 Chemnitz, Germany

Asymmetric bipolar pulsed plasma discharges in the mid-frequency (m.f.) range are of increasing interest for the deposition of *a*-C:H and *a*-SiCN:H films. This technique is attractive for industrial applications (large area coating) but less investigated yet. Moreover, using directly coupled m.f. power supply enables to choose the substrate bias voltage independent of other process parameters.

Optical emission spectroscopy (OES) is a method to characterize electrical discharges and learn about the excited species without affecting the discharge. In m.f. PECVD, the discharge frequency is lower than the plasma frequency of electrons and even ions, so that charged particles can follow changes of the electrical field. This periodical movement of charged species in the m.f. plasma is reflected in the spatially and time-resolved optical emission spectra. The deposition of *a*-C:H from acetylene (C_2H_2) or isobutylene (C_4H_8), and of *a*-SiCN:H from trimethylsilane(3MS) nitrogen argon mixtures in 100 kHz-pulsed discharges was analysed. As one result, above the powered electrode of the m.f. discharges no clear dark space was observed. The measured time behaviour of the plasma induced emission of individual species implies different excitation mechanisms.

DS 9.3 Mon 15:00 Poster D1

Optimizing the PECVD-process for low temperature growth of carbon nanotubes — •Kerstin Schneider[1], Michael Häffner[1], Boris Stamm[2], Monika Fleischer[1], Claus Burkhardt[2], Alfred Stett[2], and Dieter Kern[1] — [1]Institut für Angewandte Physik, Universität Tübingen — [2]Naturwissenschaftliches und Medizinisches Institut an der Universität Tübingen

Carbon nanotubes (CNTs) are typically grown at temperatures above 700 °C. However in the case of many electronic and life-science applications, temperature sensitive substrates require the use of growth processes at temperatures below 400 °C. In particular for the fabrication of CNT-microelectrodes on neuro-implants flexible, temperature sensitive substrates like artificial mica and polyimide have to be used. In order to grow vertically aligned CNTs at such low temperatures, we apply plasma enhanced chemical vapor deposition (PECVD)growth techniques using optimized PECVD parameters. Optimization of these parameters includes the variation of pressure, growth time, catalyst material, catalyst thickness, and gas mixture. Quantitative results of CNT length and quality as well as optimal growth parameters for growth processes below 400 °C will be presented.

DS 9.4 Mon 15:00 Poster D1

Formation mechanism of noble metal nanoparticles in reactively sputtered TiO_2 films — John Okumu[1], Dominik Köhl[2], Alexander Sprafke[2], •Hendrik Holzapfel[2], Gero von Plessen[2], and Matthias Wuttig[2] — [1]Department of Physics, Kenyatta University, P. O. Box 43844-00100, Nairobi, Kenya — [2]I. Physikalisches Institut (1A), RWTH Aachen University, D-52056 Aachen, Germany

Recently a simple preparation method has been developed to prepare Ag nanoparticles in a TiO_2 matrix [1,2]. In this scheme, silver nanoparticles are formed in a TiO_2 matrix first by sputtering a thin ($d = 15$nm) silver film sandwiched between two reactively sputtered TiO_2 layers ($d = 30$nm); this is followed by an annealing process. To determine the formation mechanism of noble metal nanoparticles in the TiO_2 matrix, we compare the behavior of Ag with that of two similar noble metals, gold and copper, by using x-ray diffraction, x-ray reflectance and optical spectroscopy. Despite the similarity of the three noble metals, we find that no Cu and Au nanoparticles are formed. This is in striking contrast to the behavior observed for Ag. The difference can be explained by a three step process, which involves oxidation of the Ag upon reactive sputter deposition of TiO_2, dissociation of the Ag oxide upon annealing and Ag aggregation to form nanoparticles. These processes do not occur at all in the case of Au, and are much slower in the case of Cu.

[1] J. Okumo *et al.*, J. Appl. Phys., **97**, 094305 (2005)
[2] C. Dahmen *et al.*, Appl. Phys. Lett., **88**, 011923 (2006)

DS 9.5 Mon 15:00 Poster D1

Inkjet printed organic layers on planar and microstructured flexible substrates for organic thin film devices — •Peter Lewer[1], Kerstin Schulze[1], Silvia Janietz[1], Felix Stelzl[2], Chegnui Bekeny[2], and Uli Würfel[2] — [1]Fraunhofer-Institute for Applied Polymer Research (IAP), Geiselbergstr. 69, 14476 Potsdam, Germany — [2]Fraunhofer-Institute for Solar Energy Systems (ISE), Heidenhofstr. 2, 79110 Freiburg, Germany

Inkjet printing of functional organic materials as deposition method holds the advantage for high throughput and low-cost production of organic electronic devices on flexible substrates in the future such as organic field effect transistors (OFETs) or organic solar cells (OSCs) [1,2]. In this context a three-dimensional electrode structure on a flexible substrate can be used for special application such as high voltage supply [3]. Therefore we investigate the inkjet printing process on these micro- or nanostructured PMMA-foils. The printing process was especially influenced by the capillary forces of the electrode structures. Here we show our results of the inkjet printing of semiconducting layers consisting of poly(3-hexylthiophene) (P3HT) in these three-dimensional structures. The preparation was done under ambient conditions and resulted in smooth layers as analysed with atomic force microscopy (AFM) and transmission electron microscopy (TEM).

[1] H. Sirringhaus, T. Kawase, R.H. Friend, T. Shimoda, M. Inbasekaran, W. Wu, and E.P. Woo, Science 2000, 290, 2123. [2] P. Calvert, Chemistry of Materials 2001, 13, 3299. [3] M. Niggemann, W. Graf, und A. Gombert, Advanced Materials 2008, 20, 4055.

DS 9.6 Mon 15:00 Poster D1

Structure formation at organic-inorganic interfaces — •Florian Szillat and Stefan G. Mayr — Leibniz-Institut fuer Oberflaechenmodifizierung, Translationszentrum fuer regenerative Medizin und Fakultaet fuer Physik und Geowissenschaften der Universitaet Leipzig, Permoserstrasse 15, 04318 Leipzig

Organic-inorganic interfaces have attracted significant scientific interest during the past decade - primarily due to their applications in the fields of organic semiconductors and biomaterials. Detailed experi-

mental and theoretical understanding - in particular of the inorganic-organic interaction - is still lacking. To address these aspects we employ polycarbonate thin films on metal alloy substrates, while our focus lies on structure formation during organic film deposition. Our metal alloy surfaces are prepared on thermally oxidized silicon wafers by electron beam evaporation, while polybisphenol A polycarbonate thin films are deposited afterwards by thermal evaporation. Structure formation is characterized primarily with atomic force microscopy and interpreted within the concept of stochastic rate equations for film growth in the presence of interfaces [1]. Based on these concepts, conclusions on the interface interactions are drawn.

[1] C. Vree and S.G. Mayr, Applied Physics Letters 94 (2009) 093110

DS 9.7 Mon 15:00 Poster D1

Condensation of silicon monoxide on Si(111) studied by infrared spectroscopy for different substrate temperatures — Steffen Wetzel, •Markus Klevenz, and Annemarie Pucci — Kirchhoff-Institut für Physik der Universität Heidelberg, INF 227, 69120 Heidelberg

The growth of thermally evaporated silicon monoxide (SiO) on a Si(111) surface was studied in situ by infrared spectroscopy under ultra-high vacuum conditions. Within the first stage of film growth a large shift of the main vibrational band from 864 cm^{-1} to the bulk value of 984 cm^{-1} was observed (at 300K). This effect can be assigned to different Si-O bond lengths of Si-O-Si bridges nearby the Si surface in comparison to the bulk material and was successfully modelled with an SiO_x ($0<x<1$) interlayer. Measurements at various substrate temperatures also reveal a clear shift of the vibrational peak position; below 300 K to lower wave numbers with decreasing substrate temperature and above 300 K to higher wavenumbers with increasing substrate temperature, respectively. For higher temperatures disproportioning of SiO into Si and SiO_2 becomes important whereas for the very low temperatures only the bonding geometry should be important. Both effects will be discussed in detail.

DS 9.8 Mon 15:00 Poster D1

Self-assembly of CF-polymer films on SiO_2 (001) from first-principles calculations — •Oliver Böhm[1,2], Roman Leitsmann[1], Philipp Plänitz[1,2], Christian Radehaus[1], Michael Schreiber[2], and Matthias Schaller[3] — [1]GWT-TUD GmbH, Material Calculations, Chemnitz, Germany — [2]Institut für Physik, Technische Universität Chemnitz, 09107 Chemnitz — [3]Globalfoundries Dresden Module Two GmbH & Co. KG, Germany

Polymeric materials with a low dielectric constant(low-k) are essential to the interlayer dielectrics used for the next-generation integrated circuits. However, along with the introduction of these materials a bunch of processing challenges appears. For example the contamination prevention of the material during wet and dry processing steps plays a key role in the fabrication process.
In this study we investigate the formation of thin CF-polymer films on ultra low-k (ULK) material surfaces during c-C_4F_8 plasma etching. In particular we use density functional theory (DFT) to study the adsorption process of different CF-polymers on SiO_2 (001) surfaces, which serves as a prototypical ULK system. For different C_nF_{2n+x} molecules the most stable adsorption sides and geometries and their impact on the electronic structure will be discussed in detail.

DS 9.9 Mon 15:00 Poster D1

Annealing of Silicon Nanopatterns — •Monika Fritzsche, Adrian Keller, Stefan Facsko, Kilian Lenz, and Jürgen Fassbender — Institute of Ion Beam Physics and Material Research, Forschungszentrum Dresden-Rossendorf, 01314 Dresden, Germany

The morphology of surfaces strongly influences optical, electrical, and magnetic properties of thin films. By changing the morphology it is possible to tailor the material properties. Oblique low energy ion beam sputtering produces periodic ripple structures with periodicities in the nanometer range. During sputtering the region near to the surface gets amorphous and some metal is deposited on the surface, i.e. Cu from the sample holder. These ripple patterns can be used as templates. By using amorphous ripples only polycrystalline films can be grown. These films have an morphology induced dipolar anisotropy. In order to grow the films epitaxially the ripples have to be crystalline. Hence, this could induce an additional anisotropy in a magnetic overlayer. One possible route to achieve crystalline ripples is annealing. Therefore, the annealing temperature dependence was studied using STM. With increasing temperature the ripples vanish. They are not removed by a reduction of the amplitude, but by the creation of circular voids. Inside these voids the surface exhibits few steps and is otherwise flat on an atomic scale. In the middle of the voids Cu clusters are found, which appear at steps. Inside the crystalline area of the voids the Si(111) "quasi 5×5" Cu surface is found. For larger temperatures the number and size of these voids increases until the ripples are removed from the whole surface.

DS 9.10 Mon 15:00 Poster D1

Multiscale nanostructuring of Si surfaces combining top-down and bottom-up techniques — •Bashkim Ziberi, Frank Frost, Klaus Zimmer, and Bernd Rauschenbach — Leibniz-Institut ür Oberflächenmodifizierung (IOM), Permoserstrasse 15, D-04318 Leipzig, Germany

Surface patterning is of tremendous importance in many technological fields with features sizes ranging from nanometers to millimeters. There are different patterning techniques that generally can be assigned to the top-down and bottom-up approaches. One bottom-up method for the generation of self-organized nanostructures is low-energy ion beam erosion. However due to the stochasticity of the process there is a lack of large scale ordering of nanostructures and of positional control. Here results on self-organized nanostructuring of pre-patterned Si surfaces will be presented. The idea is to combine the top-down technique for pre-patterning of surfaces followed by the ion beam induced self-organization process. Due to the periodicity, shape and lateral ordering of pre-patterns an improved ordering, and an exact positional control of nanostructures is achieved. The method allows also for the formation of new structures and patterning of more complex surfaces like curved one or more difficult geometries are possible. The pre-patterned substrates are fabricated by various lithographic techniques in combination with etching techniques for structure transfer. Depending on the shape of the pre-patterned structure different results are obtained. Furthermore, using the imprint technique inverse pre-patterns (e. g. pits-holes) are used to study the self-organization process.

DS 9.11 Mon 15:00 Poster D1

Smoothening and patterning of Si surfaces produced by metal surfactant sputtering — •Kun Zhang and Hans Hofsäss — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Surfactant sputtering provides a novel, versatile sputter technique utilizing the steady state coverage of a substrate surface with up to 10^{16} /cm^2 of foreign or self atoms simultaneously during sputter erosion by combined ion irradiation and atom deposition. Depending on the chemical relation of the materials between the substrate and the surfactant, nanocluster, nano-meter thin film or nano-compound can form on the substrate surface or be burred in the top layers of substrate, which strongly modify the substrate sputter yield on atomic to macroscopic length scales, and further more, produce different surface morphologies (smoothening or nano-pattern from dots to ripple). In this study, metal surfactants (such as Au, Ag, Pt, Ni, Fe and steel etc.) were used to produce ultra-smooth surface or different surface nano-pattern on silicon, specially at the incident angle near substrate normal direction, at which no nano-pattern would form in the absence of deposition of surfactant atoms, predicted by the Bradley-Harper theory and demonstrated by many experiments. Si(100) substrates were eroded using 5 keV Xe-ions at the fluence of up to 10^{18} /cm^2 under continuous deposition of metal atoms from surfactant targets, which were sputtered simultaneously by the same ion-beam. The surface topography, the composition, and the microstructure of the nanocomposites have been analyzed via RBS, AFM and TEM.

DS 9.12 Mon 15:00 Poster D1

Electrodeposition of ZnO for dye-sensitized cells on corrosion-resistive metal wires — •Kerstin Strauch, Melanie Rudolph, Thomas Loewenstein, and Derck Schlettwein — Institute of Applied Physics, Justus-Liebig-University Giessen, Germany. email:schlettwein@uni-giessen.de

This work is part of an initiative to develop a textile-based photovoltaic cell using the concept of dye-sensitization. For this purpose porous ZnO is deposited by electrodeposition and subsequently sensitized by an organic dye. The porous sensitized semiconductor electrode has to satisfy two conditions: First the substrate material has to be conductive and inert with the iodine containing electrolyte. Secondly the deposition of porous zinc oxide on the conductive textile or wire has to be homogenous and continuous. In this work different metal wires which had proven to be stable in the redox electrolyte were used

as substrate electrodes. The conditions of electrodeposition were optimized for each of the metals. We either used a constant potential ("potentiostatic") mode in contact to an oxygen saturated $ZnCl_2$ solution or a pulsed deposition using the reduction of nitrate in a $Zn(NO_3)_2$ solution. The deposition process was monitored by the developed current under the given conditions. The obtained films were analyzed by confocal laser microscopy and scanning electron microscopy. The films were tested for their uptake of sensitizing dyes. The properties of the obtained electrodes in dye- sensitized solar cells will be discussed.

DS 9.13 Mon 15:00 Poster D1

Texturing of ZnO films on glass for use as a light-scattering layer in micromorphous silicon thin film solar cells — •Kambulakwao Chakanga — EWE-Forschungszentrum für Energietechnologie e.V., Next-Energy, Oldenburg, Germany

Light Trapping is a profound tool for enhancing solar cell efficiency by increasing light absorption and decreasing reflection. Glass/TCO interfaces with textured TCO layers are commonly implemented in micromorph solar cells to scatter incident light and increase the optical path. However altering the morphology of the front contact TCO also affects the optical and electrical properties of the solar cell.

This master thesis aims to analyse this relationship between the texture and the optoelectronic properties in ZnO:Al. ZnO:Al has been chosen because it is frequently argued as being more beneficial in comparison to commercially available TCOs. The commercially available ASAHI-U-type SnO2:F is analysed as a reference.

The different surface textures are obtained by wet chemical etching with different acids in different concentrations, at different etching periods. Subsequently the morphology is investigated by atomic force microscopy. The optical properties are measured by spectrometry. The haze factor is determined as a descriptive scatter parameter. Finally the electrical properties are measured with a Four-Point-Probe.

DS 9.14 Mon 15:00 Poster D1

Proton Beam Writing — •Martina Schulte-Borchers, Ulrich Vetter, and Hans Hofsäss — II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, D-37077 Göttingen, Germany

Proton Beam Writing (PBW) is a direct-write lithography process for microfabrication of two- or three-dimensional structures. It can be used to manufacture microfluidic channels, wave guides, biosensors and other devices. Due to the maskless writing technique and the high spatial resolution obtained by the usage of protons, this method allows for the fabrication of structures with high aspect ratio and small structure width. This makes PBW preferable to other lithographic techniques like electron beam- or photolithography. We will describe the newly installed PBW system at the Goettingen 3MV Pelletron accelerator and discuss its technical characteristics together with first proton beam written structures.

DS 9.15 Mon 15:00 Poster D1

Correlation between Ion Bombardment, Lattice Expansion and Nitrogen Content After Nitriding of Austenitic Stainless Steel — •Darina Manova, Jürgen W. Gerlach, Stephan Mändl, and Horst Neumann — Leibniz-Institut für Oberflächenmodifizierung, 04318 Leipzig, Germany

Broadbeam low energy ion implantation is a versatile method for nitrogen insertion in transition metals containing alloys like austenitic stainless steel. The process is characterized by an anomalous high diffusivity leading to nitrogen enriched layers of up to several micrometers thickness coupled with an anisotropic lattice expansion of up to 12%. By using a radiation heater in addition to ion beam heating to maintain the process temperature between 350 and 450 °C, controlled continuously by pyrometer, and an electronic nitrogen ion beam switch, a reduced nitrogen ion flux was realised. As a result, the XRD peak widths of the resulting expanded austenite were reduced from about 2° to 0.7 * 0.9°, while a strong nitrogen concentration gradient was still observed within the first micrometers. Thus, the initial broadening is less related with a range of different nitrogen concentration dependent lattice expansions through the layer. At the same time, no linear correlation between the lattice expansion and the nitrogen content was observed, invalidating the use of Vegard*s law to estimate the nitrogen content from the lattice expansion.

DS 9.16 Mon 15:00 Poster D1

XPS Analysis of Phase Formation after Nitrogen Insertion in CoCr and FeCrNi Alloys — •Johanna Lutz[1,2], Jürgen W. Gerlach[1], and Stephan Mändl[1] — [1]Leibniz Institute of Surface Modification, Leipzig, Germany — [2]Translational Centre for Regenerative Medicine, University of Leipzig, Germany

Plasma immersion ion implantation for inserting nitrogen in transition metals like CoCr alloys or FeCrNi alloys is characterized by near surface ion implantation and a subsequently anomalous high diffusivity leading to nitrogen enriched layers up to several micrometers. At the same time, a lattice expansion of the original fcc structure by 5 to 10% is observed. Preferential trapping with the formation of Cr-N bonds inside the austenitic structure is acclaimed to explain the anomalous concentration profiles at lower temperatures, while beyond 450 °C a transition from the expanded austenite towards CrN precipitates occurs.

In this presentation, photo electron spectra (XPS) are investigated after nitrogen PIII in face-centred-cubic CoCr and FeCrNi alloys in the temperature range from 230 - 580 °C. The process was carried out at pulse voltages of -10 kV, a base pressure of 0.5 Pa and process time of two hours. For FeCrNi alloys, evidence of the nitrogen insertion is only found for the Cr2p peak, however independent of the process temperature, with no changes in the Fe2p and Ni2p core level spectra. For CoCr alloys, despite similar nitrogen concentrations of 30 to 35 at.%, no variation in either Co2p, Cr2p, Fe2p or Ni2p spectra was observed.

DS 9.17 Mon 15:00 Poster D1

Electrical properties of phase change materials along the pseudo binary line between GeTe and SnTe analysed with temperature dependent Hall effect measurements — •Felix Lange, Hanno Volker, Carl Schlockermann, Jenni Karvonen, and Matthias Wuttig — RWTH Aachen University, I. Physikalisches Institut (IA), 52056 Aachen, Germany

Phase change materials are a class of materials that can be reversibly switched between an amorphous and a crystalline state. These two states exhibit characteristic differences in their physical properties such as the reflectivity and the electrical resistivity. By assigning these two states to the binary values 1 and 0 one can store information as already realized in optical data storage media like CD±RW and DVD±RW. The electrical induced switching within nanoseconds [1] makes PC- materials also interesting for non-volatile RAM applications. It is obvious that a comprehensive understanding of the electrical transport properties is crucial in order to match the low power requirements of the device. Therefore we have investigated electrical properties along the pseudo binary line between GeTe and SnTe by temperature dependent Hall effect measurements.

[1] G. Bruns *et al.* (2009). App. Phys. Lett. **95**, 043108

DS 9.18 Mon 15:00 Poster D1

Field effect in GeTe thin films — •Hanno Volker, Carl Schlockermann, Daniel Krebs, Jörn Riedel, and Matthias Wuttig — RWTH Aachen University, I. Physikalisches Institut (IA), 52056 Aachen, Germany

Phase change memory is a promising candidate to replace common memory technologies such as Flash and DRAM due to its fast switching and excellent scaling perspectives. To improve memory density even further, it was proposed to combine the switchable resistor and the cell selection transistor in a single device. Current control by applying gate voltages has been demonstrated in the works of Yin et al. for $Ge_2Sb_2Te_5$ [1].

Recently, switching within a few nanoseconds has been demonstrated on a different material, GeTe [2]. We therefore studied the field effect in thin films of amorphous GeTe. Dedicated transistor devices were prepared, and the transfer characteristics of these devices were measured as a function of temperature and film thickness. Furthermore, time-dependent behavior was observed and analyzed.

[1] Y. Yin *et al.* (2006). *Japan. J. Appl. Phys.* **45**, 3238
[2] G. Bruns *et al.* (2009). *App. Phys. Lett.* **95**, 043108

DS 9.19 Mon 15:00 Poster D1

Investigation of the electrical properties of lithographically structured gold wires — •Kathrin Krüger, Peter Jost, Carl Schlockermann, Philipp Merkelbach, Karl Simon Siegert, and Matthias Wuttig — RWTH Aachen University, I. Physikalisches Institut (IA), 52056 Aachen, Germany

Ongoing miniaturization in electrical devices focuses the attention on thin film effects. Over the last decade, lithographic structures became continuously smaller. Thus, new demands are placed on the interconnects, which are realized by thin and small wires.

Because of its high conductivity and thermal stability at temperatures around room temperature, gold is an important candidate as contacting material. Gold wires are often applied to the substrate by evaporation, whereas glass or silicon is often used as substrate material. To obtain a better adhesion of the gold on glass substrates, a chromium adhesion layer can be used.

Therefore, for many measurements it is important to know the electrical properties of gold. However, it is not clear whether the electrical properties, such as the specific resistance and its temperature coefficient, are still close to bulk properties at small feature sizes. Thus, in this study the dependencies of the specific resistance and its temperature coefficient of lithographically structured and thermally evaporated gold wires on thickness and width are investigated. Also, it is studied how a chromium adhesion layer affects these electrical properties.

DS 9.20 Mon 15:00 Poster D1

The influence of Sb clusters on electrical characteristics in organic-semiconductor structures — •Markus Arnold[1], Yue Huang[2], Axel Fechner[1], and Dietrich R. T. Zahn[1] — [1]Chemnitz University of Technology, Semiconductor Physics, 09107 Chemnitz, Germany — [2]Fudan University, Department of Microelectronics, Shanghai 200433, China

Electrical characterization using capacitance-voltage (CV) and charge transient spectroscopy (QTS) of Al/copper phthalocyanine (CuPc)/Si structures are presented. The CuPc layer was modified by the incorporation of Sb clusters. In this case the CV-measurements reveal some hysteresis in contrast to structures without Sb. This is assigned to a charge trapping in the Sb clusters. In order to analyze this in detail QTS is applied.

QTS originally developed by Kirov *et al.* [1] is an electrical measurement technique related to deep-level transient spectroscopy (DLTS) developed by Lang *et al.* [2]. Using QTS it is possible to measure charge reloading processes even in the absence of a depletion region as a function of time and temperature with different pulse voltages and widths. As a result, one can determine the energetic position, the capture cross section, and the density of the electrically active traps.

[1] K. I. Kirov, K.B. Radev, Phys. Stat. Sol. (a) 63 (1981) 711
[2] D. V. Lang, J. Appl. Phys. 45 (1974) 3023

DS 9.21 Mon 15:00 Poster D1

Surface Enhanced Raman Effect of Silver Nanoparticle Covered Substrates Prepared by Nanosphere Lithography — •Michael Ludemann[1], Philipp Schäfer[1], Christoph Brombacher[2], Ovidiu Gordan[1], Manfred Albrecht[2], and Dietrich R. T. Zahn[1] — [1]Semiconductor Physics, Chemnitz University of Technology — [2]Surface and Interface Physics, Chemnitz University of Technology

Weak Raman signals can be strongly enhanced using the so called surface enhanced Raman scattering (SERS) effect employing *e.g.* nanostructured metal surfaces. In order to get a deeper understanding of the enhancement mechanisms, silver nanoparticles of well defined shape and size prepared by nanosphere lithography were applied instead of randomly roughened silver films. The dependence of SERS spectra of copper phthalocyanine (CuPc) on the film thickness is discussed. For this purpose monitoring of the Raman signal during deposition of the organic film was performed *in situ*.

DS 9.22 Mon 15:00 Poster D1

Electrical Resistivity and Hydrogen Solubility of PdHc Thin Films — •Stefan Wagner and Astrid Pundt — IMP, Uni Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Resistivity measurements are a commonly applied operator for the determination of pressure-concentration-isotherms in metal-hydrogen systems. Lee et al. [1] report on an anomalous reduction of the hydrogen induced resistivity change in PdHc thin films during hydrogen loading. Thermodynamic properties of thin films, respectivey, have been shown to be strongly interfered by microstructural and mechanical stress, appearing from thin film proprties such as nanostructure, clamping to a rigid substrate, related biaxial stress, the formation of microstructural defects and buckling. Therefore the question appears, whether there is a direct stress impact on the resistivity in PdHc thin films as well. Here we show [2] that the reduced resistivity response of PdHc thin films can mainly be attributed to a stress dependent reduction of the hydrogen solubility.

[1] Lee, M., Glosser, R.: Z. Phys. Chem., Neue Folge 147 (1986) 27. [2] Wagner, S., Pundt, A.: Acta Materialia (2009), doi:10.1016/j.actamat.2009.10.045

DS 9.23 Mon 15:00 Poster D1

Conducting ion track in tetrahedral amorphous carbon films — •Hans-Gregor Gehrke[1], Anne-Katrin Nix[1], Johann Krauser[2], Christina Trautmann[3], Alois Weidinger[4], and Hans Hofsäss[1] — [1]II. Physikalisches Institut, Universität Göttingen, Germany — [2]Hochschule Harz, Wernigerode, Germany — [3]Gesellschaft für Schwerionenforschung, Darmstadt, Germany — [4]Hahn-Meitner-Institut, Berlin, Germany

Swift heavy ions passing through insulating tetrahedral amorphous carbon (ta-C) films leave conducting tracks along their path. The huge energy loss of over 40 keV/nm of each ion transforms the ta-C with 80% sp^3 bonds into a graphite-like sp^2-rich phase creating nanosized filaments with a diameter of about 8 nm. The film thickness may vary from a few nanometers to micrometers allowing a vast range of aspect ratios. In addition, it is possible to interrupt the filaments with thin insulating layers which do not alter their conductivity during the irradiation process. This technique, allows the creation of embedded electrical quantum dot structures with dimensions in the nanometer regime. The dimensions are sufficiently small to achieve coulomb blockade effects even at room temperature. We analyzed the conduction of ion tracks and dot structures with different insulator thicknesses electrically on filament ensembles by macroscopic contact pads and single tracks measurements by AFM probing with a conducting tip.

DS 9.24 Mon 15:00 Poster D1

A novel setup for thermopower measurements on thin films — •Peter Jost, Carl Schlockermann, and Matthias Wuttig — RWTH Aachen University, I. Physikalisches Institut, 52056 Aachen, Germany

Thermopower measurements are a common mean to gain insight into the electrical transport phenomena of metals and semiconductors. The typical method relies on making electrical contacts to the sample with two thermocouples. By measuring the voltages between the legs of the two thermocouples the temperature difference between the thermocouples' junctions and the thermoelectric voltage drop on the surface of the sample can be obtained. However, this technique is limited to moderate resistive samples as the measurement amplifiers have to meet the conflicting requirements of the low resistive thermocouples and the high resistive samples at the same time.

We have developed a novel setup that allows thermopower measurements on high resistive thin film samples. By setting the temperatures of both ends of the substrate to the temperatures of the underling copper blocks electrical contacts and temperature measurement can be decoupled. Thus, the amplifiers can be matched purely to the impedance of the sample. Furthermore this technique allows the deposition of an electrically isolating capping layer on top of the film of interest.

In this work we explain our setup and show the advantages and limitations of our method.

DS 9.25 Mon 15:00 Poster D1

Electrical and thermal conductivity of individual cylindric nickel nanowires — •Johannes Kimling and Kornelius Nielsch — Institute of Applied Physics, University of Hamburg, Jungiusstr. 11, 20355 Hamburg

Thermoelectric nanowires (NWs) are predicted to exhibit a higher figure of merit ZT than the according bulk materials. In order to investigate the underlying physical mechanisms, measurements on individual NWs have to be realized. However due to the small length scales, electrical and thermal measurements in particular are challenging. Here, we report on measurements of the electrical and thermal conductivity of individual cylindric Ni NWs by means of 4-point measurements and by using the "3-omega self-heating" method, respectively.

Cylindric NWs of diameters between 20 nm and 400 nm are synthesized by potentiostatic electrodeposition of Ni in highly ordered alumina membranes. Before electrodeposition the pore channels of the templates were coated with silicon dioxide by means of atomic layer deposition. The silicon dioxide layer remains as a shell stabilizing the NWs after dissolution from the template.

For contact definition we use photolithography. Low contact resistances are achieved by controlled sputter etching to remove the oxide layer directly before the metallization of the electrodes. First results of a Ni NW with a radius of 180 nm show that the thermal conductivity and the Lorenz number are well below the bulk values.

DS 9.26 Mon 15:00 Poster D1

Thermal characterization of ZnS:SiO_2 — •Karl Simon Siegert, Carl Schlockermann, Philipp Merkelbach, Hanno Volker, and Matthias Wuttig — RWTH Aachen University, I. Physikalisches Institut (IA), 52056 Aachen, Germany

Phase change materials such as $Ge_2Sb_2Te_5$ or GeTe offer unique physical characteristics. Their strong changes in optical and electrical properties during their amorphous-crystalline phase transitions make them especially interesting for data storage applications [1]. The large contrast in reflectance between the amorphous and the fcc-phase of $Ge_2Sb_2Te_5$ is already technologically exploited in rewritable optical storage discs. As the switching between the amorphous and the crystalline state is induced by temperature, thermal characterization of the phase change material and all other surrounding materials is needed for further improvement of data storage devices. This work focuses on thin films of ZnS:SiO_2, a material, which is used for protective layers on top of the active phase change layer in optical storage media. We have created several samples of different thicknesses by sputter deposition and characterized them using AFM and XRR. Small gold wires were created on top of the sample by photo-lithography and were used to measure the cross-plane thermal conductivity with an AC-measurement technique.
[1] Wuttig *et al.* Nat. Mat. **6**, 824 - 832 (2007)

DS 9.27 Mon 15:00 Poster D1

Optical analysis of ZnS:SiO_2 used as a Capping layer for phase change alloys — •Stephanie Grothe, Peter Jost, Michael Woda, Jenni Karvonen, and Matthias Wuttig — RWTH Aachen University, I. Physikalisches Institut (IA), 52056 Aachen, Germany

Phase change materials which can be switched rapidly between the amorphous and the crystalline phase are a promising candidate for new memory devices. These materials can be identified by a strong contrast in the optical dielectric constant between both phases which is due to resonant bonding [1]. As the optical dielectric constant can be evaluated from the dielectric function it is of great importance to measure the dielectric function with high accuracy.

However, an exact investigation of the dielectric constant is impeded by ageing effects which occur in the alloys after sputtering. First, we explored the dielectric function of $Ge_1Sb_2Te_4$ by infrared spectroscopy and spectroscopic ellipsometry and analysed the effect of ageing on the optical spectra.

Then, we investigate how these ageing effects can be prevented by the use of a suitable capping layer. We found out that a thin layer of ZnS:SiO_2 sputtered on top of the phase change material prevents ageing to a large extend. Additionally, after taking the ZnS:SiO_2 surface layer into account we can still investigate the optical properties of phase change materials which are capped by ZnS:SiO_2.
[1] Shportko, K. *et al.*, *Nature Mater.* **7**, 653-658 (2008).

DS 9.28 Mon 15:00 Poster D1

Sb doped SnO2: attractive alternative TCO material for ITO — •Janika Boltz, Dominik Koehl, and Matthias Wuttig — I. Physikalisches Institut (IA) RWTH Aachen 52056 Aachen Germany

Transparent Conducting Oxides (TCO) are widely employed in applications such as displays, solar cells or architectural glazing. Most commonly used materials today are based on Indium Tin Oxide (ITO). Limited amounts of explorable Indium will soon lead to a shortage of ITO, thus alternatives based on other materials are needed. Sb-doped SnO2 films possess a high optical transparency and good electrical conduction, which makes them attractive for TCO applications. In order to deposit suitable films on large area substrates we have explored the properties of Sb-doped SnO2 thin films that have been prepared by reactive dc magnetron sputtering from a metallic target at room temperature. The films were subsequently analysed regarding their optical, electrical and structural properties. Our results show that there is only a narrow process window for the sputter deposition of transparent and conducting tin oxide films at room temperature. A sharp minimum in resistivity is observed at an oxygen content of approximately 17 % in the sputtering gas. Under these deposition conditions, the SnO2:Sb films turn out to be highly transparent and crystalline.

DS 9.29 Mon 15:00 Poster D1

Spectroscopic Characterisation of Amorphous Silicon Thin Films — •Philipp Schäfer[1], Frank Nobis[2], Hartmut Kupfer[2], Frank Richter[2], and Dietrich R. T. Zahn[1] — [1]Semiconductor Physics, Chemnitz University of Technology — [2]Solid State Physics, Chemnitz University of Technology

Amorphous Silicon (a-Si) and especially hydrogenated amorphous silicon is widely used in photovoltaic applications. Despite its lower total efficiency compared to crystalline silicon, a-Si has the advantage of cheaper and easier proccessing. It can be deposited at low temperatures, it is mechanically flexible, and it provides technically relevant films already at sub-micrometre film thicknesses. However, an elaborated understanding of the film properties is required in order to improve the preparation parameters.

In this work d.c.-pulsed magnetron sputtered a-Si films are probed with various spectroscopic techniques. Thus, a comprehensive picture of their properties is achieved: *Raman* spectroscopy provides access to the morphological aspects of the film. One can distinguish between microcrystalline, crystalline, and amorphous films. Furthermore, it allows a detailed morphological characterisation of amorphous film in terms of the spread in mean bond angle $\Delta\theta$ to be obtained. Fourier transform infrared spectroscopy, on the other hand, reveals the concentration of hydrogen. Variable angle spectroscopic ellipsometry is applied and the complex dielectric function $\varepsilon(\nu)$ of the a-Si layer is evaluated using a *Tauc-Lorentz* model. A detailed comparison of a-Si layers prepared under various sputtering conditions is provided.

DS 9.30 Mon 15:00 Poster D1

The optical properties of boron carbide near boron K-edge inside periodical multilayers — •Dmitriy Ksenzov, Christoph Schlemper, and Ullrich Pietsch — University of Siegen, Walter-Flex Str. 3, 57068, Siegen, Germany

Multilayer mirrors made for the use in the wavelength range near K-edge of boron (˜188eV) are of great interest for X-ray fluorescence analysis of boron content in doped semiconductors, plasma diagnostics, astronomy and lithography. Moreover, multilayer mirrors composed by a metal and a low Z element like boron are used as optical elements in both the soft x-ray spectral range as well as at higher photon energies on 3rd generation synchrotron beamlines.

Using an energy-resolved photon-in-photon-out method we reconstructed the optical data from energy dependence of both integrated peak intensity and FWHM of the 1st order ML Bragg peak measured at the UHV triple axis soft-x-ray reflectometer at BESSY II. The experiments clearly demonstrate that the peak shape of the ML Bragg peak is most sensitive to any kind of electronic excitation and recombination in solid.

The soft-ray reflectivity can give detailed information for MLs with thickness up to several tens of nanometers. In addition, measurements close to a resonance edge probe the chemical state of the respective constituent accompanied with a high sensitivity of changes close to the sample surface.

DS 9.31 Mon 15:00 Poster D1

Spectroscopic Ellipsometry Investigation of Ultrathin Nb_2O_5 and Nb_2O_5/Al_2O_3 Layers — Marion Friedrich[1], Yue Huang[2], Yan Xu[2], Shi-Jin Ding[2], Li Ding[1], Ovidiu Gordan[1], and •Dietrich R. T. Zahn[1] — [1]Semiconductor Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]State Key Laboratory of ASIC and System, Department of Microelectronics, Fudan University, Shanghai 200433, China

Since amorphous Nb_2O_5 films have unique properties, they are widely used as optical interference filters, O_2 sensors and electrochromic material. Also, there is considerable interest in using it as a high permittivity dielectric to replace gate insulators and integrated capacitors. The high k/low k combination of Nb_2O_5/Al_2O_3 is a good candidate to implement the "VARIOT" concept in nonvolatile memory devices. Single Nb_2O_5 layers and Nb_2O_5/Al_2O_3 double layers on silicon were characterised by variable angle spectroscopic ellipsometry in the spectral range from 0.74 eV to 5 eV and by means of vacuum ultraviolet ellipsometry up to 9.8 eV at 67.5° angle of incidence at the synchrotron source BESSY. For the Nb_2O_5 layers the thickness and optical constants were determined. Furthermore, the influence of annealing on the optical properties and the band gap was investigated.
All samples were prepared by atomic layer deposition on HF cleaned silicon substrates at 300°C. The precursors for Nb_2O_5 and Al_2O_3 are $Nb(OEt)_5$ and $Al(CH_3)_3$, together with H_2O, respectively. The base pressure was 2.3×10^2 Pa. Post-deposition annealing was performed in N_2 ambient for 30 seconds at temperatures between 500°C and 800°C.

DS 9.32 Mon 15:00 Poster D1

Vibrational Modes of thin Silicon Membranes — •Reimar Waitz[1], Olivier Schecker[1,2], and Elke Scheer[1] — [1]Universität Konstanz, Germany — [2]jetzt Robert Bosch GmBH

Membranes with thicknesses of a few hundred nanometers and macroscopic lateral size are interesting systems to study the mechanical properties of solids on various length scales. In our experiment a piezo is used to couple in vibrations, which can be observed with a white light interferometer using stroboscopic light. This way we image transverse modes of frequencies up to 12 MHz. The influence of strain on the the dispersion relation is investigated by applying a pressure difference between both sides of the membrane.

DS 9.33 Mon 15:00 Poster D1

Preparation and investigation of epitaxial grown $CaRuO_3$ / $SrTiO_3$/ $CaRuO_3$ - structures — •Janine Fischer, Veit Grosse, Andreas Siebert, Frank Schmidl, and Paul Seidel — Friedrich-Schiller-Universität, Institut für Festkörperphysik, Helmholtzweg 5, 07743 Jena

We deposited layer systems of $CaRuO_3$ / $SrTiO_3$ / $CaRuO_3$ on $LaAlO_3$ using PLD by variation of the $SrTiO_3$ film thickness. The prepared layer systems were characterised via X-rays and AFM. We prepared capacitor structures from these systems after optimisation of the preparation parameters - e.g. substrate temperature, laser energy and oxygen pressure. The temperature dependence of the conductivity and the dielectric properties of the $SrTiO_3$ layers from these structures were investigated. In addition we present first measurements.

DS 9.34 Mon 15:00 Poster D1

Properties of YSZ thin films prepared by RF sputter deposition using a ceramic target — •Benjamin Pachner[1], Angelika Polity[1], Sven Ole Steinmüller[2], and Jürgen Janek[2] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Physikalisch-Chemisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 58, 35392 Giessen, Germany

Yttria-stabilized zirconia (YSZ) as an oxygen ion conductor is widely used in technical applications like solid oxide fuel cells for example. The question of film stability and structure is important for increasing the efficiency of these films. In this work YSZ thin films have been prepared by radio frequency (RF) sputter deposition on float glass substrates using a ceramic YSZ target doped with 9.5 mol% yttria and argon as sputtering gas. Several process parameters such as substrate temperature, RF power level, process gas flow rate and the amount of additional oxygen as reactive gas have been varied. The influence of these variations on the structure of the YSZ thin films has been investigated using (among others) scanning electron microscopy (SEM), X-ray diffraction, and optical absorption spectroscopy.

DS 9.35 Mon 15:00 Poster D1

Characterization of magnetron sputtered doped amorphous Silicon films — •Frank Nobis, Philipp Schäfer, Hartmut Kupfer, Frank Richter, and Dietrich R. T. Zahn — Institute of Physics, Chemnitz Univ. of Technol., 09107 Chemnitz, Germany

Thin film techniques provide excellent capabilities to develop low cost solar cell technologies using amorphous silicon (a-Si). From many research groups a substitutional doping of a-Si films was demonstrated. In contrast to the doping of mono-/polycrystalline Si the doping efficiency is very low, i.e. only a few percent of the chemically incorporated dopants are electrically active. Therefore, an improved doping efficiency is one of the main goals of current investigations.

We have used pulsed d.c. magnetron sputtering to deposit phosphorus- and boron-doped amorphous silicon films. Heavily doped monocrystalline Si targets (n^+, p^+) were sputtered using Ar and Ar/H process gas. The electrical properties and the chemical composition of the films have been characterized by four point probe measurements and secondary ion mass spectrometry (SIMS), respectively. The Raman spectroscopy yielded information about the film structure. The hydrogen incorporation into the Si films was determined by Fourier-transform infrared spectroscopy (FTIR). The film properties will be discussed with respect to the dopant incorporation and to the deposition process parameters.

DS 9.36 Mon 15:00 Poster D1

Mechanical and tribological properties of thin sputtered a-C and CNx layers on polymer substrates — •Zdenek Stryhal[1], Arndt Schumann[2], Hartmut Kupfer[1], Frank Richter[1], and Jens Sumpf[2] — [1]Chemnitz University of Technology, Faculty of Natural Sciences, Reichenhainer Straße 70, D-09126 Chemnitz, Germany — [2]Chemnitz University of Technology, Faculty of Mechanical Engineering, Reichenhainer Str. 70, D-09107 Chemnitz, Germany

Amorphous carbon layers in many forms have been studied for decades and were already used in many industrial applications. These carbon layers are often used due to their good protecting, low friction and low wear properties. PACVD techniques based on discharge in hydrocarbons or hydrogen/hydrocarbon mixture is mostly used and studied. We have studied amorphous carbon and nitrogen doped carbon layers prepared by pulsed DC magnetron sputtering of graphite in argon and argon/nitrogen gas mixture. These layers were deposited on various polymer substrates that are in use in industrial transport systems. Properties like intrinsic stress, adhesion, wear resistance, friction coefficient and surface topography have been investigated. Friction and wear tests were made at conditions similar to those we expect in real transport systems. The aim of the work is to reduce energy consumption by reducing friction losses and by extending durability of coated polymer parts.

DS 9.37 Mon 15:00 Poster D1

Growth and characterization of a copper/cobalt heterostructure on Cu(100) — •Philipp Kloth, Martin Wenderoth, Henning Prüser, and Rainer G. Ulbrich — IV. Physikalisches Institut, Georg-August Universität Göttingen

The copper/cobalt/copper heterostructure is a long known system for the research on quantum well oscillations in thin films [1, 2]. Preparing this system one has to find a trade-off between flat interfaces and intermixing of Co and Cu. We performed a detailed structure analysis for every step of the growth sequence. In the need of sufficient flat interfaces and surfaces one must conduct additional annealing steps after each deposition process. To avoid intermixing the evaporation is done at 80 Kelvin. Low energy electron diffraction (LEED) experiments show an epitaxial deposition. In order to find the appropriate annealing temperature we analyze the surface with auger electron spectroscopy (AES) so that intermixing can be neglected. Scanning tunneling microscopy analysis indicates a successful preparation process: we observe large flat areas. But in comparison to our AES setup (SPECS ErLeed) high resolution STM topographies show that cobalt tends to intermix with the copper film even for rather low heating temperatures. This work is supported by the SFB 602 TP A3.

[1] J. E. Ortega et al., Phys. Rev. Lett. 69, 844 (1992)
[2] T. Uchihashi, Phys. Rev. B 78, 033402 (2008)

DS 9.38 Mon 15:00 Poster D1

Deposition of multi-structural biocompatible thin films with an antimicrobial effect by pulsed magnetron sputtering — •Vitezslav Stranak[1,2], Marion Quaas[1], Martin Cada[2], Zdenek Hubicka[2], Carmen Zietz[3], Kathleen Arndt[4], Rainer Bader[3], Andre Podbielski[4], and Rainer Hippler[1] — [1]University of Greifswald, Institute of Physics, Felix-Hausdorff-Str. 6, 17489 Greifswald, Germany — [2]Academy of Sciences of the Czech Rep., Institute of Physics, Na Slovance 2, 18221 Praha 8, Czech Republic — [3]University of Rostock, Department of Orthopaedics, Doberaner Str. 142, 18057 Rostock, Germany — [4]University of Rostock, Dept. of Med. Microbiol., Vir. and Hyg., Schillingallee 70, 18057 Rostock, Germany

The aim of our work is to produce materials and surfaces for medical devices such as endoprosthetic implants, which combine good cellular adhesion of osteoblasts at the surface with distinguished antimicrobial effects. Our actual approach is to insert Cu as a metal with known antimicrobial properties into the surface of titanium substrates. Crystallographic phases of deposited thin films are investigated by grazing incidence x-ray diffractometry (XRD) and chemical composition is estimated by x-ray photoelectron spectroscopy (XPS). Plasma properties are characterized by time-resolved Langmuir probe measurement, ion particle flux and total energy flux measurements. The combination of these diagnostic methods enables an extensive characterization of the films and also agents responsible for formation of thin films. The work is supplemented by measurements of copper release and antimicrobial effects to give a survey of bio-properties of the thin films.

DS 9.39 Mon 15:00 Poster D1

Structural and electrical properties of sol-gel derived Ge nanocrystals in thin SiO2 layers — •Sebastian Knebel, Agathi Kyriaikidou, Hartmut Bracht, Harald Rösner, and Gerhard Wilde — Institut für Materialphysik, WWU Münster, Wilhelm-Klemm-Str. 10, 48149-Münster, Germany

A sol-gel based method for the synthesis of germanium nanocrystals (Ge-nc) in thin amorphous silicon dioxide (SiO2) films on silicon is presented. The synthesis process consists of a wet chemical coating step of Si substrate wafers and annealing steps under both oxidizing

and reducing atmosphere. Size, structure and local distribution of the Ge-nc were studied by means of conventional and high-resolution transmission electron microscopy (HRTEM).

The structural properties are dependent on the thickness of the thin film as well as on the temperatures and times used in the annealing steps. Analysis of the thin glass films with energy dispersive x-ray spectroscopy (EDX) shows that Ge migrates to both the Si substrate and the free SiO2 surface. Capacitance-voltage (CV) measurements reveal a hysteresis indicating a trapping of charges in the glass layer.

DS 9.40 Mon 15:00 Poster D1

Focusing Neutron Beams to Sub-Millimeter Size — •Roxana Valicu and Peter Böni — Physik-Department E21, Technische Universität München, D-85747 Garching, Germany

Focusing neutron guides are a well-established means to significantly increase the neutron flux for the investigation of small samples or samples subject to extreme conditions such as pressure or high magnetic fields. Parabolic and elliptic guides can focus the beam in a single point beyond the guide exit with well defined beam characteristics and a gain in intensity of over 30 compared to a non-focused beam. Focusing guides find applications in elastic and inelastic neutron scattering as well as in neutron imaging to increase the spatial resolution and for magnification. The aim of the Monte Carlo simulations using McStas was to produce focal spots with a diameter of the order of 0.1 mm using supermirrors with large angles of reflection. We will discuss the results of our simulations, i.e. the gains obtained, their variation with wavelength as well as the evolution of the beam size.

DS 9.41 Mon 15:00 Poster D1

Synthesis and characterization of ion-conducting lithium phosphorus oxynitride thin Films — •Eric Hofmann, Thomas Leichtweiss, Angelika Polity, and Bruno K. Meyer — Justus-Liebig- Universitaet Giessen, I. Physikalisches Institut, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

Transparent amorphous lithium phosphorus oxynitride (LiPON) thin films can be used in smart windows as solid Li+-ion-conductors. Our films were deposited by RF-sputtering from a ceramic Li3PO4 target in pure N2-atmosphere on glass substrates, the film thickness is typically 100 nm. Our aim is to optimize the deposition parameters in view of the ion-conductivity.

The deposition parameters such as the deposition rates, the film stoichiometry and the morphology were studied by X-ray reflection, photo electron spectroscopy and AFM-microscopy. The dependence of the ion-conductivity on the deposition parameters was measured by impedance spectroscopy using InCu|LiPON|InCu sandwich structures.

DS 9.42 Mon 15:00 Poster D1

Characterization of Ion- bombardment induced modifications of periodic La/B_4C-multilayer-mirrors for the reflection of soft X-ray radiation — •Fabian Merschjohann[1], Maike Lass[1], Lennart Gorholt[1], Marc D. Sacher[1], Franz Schäfers[2] und Ulrich Heinzmann[1] — [1]Molecular and Surface Physics, Bielefeld University, D-33615 Bielefeld — [2]Helmholtz-Zentrum Berlin für Materialien und Energie, Elektronenspeicherring BESSY II

The applicability of reflective optical components for the soft X-Ray region depends on the existence of multilayer-optics. Therefore stacks of alternating layers of two materials with different refractive index are applied. For the photon energy range of 100 - 190 eV Lanthanum (La) is favoured as the absorber material and Boroncarbide (B_4C) as the spacer material. Thin periodic layer systems of those materials with double layer periods of 5.6 nm have been produced by UHV Electron Beam Evaporation. The layer thickness is controlled by in-situ X-Ray Reflectometry. The purity and the stoichiometry of the layers has been analyzed by electron beam induced in-situ Auger Spectroscopy. Ion Polishing of each interface should diminish the interface roughness and thus enhance the reflectivity. The modification of the La- and B_4C-layers due to ion bombardment has been investigated by the in-situ Auger Spectroscopy, ex-situ X-Ray Diffraction and at-wavelength reflectivity measurements by use of Synchrotron radiation at the BESSY II facility. Effects of compaction, mixing, sputter-etching and smoothing have been found. The modifications can be influenced by varying the kinetic energy of the ions and/or the duration of the treatment.

DS 9.43 Mon 15:00 Poster D1

X-ray waveguides fabricated by thin film techniques — •Sven Philip Krüger, Giewekemeyer Klaus, Kalbfleisch Sebastian, Henrike Neubauer, and Tim Salditt — Georg-August Universität, Institut für Röntgenphysik, 37075 Göttingen, Deutschland

Waveguides can be used for spatial and coherent filtering of x-rays. We present a two-component waveguide design [1] of enhanced transmission efficiency at carbon guiding layer cross-sections up to sub-10 nm fabricated by magnetron sputtering. The transmission is enhanced by choosing an appropriate molybdenum interlayer. At the same time a strongly absorbing germanium cladding allows for short waveguide lengths which lead to an enhanced efficiency of the waveguide. We used an arrangement of two short waveguide slices to obtain an two-dimensionally confining waveguide with an effective source size of sub-15 nm^2. A first imaging experiment of a test pattern is presented and the images are reconstructed by holographic and iterative phase retrieval algorithms.

[1] T. Salditt et al, Phys. Rev. Lett. 100, 184801, (2008).

DS 9.44 Mon 15:00 Poster D1

Multilayer Bragg Fresnel Zone Plate for coherent HHG radiation — •Christian Späth[1], Michael Hofstetter[2], Jürgen Schmidt[1], Ferenc Krausz[1,2], and Ulf Kleineberg[1,2] — [1]Fakultät für Physik, Ludwig Maximilians Universität München, Garching, Germany — [2]Max Planck Institut für Quantenoptik, Garching, Germany

Coherent Diffractive Imaging in the (soft) X-ray regime is an emerging new lens-less X-ray microscopy technique with the future potential of molecular or even atomic resolution, because it is ultimately limited by the wavelength of the illuminating radiation and not by the imaging quality of the x-ray lens. However, this technique depends on the availability of coherent x-ray sources as well as optics for spectral filtering and focusing. We describe the development fabrication and testing of a reflective multilayer Bragg Fresnel phase zone plate for focusing coherent XUV radiation at 13 nm wavelength from a High Harmonic Generation source. This x-ray optical device serves for spectral filtering as well as sub-micron focusing of the HH spectrum in a single element for largely reduced losses. Large zone plate structures (conventional, spiral) matching the HH beam size are recorded by e-beam lithography in ultrathin HSQ e-beam resist and over-coated with a reflective Mo/Si multilayer by Ion Beam Deposition. By accurately matching the groove depth of the diffractive structure to odd multiples of the quarter Bragg wavelength, the total diffraction efficiency can be improved by a factor of 4 theoretically compared to amplitude structures.

DS 9.45 Mon 15:00 Poster D1

Preparation of a heater and sensor arrangement on Si_3N_4 thin membranes for in-plane thermal conductivity measurements — •David Hartung, Torsten Henning, and Peter J. Klar — I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Germany

The aim of this work is to characterize the lateral heat flow in a thin material layer on a Si_3N_4 membrane. Thin Si_3N_4 membranes (200 nm thickness, 500 μm × 500 μm) on Si-substrates (200 μm thickness, 2.5 mm × 2.5 mm) fabricated by Plano GmbH are used as substrates for the heater and sensor arrangement. A meandering Ag wire along the middle axis of the membrane serves as an electric heater, three Ag-wires of 5 μm thickness at different distances from, but parallel to the heater wire, serve as temperature sensors. The arrangement was defined by electron-beam-lithography on to the membrane. After a development step thin layers of chrome, working as a primer and then silver as the actual wire material were evaporated on to the structured PMMA. A following lift off step completes the nanofabrication of the wire arrangement on the membrane. (spp 1386)

DS 9.46 Mon 15:00 Poster D1

3ω measurements of thermal conductivity in oxide thin films — •Stefanie Wiedigen[1], Manuel Feuchter[2], Christian Jooss[1], and Marc Kamlah[2] — [1]Institute for Materials Physics, University of Göttingen — [2]Institute for Materials Research II, KIT

Several novel approaches for high- efficiency thermoelectric devices are based on thin film geometries like multilayer structures or nanosized devices. Thereby, the 3ω method is one of a few measurement techniques which allows a reliable determination of thin film thermal conductivity. However, the application of the 3ω method on complex geometries and material combinations needs an extension of the standard evaluation techniques. In this contribution, we analyze the conditions for high precision measurements based on the 3ω method in experiment and numerical simulations. For the thin film configurations investigated here, the heat conduction problem is solved by the numerical finite element method. Techniques for modeling the problem

and evaluating the results are under development to study the impact of parameters as heater geometry, film thickness and frequency on the voltage signal. The simulation results are compared with the measured frequency spectrum of the ac voltage determined by a 4 terminal geometry. The measurements are performed for Manganite and Cobaltate thin films as promising new thermoelectric materials on $SrTiO_3$ and MgO substrates with different bulk thermal conductivity. Our results are the first steps for an optimization of the measurement configurations and the evaluation of the applicability of common analytical solutions.

DS 9.47 Mon 15:00 Poster D1

Modelling thermoelectric properties of ZnO/ZnS multilayer systems with a network model — •Florian Gather, Gert Homm, Markus Piechotka, Christian Heiliger, Peter J. Klar, and Bruno K. Meyer — I. Physikalisches Institut, Justus-Liebig-University, Heinrich-Buff-Ring 16, 35392 Giessen

Two different types of ZnO/ZnS multilayer systems are investigated. The first is a multilayer system with alternating layers of ZnO and ZnS. The second one consists of a chequer-board pattern of the two materials. For the modeling of the electric and thermal properties of both systems a two-dimensional network model was used. The spatial properties such as layer thicknesses and interface roughness are translated into a pixel grid. In order to calculate the thermal or electric resistance, each pixel cell consists of a node with a local resistance connected to the four nearest-neighbour pixel cells. The calculated total resistance of the network is then converted into an either electric or thermal conductance of the multilayer structure. To calculate the effective Seebeck-coefficient of the system a temperature difference between the contacts is applied. Then the individual temperature differences between the nodes are determined and used to calculate the local Seebeck-voltages. These are now implemented into the electric resistance network via voltage sources. To determine the effective Seebeck-coefficient of the multilayer structure the voltage between the contacts of the multilayer structure is calculated and divided by the applied temperature difference. The influence of the spatial parameters on the thermoelectric properties is studied. (SPP 1386)

DS 9.48 Mon 15:00 Poster D1

Ab initio investigations of ZnO/ZnS interfaces — •Michael Bachmann, Robert Henrich, and Christian Heiliger — I. Physikalisches Institut, Justus Liebig University Giessen, D-35392, Germany

ZnO/ZnS nanostructures are a promising material for thermoelectric applications due to the expectation of a strong phonon scattering at the interface but a high transmission of electrons through the interface. Therefore, the atomic positions, the coupling of the atoms, and the electronic states at the interface are of special interest. We present ab initio calculations of ZnO/ZnS interfaces in wurzite structure for different boundary conditions based on a pseudopotential method. We calculate the equilibrium positions of the atoms at the interface and the coupling between them.(SPP 1386)

DS 9.49 Mon 15:00 Poster D1

Thermoelectric properties of silicon nano pillars — •Andrej Stranz, Ünsal Sökmen, Andreas Waag, and Erwin Peiner — Institute of Semiconductor Technology, Braunschweig, Germany

In order to establish silicon as a efficient thermoelectric material, its high thermal conductivity has to be reduced which is feasible, e.g., by nano structuring. Therefore, in this study Si-based sub-micron pillars of various dimensions were investigated. Using anisotropic etching followed by thermal oxidation we could fabricate pillars of diameters < 500 nm, about 25 *m in height with aspect ratios of more than 50. The distance between the pillars was varied from 500 nm to 10 micron. Besides the fabrication and structural characterization of sub-micron silicon pillars, and adequate metrology for measuring their thermoelectric properties was implemented. Commercial tungsten probes and self-made gold probes, as well as Wollaston wire probes were used for electrical and thermal conductivity, as well as Seebeck voltage measurements on single pillars in a scanning electron microscope equipped with nano manipulators.

DS 9.50 Mon 15:00 Poster D1

Thermoelectric properties of hot wall deposited thin SnS films — •Dzianis M. Unuchak[1], Vasil A. Ivanov[2], Valeriy F. Gremenok[2], and Klaus Bente[1] — [1]Institut für Mineralogie, Kristallographie und Materialwissenschaft, Universität Leipzig, Scharnhorststr. 20, 04275 Leipzig, Germany — [2]State Scientific and Production Association "Scientific-Practical Materials Research Centre of the National Academy of Sciences of Belarus", P. Brovka str., 19, 220072 Minsk, Belarus

Polycrystalline ingots of SnS was directly synthesized from a stoichiometric mixture of 99.999 % purity Sn and S in a vacuum-sealed quartz ampoule. Thin SnS films were deposited by hot wall technique on glass and molybdenum substrates under an ambient pressure of $5*10^{-6}$ mbar. The elemental composition of the obtained films was determined to be stoichiometric (SEM-EDX). The crystal structure and crystalline phases of the samples were studied by X-ray diffraction (Siemens D-5000 diffractometer with CuK_α radiation). The obtained films were polycrystalline, monophase in nature and had orthorhombic crystal structure. The films on glass were highly oriented along (001) plane whereas films on molybdenum showed SnS phase with different orientation. The as-prepared films show p-type electrical conductivity confirmed by the thermoelectric probe measurement. The value of Seebeck coefficient was about 1000 and 400 μV/K for films on glass and Mo, respectively.

DS 9.51 Mon 15:00 Poster D1

Properties of thin films and bulk of $Pb_{1-x}Sn_{1+x}X_2$ (X=S, Se) mixed crystals — •Vera Lazenka[1], Klaus Bente[1], and Valery Gremenok[2] — [1]Institut für Mineralogie, Kristallographie und Materialwissenschaft, Universität Leipzig, Scharnhorststr. 20, 04275 Leipzig, Germany — [2]State Scientific and Production Association "Scientific-Practical Materials Research Centre of the National Academy of Sciences of Belarus", P. Brovka str., 19, 220072 Minsk, Belarus

Mixed crystals of the galena-herzenbergite-system implying intermediate $PbSnS_2$ are perspective for thermoelectric, photovoltaic etc. materials. In addition to the Pb-Sn-substitution the replacement of S by Se and Te is studied, taking in account that thermoelectrical properties of e.g. PbX are improved by the substitution of S for Se and Te. The work aims to investigate the effect of anionic and metal atom substitutions in SnX - $PbSnX_2$ on structure and optical and electrical properties. For target synthesis Sn, Pb, S and Se (99.998 %) were reacted in vacuum-sealed quartz ampoules. Because of the thermoelectrical properties improvement caused by metal impurities in galena, also natural PbS is used. Thin films were prepared from powder material by hot wall evaporation method at $7*10^{-6}$ mbar on glass substrates at 200-350 °C. $Pb_{1-x}Sn_{1+x}X_2$ (X=S, Se) characterized by XRD and EPMA and effects of Pb-Sn and S-Se ratios on the thermopower are presented.

DS 9.52 Mon 15:00 Poster D1

Thermoelectric properties of ball-milled and subsequent short-term sintered $In_xCo_4Sb_{12}$ skutterudites — •Andreas Sesselmann, Ralf Hassdorf, Lothar Böttcher, Christian Stiewe, Andreas Schmitz, and Eckard Müller — German Aerospace Center (DLR), Institute of Materials Research, 51170 Cologne, Germany

For more than a decade, $CoSb_3$ has been widely studied as a promising thermoelectric (TE) material at intermediate temperatures. High thermoelectric figure of merit (ZT) in this material system can be achieved by filling guest atoms known as rattlers. One of the best improvements in ZT is reported when In is used as a filler atom leading to a ZT_{max} of about 1.2 at 575 K [1]. Another approach to lower the lattice thermal conductivity is by nano-structuring which leads to increased phonon scattering at the grain boundaries. The approach in this study is based on planetary ball milling, which allows for grain sizes on the nanometer scale and subsequent compaction by short-term sintering in favour of grain growth confinement. Phase homogeneity of the bulk material has been probed by XRD and EDX. TE properties (i.e. electrical conductivity, Seebeck coefficient, thermal conductivity) have been analyzed in the temperature range from 300 K to 700 K. The functional homogeneity of the samples was checked by Potential-Seebeck Microprobe (PSM). Based on these results, the combined effect of In filling and nano-structuring on the TE properties will be discussed.
[1] T. He *et al.*, Chemistry of Materials, 2006, 18, 759-762

DS 9.53 Mon 15:00 Poster D1

Complex Chalcogenides for Thermoelectrics: Microstructural-Property Relationship — •Susanne Perlt and Thomas Höche — Leibniz Institute of Surface Modification, Permoserstrasse 15, D-04318 Leipzig, Germany

The quaternary compound $AgPb_{18}SbTe_{20}$ (LAST) is a typical high-temperature thermoelectric material. The manufactoring process

needs to be controlled in such a way, that the figure of merit, ZT [1], gets maximized. In this respect, a high electronic conductivity σ, a high thermopower S, and a low thermal conductivity κ are crucial. The high thermoelectric performance of LAST is assumed to be caused by the nanoscale precipitates formed by spinodal decomposition [2]. Based on properties monitored by a Seebeck probe, structure-property relationships are studied by SEM and TEM analysis. Site-specific lift-out of TEM lamellae from thermoelectrically characterised samples is made by focused ion beam (FIB) machining. Composition analyses, phase analyses (via electron diffraction) and element distributions are done by energy-dispersive X-ray spectrometry.

[1] D. Bilc et al., Phys. Rev. Lett. **93**, 146403 (2004)
[2] M.-K. Han et al., Chem. Mater. **20**, 3512 (2008)