HL 61: Poster II: Materials, Interfaces and Heterostructures

Time: Thursday 18:00–20:00 Location: Poster D1

HL 61.1 Thu 18:00 Poster D1

Phase Change RAM: Non-volatile switching at DRAM speeds — •Philipp Merkelbach[1], Gunanr Bruns[1], Carl Schlockermann[1], Martin Salinga[1], Matthias Wuttig[1], Thomas Happ[2], Jan Boris Philipp[3], and Michael Kund[3] — [1]I. Physikalisches Institut (IA), RWTH Aachen University, 52056 Aachen, Germany — [2]Qimonda Dresden GmbH & Co. OHG, Königsbrücker Strasse 180, 01099 Dresden, Germany — [3]Qimonda AG, Bibergerstr. 93, 82008 Unterhaching, Germany

Phase Change Materials are promising candidates for novel data storage. Known from rewritable optical media like CD-RW and DVD-RW they possess a unique combination of properties: the ability to be switched within nanoseconds between the amorphous and the crystalline phase and a large optical and electrical contrast between both phases. Yet the physical driving mechanism of this transition is not fully understood.

Regarding their crystallization behavior phase change materials can be divided into two different classes, i.e. growth and nucleation dominated. Previously this classification has been established by laser induced crystallization, where the smallest diameter was approximately 1 μm. Now experiments are presented where the bit size is as small as 60 nm. A clear trend of higher switching speeds with smaller amorphous region was observed. This finding is attributed to the increasing impact of crystal growth upon decreasing switchable volume. Using GeTe or materials with similar crystal growth velocities, hence promises non-volatile phase change memories with DRAM like switching speeds.

HL 61.2 Thu 18:00 Poster D1

Ultrafast phase change RAM cell characterization — •Carl Schlockermann, Gunnar Bruns, Philipp Merkelbach, Hanno Volker, Martin Salinga, and Matthias Wuttig — 1. Physikalisches Institut (1A)

Phase Change materials possess unique material properties which already allow nonvolatile rewritable data storage in optical media (e.g. DVD-RW). The information is stored by the distinct difference of optical properties between the amorphous and crystalline structure. A sufficient data rate can be achieved by the ultrafast crystallization at elevated temperatures. A distinct difference in electrical properties between the phases together with the phenomenon of threshold switching, a sudden drop in resistivity at high electric fields, allows the use of such materials as a purely electronic storage called phase change RAM. Although such memory devices are close to the market with comparable properties as NOR FLASH memories, the afore mentioned phenomenon of threshold switching and the limits of crystallization speed are not yet identified. One reason are limits in the measurement techniques used so far which restrict the measurement speed of such electronic memory cells. In addition they did not allow the measurement of the cell current during the application of voltage pulses with high bandwidth. In this work we present a new measurement setup which overcomes these limits. Our results show that crystallization is possible at extremely high speed in these materials[1]. This may offer the possibility for such memories to compete with DRAM in the future. [1] Bruns G. et. al., App. Phys. Lett. 95, 043108 (2009)

HL 61.3 Thu 18:00 Poster D1

Neutron Scattering and ab initio Studies of $CuCrS_2$ — •Karin Schmalzl[1], Julia Rasch[2,3], Martin Boehm[2], Hannu Mutka[2], Juerg Schefer[3], G. M. Abramova[4], and Joerg F. Loeffler[5] — [1]IFF, Forschungszentrum Juelich, JCNS at ILL, 38042 Grenoble, France — [2]Institut Laue-Langevin, BP 156, 38042 Grenoble, France — [3]LNS, ETH Zuerich and PSI, 5232 Villigen PSI, Switzerland — [4]L. V. Kirensky Institute of Physics, SB RAS, Krasnoyarsk, 660036, Russia — [5]Laboratory of Metal Physics and Technology, Department of Materials, ETH Zuerich, 8093 Zuerich, Switzerland

Transition metal dichalcogenides show a quasi-two dimensional layered structure leading to interesting electronic properties like charge density wave or superconductivity. Due to the triangular lattice of the Cr^{3+} ions $CuCrS_2$ is prone to geometrical frustration. Below T_N=37 K a complex magnetic structure with an incommensurable magnetic propagation vector is present. The magnetic order is coupled to a structural transition. At higher temperatures ionic conductivity of the weakly bound Cu ions emerges.

Inelastic neutron scattering experiments below T_N show a strong non-dispersive, localised mode in Q at about 12 meV. Additionally an enhanced intensity has been observed at crossings of phonon and magnon modes at about 8 meV. Temperature dependent measurements of the phonon density of states show a change of low lying phonon branches, where the strongest change appears at about 150 K at an energy of about 8 meV. Ab initio calculations assign this energy to in plane motions of the Cu atoms.

HL 61.4 Thu 18:00 Poster D1

$Ba_{0.7}Sr_{0.3}O$ thin films on n-Si as high-k material: correlation between structural and electrical properties — •Lisa Kühnemund[1], Dirk Müller-Sajak[1], Alexandr Cosceev[2], Herbert Pfnür[1], and Karl R. Hofmann[2] — [1]Leibniz-Universität Hannover, Inst. f. Festkörperphysik — [2]Leibniz-Universität Hannover, Bauelemente der Mikro- und Nanoelektronik

Crystalline and perfectly lattice matched $Ba_{0.7}Sr_{0.3}O$ films were grown on Si(001), which have a dielectric constant of $\epsilon_r \approx 28$. The thin films have a perfect atomically sharp interface, as found by XPS. They were grown in a UHV chamber by MBE in oxygen ambient conditions and capped with 100nm Au for ex-situ electrical measurements. A 0.5-2ML thick Al intermediate layer improves the adhesion between the Au and the oxide, which have an influence on the electrical properties depending on the thickness of the Al layer.

This material has attractive electrical properties: XPS measurements at the interface show no evidence for SiO_2 formation. Furthermore the density of states at the interface (determined by the Terman method) is very low ($6.3 \cdot 10^{10} eV^{-1}cm^{-2}$) and a factor 10-100 lower than for amorphous BaO, SrO and $Ba_{0.7}Sr_{0.3}O$. This is caused by the good structural properties of the crystalline oxide. Low leakage current densities ($<10^{-6}A/cm^2$) have been found by current-voltage (IV) measurements, supported by sufficient valence and conduction band offsets >1eV at the semiconductor/insulator interface, as measured with XPS and EELS. These band offsets can be tuned by varying the conditions during growth of the interface.

HL 61.5 Thu 18:00 Poster D1

Lanthanide oxides thin films for graphene-based devices — •Ihor Petrov[1], Teodor Toader[1], Claudia Bock[1], Ulrich Kunze[1], Andrian Milanov[2], Anjana Devi[2], and Roland A. Fischer[2] — [1]Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum — [2]Anorganische Chemie II, Ruhr-Universität Bochum

We study the application potential of gadolinium and dysprosium oxide for graphene-based devices. Lanthanide oxide thin films of defined thickness are deposited in the presence of oxygen as well as nitrogen at 400 °C by thermal CVD on an n^+-Si(100) substrate [1]. The roughness of the films is determined by atomic force micrographs and the thickness by cross-section scanning electron microscopy. A breakdown field in the range of 0.3 Vnm^{-1} is determined by I-V measurements for both rare earth oxides. From C-V measurements at 1 MHz the dielectric constant of Gd_2O_3 ($\epsilon_r = 9$) and Dy_2O_3 ($\epsilon_r = 8$) are extracted. Since the dielectric constant of the rare earth oxides are higher compared to SiO_2 we expect an improved screening of charged impurities [2] and therefore an improved performance for graphene-based devices due to the oxides. By using a Fresnel-law based model [3] the contrast of graphene is calculated as a function of wavelength for different oxide thicknesses and compared to optical and atomic force micrographs of exfoliated graphene on Gd_2O_3 and Dy_2O_3.

[1] A.P. Milanov, *et al.*, Chemistry of Materials **21**, 5443 (2009).
[2] S.V. Morozov, *et al.*, Phys. Rev. Lett. **100**, 016602 (2008).
[3] P. Blake, *et al.*, Appl. Phys. Lett. **91**, 063124 (2007).

HL 61.6 Thu 18:00 Poster D1

First observation of the strong nonlinear optical response of graphene measured by four-wave mixing — Euan Hendry[1], Peter Hale[1], Julian Moger[1], Alexander Savchenko[1], and •Sergey Mikhailov[2] — [1]School of Physics, University of Exeter, UK — [2]Institute of Physics, University of Augsburg, Germany

We present the first experimental investigation of nonlinear optical properties of graphene at visible and near infrared frequencies measured by four-wave mixing technique. It is shown that graphene produces strong third-order nonlinear optical response, described by non-

linear susceptibility comparable to that of other strongly nonlinear materials, such as carbon nanotubes. In contrast to carbon nanotubes, however, this nonlinear response is essentially dispersionless over the wavelength range in our experiments (emission with wavelength of 760 - 840 nm). We show that the nonlinear response of graphene can be exploited for high-contrast optical imaging of flakes: the image contrasts for monolayer flakes on a dielectric substrate are several orders of magnitude higher than those in reflection microscopy.

This work was funded by the RCUK, EPSRC and Deutsche Forschungsgemeinschaft.

HL 61.7 Thu 18:00 Poster D1

Raman analysis of manipulated graphene — •Stefanie Heydrich, Michael Hirmer, Jonathan Eroms, Dieter Weiss, Tobias Korn, and Christian Schüller — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg

We present recent results of Raman spectroscopy on unstructured graphene, gated graphene and graphene etched with anti-dot lattices.

We utilize fast, high-resolution scans to map graphene flakes on Si/SiO_2-substrates. The Raman spectrum, acquired by a Triple Raman System, optimized for maximum stray light suppression, is evaluated and height, position and FWHM of the characteristic G (1580 cm^{-1}), D (1350 cm^{-1}) and 2D (2700 cm^{-1}) peaks are plotted for each point. Thus, a Raman image of both the flake and its structured areas is created and the chirality of a flake's edges can be extracted.

In unstructured flakes, the D peak is observed only at the edges, while the G peak is present everywhere on the graphene sheet.

In flakes patterned with anti-dot lattices, both D and G peak are observed everywhere on the flake. We find a stiffening of the G-peak on the structured areas compared to unstructured parts. This could be due to the strain effect. The shift is dependent on diameter and distance of the anti-dot holes.

Additionally, we study the G peak in a gated graphene flake. The gate voltage influences the charge-carrier density in the material and thus the LO-Phonon in graphene, which is coupled to this density. Therefore, by varying gate voltage, one can manipulate the G-peak position.

HL 61.8 Thu 18:00 Poster D1

Spin Transport and Spin Precession in Bilayer Graphene with Transparent Ferromagnetic Contacts — •Bastian Birkner, Dieter Weiss, and Jonathan Eroms — Institut für Experimentelle und Angewandte Physik, Universität Regensburg

We achieved electrical spin injection with a DC current from a ferromagnetic material (Co) into bilayer graphene without using any tunnel barrier. This results in a contact resistance of about 450 Ohm which indicates that the junctions between the Co and graphene are transparent. The graphene flakes were mechanically exfoliated from natural graphite by using adhesive tape. The induced spin accumulation diffuses away from the injection point and is probed in a non-local four terminal scheme where charge and spin current are completely separated from each other. We obtain a clear spin signal $R_{nl}=U_{nl}/I$ whose sign depends on the magnetization orientation (parallel/antiparallel) of the ferromagnetic electrodes. By applying a perpendicular magnetic field we also detected spin precession (Hanle effect) that confirms that the non-local signal originates from spin injection and spin transport. Fitting of Hanle curves yields a spin relaxation time in the range of 60-130 ps and a spin diffusion length of below one micrometer. The polarization was estimated to be less than 5 percent.

HL 61.9 Thu 18:00 Poster D1

Investigation of top gates with ALD deposited dielectric on graphene structures — •Franz-Xaver Schrettenbrunner, Dieter Weiss, and Jonathan Eroms — Institut für Experimentelle und Angewandte Physik, Universtität Regensburg, 93040 Regensburg

We report the fabrication and transport measurements of top gated mono- and bilayer graphene devices. The insulating Al_2O_3 top gate was realized using atomic layer deposition (ALD). With a TMA/water process at 100 °C we could achieve complete coverage of the graphene flakes and produce stable gates with a thickness down to 30nm. In particular, using both the aluminum oxide top gate and the 300nm SiO_2 backgate on our Si-chip, we were able to create a gate-induced insulating state in bilayer graphene. Using a model which regards the two layers as electrically decoupled, we could determine the density of background impurities and on which of the two layers they were preferentially located.

HL 61.10 Thu 18:00 Poster D1

Fabrication of suspended graphene sheets — Benjamin Söll, Dieter Weiss, and •Jonathan Eroms — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg

We report the fabrication of single layer graphene devices suspended 150 nm above a Si/SiO_2 substrate. Suspension of the graphene flake was achieved by dipping entire conventional devices with gold contacts into buffered oxide etch. Thereby we removed 150 nm of SiO_2, including the area underneath the flake, while SiO_2 masked by the gold electrodes remained unetched. To dry the samples we used a critical point dryer to avoid the surface-tension-induced collapse of the suspended sheet. After suspending, the devices were baked in forming gas at 200 °C for 10 minutes to remove residues left from sample fabrication. Further cleaning was carried out by current induced cleaning in the cryostat, with a typical current of 1mA per μm of sample width. First measurements show an improvement of sample properties after current induced cleaning.

HL 61.11 Thu 18:00 Poster D1

Electric properties of multiwall carbon nanotubes with defects — •Andreas Stetter, Johann Vancea, and Christian H. Back — Universität Regensburg

Carbon nanotubes are of high interest for future electronics. However, the performance of an electronic device generally depends on the quality of the material. Therefore, it is fundamental to study the properties of non ideal tubes.

We investigated the electric response on several defects in current conducting multiwall carbon nanotubes using scanning tunnelling potentiometry. This technique yields a potential profile along the tube while a current is flowing through it. We observed a voltage drop at the end of an incomplete outermost shell. We used this potential profile to separate the intrashell resistance and the intershell conductance. Furthermore, we studied a stretched carbon nanotube with a kink, where a strong increase in the resistance was observed.

HL 61.12 Thu 18:00 Poster D1

Temperature dependent combination modes in the intermediate frequency region of single walled carbon nanotubes — •Felix Fromm, Daniel Niesner, Jonas Röhrl, Ralf Graupner, and Martin Hundhausen — Universität Erlangen-Nürnberg, Lehrstuhl für Technische Physik, 91058 Erlangen, Germany

Single walled carbon nanotube (SWCNT) samples have different diameter distributions, depending on the production method. Resonant Raman scattering can be employed for their characterisation since it is sensitive to the diameters of the SWCNTs. We measured Raman spectra with different laser excitation energies in the temperature range between 10 K to 700 K in order to study SWCNTs produced by the laser ablation (LA) process and the high-pressure catalytic decomposition of carbon monoxide (HiPco). We focus here on the so called intermediate frequency modes (IFMs) which lie in between the well known radial breathing modes (RBMs) and the defect induced D-band. The Stokes Raman spectra of the IFMs contain both one-phonon and two-phonon modes. The two-phonon modes either correspond to the excitation of two phonons or to the excitation of one phonon of higher energy combined with the annihilation of one lower-energy phonon. Since the annihilation is strongly temperature dependent, it is possible to distinguish between these two alternatives. We also estimate the energy of the annihilated phonon from the temperature dependence.

HL 61.13 Thu 18:00 Poster D1

Effect of swift heavy ion irradiation on diamond — •Anne-Katrin Nix[1], Ulrich Vetter[1], Daniel Severin[2], Christina Trautmann[2], and Hans Hofsäss[1] — [1]II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]GSI Helmholtzzentrum für Schwerionenforschung, Planckstraße 1, 64291 Darmstadt, Germany

Diamond is a wide band-gap semiconductor with many applications. Some of these applications require doping of diamond, which can be achieved by ion implantation. The process has the detrimental effect to produce many lattice defects, which in principal can be removed by thermal annealing. In the case of diamond, the treatment requires high temperatures which may result in surface graphitization before electronic or optical activation of the dopants becomes successful. In this work, we tested swift heavy ion beams as possible alternative method for annealing of doped diamonds as analyzed in [1]. Type Ia brownish diamonds were implanted with 100 keV Argon of fluences between

$3 \cdot 10^{13}$ and 10^{14} ions/cm^2. Subsequently, the samples were irradiated at 500 °C using 1.4 GeV Xenon of fluence $2.8 \cdot 10^{12}$ ions/cm^2. Before and after implantation and irradiation, the cathodoluminescence of the samples was examined. We found that tempering alone at 500 °C for 1.5 h improves the luminescence and reduces the implantation damage. Swift heavy ion irradiation however did not lead to defect annealing and in non-implanted diamonds, the ion exposure leads to the formation of H3 centers.

[1] J. Nakata, Phys. Rev. B, 60 (1999) 2747

HL 61.14 Thu 18:00 Poster D1

Excited States of the Negatively Charged Nitrogen-Vacancy Color Center in Diamond — •Yuchen Ma[1], Michael Rohlfing[1], and Adam Gali[2] — [1]Fachbereich Physik, Universität Osnabrück, Germany — [2]Department of Atomic Physics, Budapest University of Technology and Economics, Hungary

Optical excitation in the negatively charged nitrogen-vacancy (NV) color center in diamond induces a strong spin polarization in the ground-state, which makes the NV center a competitive candidate for solid state quantum information processing and nanoscale magnetic imaging. However, the excited-state structure and the spin-polarization process of the NV center are not yet fully understood. Here we investigate details of the excitations within ab initio many-body perturbation theory (MBPT). We find that three singlets, one of which exhibiting an intersystem crossing with the excited triplet, may be relevant for the fluorescence process in a way which has never been considered before. The calculated zero-phonon line (ZPL) for the visible excitation and that for the transition among the singlets are in good agreement with the experiments. Our results provide new insight into the optical process in the NV center relevant for its future application.

HL 61.15 Thu 18:00 Poster D1

Relationship between structural properties and electrochemical characteristics of electrochemical double-layer electrodes in aqueous and organic electrolyte — •Volker Lorrmann[1], Mario Zeller[1], Gudrun Reichenauer[1], Jens Pflaum[1,2], and Vladimir Dyakonov[1,2] — [1]Bavarian Center of Applied Energy Research e.V. (ZAE Bayern), 97074 Würzburg — [2]Experimental Physics VI, Julius-Maximillians-University of Würzburg, 97074 Würzburg

Electrochemical double-layer capacitors (EDLC) are energy storage devices with rather low energy density, but high power density. The charges are stored at the interface between the electrode and the electrolyte. The capacitance and the transport kinetics to the interfacial surface area strongly depend on the porous nanostructure of the electrodes. Carbon aerogels, based on sol-gel derived organic precursors, are promising candidates for EDLC electrodes because their nanostructure (e.g. pore- and particlesize) is tuneable over a wide range. For the same reason these materials also represent excellent model systems for the investigation of correlations between structural properties and electrochemical characteristics. We prepared carbon aerogel EDLC electrodes with a different nanostructures by varying the catalyst and reactant concentration in the starting solution. The structure of the carbon was characterised by nitrogen sorption and scanning electron microscopy. Electrochemical investigation was performed by cyclic voltammetry and impedance spectroscopy in aqueous and organic electrolytes. The relationship between the nanostructure and the electrochemical performance of the EDLC electrodes is discussed.

HL 61.16 Thu 18:00 Poster D1

Hybrid electrode for electrochemical capacitors consisting of a MnO_2 infiltrated carbon aerogel — •Christian Weber[1], Volker Lorrmann[1], Jens Pflaum[1,2], Gudrun Reichenauer[1], and Vladimir Dyakonov[1,2] — [1]Bavarian Centre for Applied Energy Research e.V. (ZAE Bayern), D-97074 Würzburg — [2]Julius-Maximilians-University of Würzburg, Institute of Physics, Experimental Physics VI, D-97074 Würzburg

Electrochemical capacitors (EC) bridge the gap between conventional capacitors with high power but low energy density and batteries with high specific energy density but rather low power density. There are two types of EC: Double-layer supercapacitors, that store charges electrostatically in the Helmholtz-layer between the electrolyte and the electrode of large surface area, the latter typically consisting of activated carbon. In pseudocapacitance supercapacitors charging is of faradaic nature, e.g. by redox processes in MnO_2. We have prepared EC hybrid electrodes by infiltrating a carbon aerogel with MnO_2. Structural analysis of these electrodes shows a decrease of surface area with increasing MnO_2-loading. Cyclic voltammetry measurements reveal an increase of the total capacitance of the electrode with MnO_2 concentration. However, the increase in capacitance arises at the cost of the cycling behaviour: low conductivity of MnO_2 and narrowed electrolyte pathways resulting from dispersed MnO_2 lead to an increase in the total resistance of the electrode. Correlations between compostition, structural characteristics and electrochemical properties are discussed in detail.

HL 61.17 Thu 18:00 Poster D1

Ni(Al)-SiC-Interfaces studied by Transmission Electron Microscopy — •Alexander Alexewicz[1], Hartmut Bracht[1], Kathrin Rüschenschmidt[2], and Roland Rupp[2] — [1]Institut für Materialphysik, WWU Münster — [2]Infineon Technologies AG Villach

The development of a reliable, low-ohmic contact between a metallic conductor and a p-doped SiC-semiconductor is not yet controllable. An empirical approach is the use of nickel as metal-contact. SiC-Wafers with NiAl-layers of two different thicknesses (40 and 150 nm) on top were annealed at 980°C. For understanding the behaviour of the involved elements, analyses of the microstructure in the contact area have been performed. High Resolution Transmission Electron Microscopy (HRTEM) gives a representation of the atomic structure on a nanometer scale. In order to identify the silicide, which is formed in the layer, and to detect the aluminium distribution, Energy Dispersive X-Ray Spectroscopy (EDX) is used. The released carbon as well as the content of oxygen is localized by Electron Energy Loss Spectroscopy (EELS).

HL 61.18 Thu 18:00 Poster D1

Iron-related Defect Centers in 4H-SiC Detected by Deep Level Transient Spectroscopy — •Lia Trapaidze, Michael Krieger, and Gerhard Pensl — Lehrstuhl für Angewandte Physik, Universität Erlangen-Nürnberg, Staudtstr. 7 / Bau A3, 91058 Erlangen, Germany

Iron (Fe) is a impurity, which is frequently introduced during the processing of semiconductors. It is known from silicon that Fe forms electrically active defect centers. However, for the wide-bandgap semiconductor silicon carbide (SiC) nothing has been reported in the literature so far.

In order to identify and investigate Fe-related defect centers in 4H-SiC, Fe ions have intentionally been introduced into n-type and p-type 4H-SiC epitaxial layers by means of ion implantation. A Fe box profile with a depth of 1.7 μm and a mean concentration of [Fe] = 1×10^{15} cm^{-3} was formed by multiple implantations of Fe^+ ions with different energies at $T_i mpl$ = 300°C. Subsequently, the samples were annealed at various temperatures ranging from room temperature up to 1700°C. Schottky contacts were evaporated using Pd or Ti/Al for n-type or p-type layers, respectively. The samples have been analyzed by means of deep level transient spectroscopy (DLTS).

Compared to the DLTS spectra of not-implanted reference samples, a new defect center at E_C-E_T = 1080 meV is observed in the DLTS spectra taken on Fe-implanted samples. The dependence of the DLTS spectra on the annealing temperature and on the implanted Fe concentration is discussed.

HL 61.19 Thu 18:00 Poster D1

***Ab initio* study of strain effects on the quasiparticle bands and effective masses in silicon** — •Mohammed Bouhassoune and Arno Schindlmayr — Department Physik, Universität Paderborn, 33095 Paderborn, Germany

Strain engineering has emerged as a promising technology to improve the performance of silicon-based MOSFETs. In general, strain influences the carrier mobility and hence the switching times by two mechanisms: a partial lifting of band-edge degeneracies, which reduces the scattering rate, and modified effective masses due to band warping. For monoclinic deformations along the [110] direction, which have attracted particular interest, experimental evidence suggests that both factors contribute to the observed high electron mobility in n-doped samples. In order to assess their relative importance, we study the electronic properties of silicon under uniaxial and biaxial [110] strain quantitatively with *ab initio* computational methods. For this purpose we combine density-functional theory in the local-density approximation with the GW approximation for the electronic self-energy, which gives a highly accurate description of the quasiparticle band structure. The elastic constants, Poisson ratios and related structural parameters are determined with full volume and internal relaxation from the variation of the total energy. Then we calculate the energy splitting of

the six originally degenerate conduction-band minima and the electron effective masses as a function of the applied strain. The results confirm a significant reduction of the effective mass associated with the lowest, twofold degenerate subband for tensile uniaxial strain.

HL 61.20 Thu 18:00 Poster D1

Effect of codoping donor atoms in germanium — •Hartmut Bracht[1], Alexander Chroneos[2], and Robin W. Grimes[2] — [1]Institut für Materialphysik, WWU, Münster, Germany — [2]Department of Materials, Imperial College, London, UK

It has been established that donor atoms migrate predominantly via their interaction with lattice vacancies in germanium. Under high doping conditions donor atoms can form large immobile clusters that contain vacancies. The control of the concentration of free vacancies is essential to control the diffusion of the donor atoms and the formation of larger clusters, which lead to the deactivation of a significant proportion of the donor atoms. In the present study electronic structure calculations in conjunction with mass action analysis are used to predict the concentrations of free vacancies and deactivated donor atoms in germanium codoped with different proportions of carbon, or fluorine, or another donor species. The effect of the different codoping species and the relative concentrations of these on the donor diffusion and deactivation is discussed over a wide temperature range.

HL 61.21 Thu 18:00 Poster D1

Structure and defect processes in $Si_{1-x-y}Ge_xSn_y$ random alloys — •U. Schwingenschlögl[1], A. Chroneos[2], C. Jiang[3], R.W. Grimes[2], and H. Bracht[4] — [1]PSE Division, KAUST, Thuwal 23955-6900, Saudi Arabia — [2]Department of Materials, Imperial College London, London SW7 2BP, United Kingdom — [3]Materials Science and Technology Division, Los Alamos National Laboratory, Los Alamos, NM 87545, USA — [4]Institute of Material Physics, University of Münster, Wilhelm-Klemm-Straße 10, D-48149 Münster, Germany

Binary and ternary $Si_{1-x-y}Ge_xSn_y$ random alloys are being considered as candidate materials to lattice match III-V or II-VI compounds with Si or Ge in optoelectronic or microelectronic devices. The simulation of the defect interactions of these alloys is hindered by their random nature. Here we use the special quasirandom approach (SQS) in conjunction with density functional theory calculations to study the structure and the defect processes. For the binary alloy Ge_xSn_{1-x} the SQS method correctly describes the deviation of the lattice parameters from Vegard's Law. For the ternary alloy $Si_{0.375}Ge_{0.5}Sn_{0.125}$ we find an association of As atoms to lattice vacancies and the formation of As-vacancy pairs. It is predicted that the nearest-neighbour environment exerts a strong influence on the stability of these pairs.

HL 61.22 Thu 18:00 Poster D1

Definierte Variation der Nanostruktur in Ge-Schichten mittels Glanzwinkelabscheidung — •Michael Weise[1], Chinmay Khare[1], Bodo Fuhrmann[2], Jens Bauer[1] und Bernd Rauschenbach[1] — [1]Leibniz-Institut für Oberflächenmodifizierung, Permoserstraße 15, D-04318 Leipzig — [2]Martin-Luther-Universität Halle-Wittenberg, Heinrich-Damerow-Straße 4, D-06120 Halle

Die Glanzwinkelabscheidung (GLAD) erlaubt eine einfache Herstellung von selbstorganisierten porösen Nanostrukturen auf dem Prinzip der gegenseitigen atomaren Abschattung. Über die Wahl der Abscheideparameter Einfallwinkel und Substratrotationsgeschwindigkeit (konstant oder mit definierter zyklischer Änderung) sowie unter Verwendung vorstrukturierter Oberflächen lassen sich variable Morphologien und geometrische Anordnungen erzeugen. Es wurde das Wachstum von Silizium und Germanium auf unbehandelten und vorstrukturierten Substraten untersucht. Die Variation des Einfallswinkels erlaubt eine Veränderung der Dichte der deponierten Schicht. In Abhängigkeit von der Rotationsgeschwindigkeit können säulen-, schrauben- oder spiralartige Morphologien erzeugt werden. Eine zyklische Änderung der Winkelgeschwindigkeit ermöglicht einen weiteren Einfluss auf die Formgebung der Strukturen, wie z.B. das Wachstum von Strukturen mit rechteckiger Grundfläche. Durch Substratvorstrukturierung, z.B. mittels Nanokugellithographie, Elektronenstrahllithographie oder unter Verwendung fokussierter Ionenstrahlen, lassen sich Wachstumsplätze vorgeben. Die dadurch festgelegte Abschattung hat Einfluss auf die Morphologie, z.B. dreieckige Säulen bei wabenartiger Anordnung.

HL 61.23 Thu 18:00 Poster D1

Epitaxial growth of ZnS thin films on GaP and GaAs — •Udo Römer, Stefan Lautenschläger, Sebastian Eisermann, Oliver Graw, Melanie Pinnisch, Sven Ole Steinmüller, Jürgen Janek, and Bruno K. Meyer — I. Physikalisches Institut und Institut für Physikalische Chemie Justus-Liebig-Universität Giessen

Due to its large band gap of 3.6 eV ZnS is a promising semiconductor for optoelectronic applications. Epitaxial ZnS films can be grown in zincblende structure using substrates like GaP or GaAs. For many applications, for example the construction of quantum well structures, this is an advantage compared to other wide band gap semiconductors like ZnO or GaN which crystallizes in the wurtzite structure only. To study the effects of the different substrates and the growth parameters on the quality of the ZnS films, we have investigated the films using X-ray diffraction (XRD), low temperature photoluminescence (PL), atomic force microscopy (AFM) and time of flight secondary ion mass spectroscopy (TOF-SIMS). The undoped films are electrically insulating, first experiments to dope the films n-type were undertaken.

HL 61.24 Thu 18:00 Poster D1

Quantitative Untersuchung von ZnTe-basierten optoelektronischen Heterostrukturen mittels Transmissionselektronenmikroskopie — •Kristian Frank[1], Marco Schowalter[1], Andreas Rosenauer[1], Wojciech Pacuski[1,2], Carsten Kruse[1] und Detlef Hommel[1] — [1]Institut für Festkörperphysik, Universität Bremen, Otto-Hahn-Allee 1, 28359 Bremen, Deutschland — [2]Institute of Experimental Physics, University of Warsaw, *Hoża* 69, PL-00-681 Warszawa, Poland

Es wurde eine mittels MEE(migration enhanced epitaxy) gewachsene CdZnTe/ZnTe Quantenpunktschicht untersucht. Um die für die Untersuchung benötigten 10-20 nm dünnen Proben mit reiner Oberfläche zu erhalten wurden FIB(focused ion beam)-Lamellen präpariert, welche anschließend mit niederenergetischer Ionenätzung bei einer Ar^+-Ionenenergie von 400V behandelt wurden. Diese Proben wurden dann mit dem Transmissionselektronenmikroskop untersucht. Durch Abbildung mit dem verzerrungssensitiven 004-Reflex konnten Verzerrungsfelder sichtbar gemacht werden, welche auf das Vorhandensein von Quantenpunkten hindeuten. Sowohl Untersuchungen mittels der CELFA(composition evaluation by lattice fringe analysis)-Methode, als auch Analysen der Gitterverzerrung mit DALI(digital analysis of lattice fringe images) weisen auf signifikante Fluktuationen der Cadmium-Konzentration innerhalb der Quantenschicht hin. Für beide Methoden wurden hochaufgelöste Gitterebenenabbildungen aufgenommen und der Kontrast der Gitternetzebenen bei CELFA bzw. der Gitternetzebenenabstand bei der Verzerrungsanalyse ausgewertet.

HL 61.25 Thu 18:00 Poster D1

Systematic Study of the Influence of Photo-Generated Carriers on the Mn-Spins in CdMnTe Quantum Wells — •Sina Zapf[1], Christian Kehl[1], Hedwig Mueller[1], Georgy Astakhov[1], Jean Geurts[1], Wolfgang Ossau[1], Yuri Kusrayev[2], Kyrill Kavokin[2], Tomek Wojtowicz[3] und Greg Karczewski[3] — [1]Universitaet Wuerzburg, Phys. Inst., EP3, 97074 Wuerzburg, Germany — [2]Ioffe Institute, RAS, 194021 St. Petersburg, Russia — [3]Institute of Physics, PAN, 02668 Warsaw, Poland

In II-VI diluted magnetic semiconductor quantum wells the strong exchange interaction between the magnetic ions and a two-dimensional gas of heavy holes (2DHG) is predicted to reduce the Zeeman splitting of localized ion spins in an in-plane magnetic field [1]. This can be demonstrated by Spin-Flip-Raman Spectroscopy in a modulation doped CdMnTe/CdMgTe quantum well influencing the 2DHG concentration by photo-generated carriers from above barrier with the modulation doping caused by a thin capping layer of the quantum well.

Now a clear decrease of the Zeeman splitting quantified by the g-factor of the Mn-ions with increasing net charge carrier has been observed systematically by varying the cap layer thickness and the Mn-content, respectively. This influences specifically the carrier dynamics and thus the g-factor.

[1] K.V. Kavokin, Phys. Rev. B 59, 9822 (1999)

HL 61.26 Thu 18:00 Poster D1

Optical investigations of excitons in collodial semiconductor nanocrystals — •Sergey Skripets[1], Martin Pohl[1], Martin Kneip[1], Dmitrii Yakovlev[1], Manfred Bayer[1], Celso Mello-Donega[2], Dominika Grodzinska[2], and Daniel Vanmaekelbergh[2] — [1]Experimentelle Physik E2, TU Dortmund, Deutschland — [2]Debye Institut, Universität Utrecht, Niederlande

The optical properties of collodial semiconductor quantum dots with varying concentration were studied by means of optical methods. In these systems, electrons, holes and excitons are strongly confined in the

nanocrystal host, resulting in discrete energy levels for these nanocrystals. Investigations were performed in resonant and nonresonant excitation regime over a wide temperature range from 2 up to 300 K with magnetic fields between 0 and 10 T. Furthermore the relaxation time of the photoluminescence was studied in picosecond range by means of streak camera and nanosecond range by means of gated ccd. Results will be shown for PbSe,CdSe core-shell and CdSe/Cd(S,Se)/ZnS core-shell-shell structures.

The workings were done in the framework of the Herodot-program "heterogeneous quantum rod and quantum dot nanomaterials" at the physics department of the TU Dortmund with samples grown at the University of Utrecht.

HL 61.27 Thu 18:00 Poster D1

Defect induced changes on the dynamics of the Mn $3d^5$ luminescence in ZnS:Mn nanowires — •Uwe Kaiser[1], Limei Chen[1], Wolfram Heimbrodt[1], Sebastian Geburt[2], and Carsten Ronning[2] — [1]Dept. Physics, Philipps University Marburg, Germany — [2]Inst. for Solid State Physics, Friedrich-Schiller-University Jena, Germany

ZnS nanowires with diameters between 100-300 nm and lengths of several micrometer have been ion-implanted with Mn yielding a concentration of $9,91 \cdot 10^{17}\, cm^{-3}$. The concentration of defects were varried by different annealing and Mn-implantation temperatures. The samples were afterwards irradiated with different fluence of Neon in order to create controlled numbers of defects.

The nanowires were studied by photoluminescence spectroscopy at 10 K. The temporal behavior of the internal $Mn^{2+}(3d^5)$ luminescence was measured in dependence of the defect concentration. The migration of Mn excitation is based on the dipol-dipol interaction inside the Mn subsystem. The decay is determined by dipol-dipol transfer from Mn to killer centres leading to a non-radiative annihilation. To interpret the data a modified Förster model based on dipol-dipol interaction was applied [1]. The aim of this work was to reveal a relation between the concentration of defects and the behaviour of the transients of the Mn photoluminescence.

[1] L.Chen et al., Phys Rev B 76, 115325 (2007)

HL 61.28 Thu 18:00 Poster D1

THz photoresponse of devices with quantum wells of narrow-gap semiconductors. — •Fathi Gouider[1], Yuri.B. Vasilyev[2], Christoph Brüne[3], Hartmut Buhmann[3], Jens Könemann[4], Phil.D. Buckle[5], and Georg Nachtwei[1] — [1]Institut für Angewandte Physik, Technische Universität Braunschweig, Germany — [2]A. F. Ioffe Physical Technical Institute,St. Petersburg, Russia — [3]Fakultät für Physik und Astronomie, Julius-Maximilians-Universität Würzburg,Germany — [4]Physikalisch-Technische Bundesanstalt, Braunschweig, Germany — [5]QinetiQ Ltd, Malvern WR14 3PS, United Kingdom

The THz spectral range is very intersting both from the aspect of fundamental physics as for technical applications.The THz waves we generate by a p-Ge laser system ($120\mu m < \lambda < 180\mu m$). We present observations of the photoresponse (PR) obtained at samples made from wafers with a narrow gap as HgTe quantum wells embedded in barriers of HgCdTe as well as InSb quantum wells embedded in barriers of AlInSb. We observed the cyclotron resonance by the measurement of the transmission as a function of the magnetic field B. Further, we measured the photoconductivity in Corbino-shaped devices made from the HgCdTe/HgTe/HgCdTe and AlInSb/InSb/AlInSb wafers.

HL 61.29 Thu 18:00 Poster D1

Fabrication of ZnO cavities for planar microresonators — •Helena Hilmer[1], Chris Sturm[1], Rüdiger Schmidt-Grund[1], Jesús Zúñiga-Pérez[2], Holger Hochmuth[1], Marina Cornejo[3], Frank Frost[3], and Marius Grundmann[1] — [1]Universität Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig, Germany — [2]CRHEA, Rue Bernard Grégory, 06560 Valbonne, France — [3]IOM e.V., Permoserstr. 15, 04318 Leipzig, Germany

We report on the growth of planar microresonators by pulsed laser deposition (PLD), which consist of two all-oxide Bragg reflectors (BR), made of yttria stabilized zirconia and alumina, surrounding a ZnO cavity as active medium. Detailed photoluminescence (PL) and reflectivity analyses have shown, that the resonators are in the strong coupling regime up to 410 K [1], but Bose-Einstein-Condensation is still a challenge. As the BR materials do not grow epitaxially on the substrates, the main task lies in the optimisation of the ZnO cavity layer, i.e low surface roughness and intensive, narrow luminescence.

Therefore suitable PLD growth conditions were combined with an annealing step as well as two additional strategies: First, conventional ZnO half-resonators, i.e. the lower BR with the ZnO cavity, have been ion beam polished to smooth the rough ZnO layer. Second, the cavity was grown by molecular beam epitaxy (MBE) on top of PLD-grown BR. Compared to PLD samples, PL measurements do not indicate any degradation due to ion beam smoothing of the PLD samples and show narrower ZnO luminescence for the (rougher) MBE samples.

[1] C. Sturm *et al.*, NJP **11**, 073044 (2009).

HL 61.30 Thu 18:00 Poster D1

Thermoelectric measurements on artificially structured ZnO/ZnS multilayers — •Steve Petznick, Achim Kronenberger, Gert Homm, Thorsten Henning, Peter J. Klar, and Bruno K. Meyer — 1. Physikalisches Institut, Gießen, Deutschland

A multilayer-system of alternating ZnO and ZnS layers of about 1 μm thickness in total is deposited by RF magnetron sputtering on different substrates. A pattern of square-holes in the μm range is transferred into this multilayer system by photolithography followed by ion beam or wet-chemical etching. In a second sputter step another multilayer-system of the same two materials is sputtered on the sample with the identical number of layers but with the reversed layer sequence. In the cross section of the sample one obtains a pattern of the alternating materials. The ZnO layers are n-type with different electron concentrations while the ZnS layers are almost insulating. The Seebeck coefficient of this system is measured in the temperature range of 50 to 300 K. The influence of the high number of interfaces on the transport behaviour and on the Seebeck coefficient is investigated.

HL 61.31 Thu 18:00 Poster D1

Fabrication and characterization of heterostructure LEDs based on the material system MgZnO/AlGaN — •Julian Benz[1], Sebastian Eisermann[1], Torsten Henning[1], Peter J. Klar[1], Bruno K. Meyer[1], Theeradetch Detchprohm[2], and Christian M. Wetzel[2] — [1]I. Physikalisches Institut, Justus-Liebig-Universität, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Department of Physics, Applied Physics, and Astronomy, Rensselaer Polytechnic Institute, 110 Eighth Street, Troy, NY 12180-3590, U.S.A.

The wide band gap semiconductors ZnO and GaN and their related alloys are interesting materials for the production of blue and ultraviolet optoelectronic devices, such as light emitting diodes (LEDs), laser diodes and photo diodes. Active regions based on ZnO may further improve the efficiency of current short wavelength devices based on GaN and InGaN due to the higher exciton binding energy in ZnO. We report on the growth, fabrication, optical and electrical characterization of heterostructures based on the MgZnO/AlGaN material system, which can be seen as a first step towards more sophisticated devices including MgZnO/ZnO quantum wells in the active region.

HL 61.32 Thu 18:00 Poster D1

Photoluminescence studies of top-down $Zn_{1-x}Mg_xO$/ZnO quantum disk samples with different dimensions — •Martin Fischer[1], Markus Piechotka[1], Torsten Henning[1], Bernhard Laumer[2], Peter Klar[1], Martin Eickhoff[1], and Bruno Meyer[1] — [1]I. Physikalisches Institut, Justus Liebig Universität Giessen, Heinrich Buff Ring 16, 35392 Gießen — [2]Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching

Quantum disc structures with diameters of 100 and 200 nm were prepared from PAMBE-grown $Zn_{1-x}Mg_xO$/ZnO single quantum well structures of different well widths by using electron beam lithography followed by a combination of wet chemical and ion-beam etching. The samples were studied by photoluminescence spectroscopy. We investigated the influence of strain relaxation in quantum disks of different diameter on the excitonic transitions. We also study the impact of the quantum disc size on the linewidths of the excitonic energies as well as on the emission intensities in the PL spectra. The lateral dimension of the quantum discs allows one to exclude additional lateral quantum confinement effects in the samples.

HL 61.33 Thu 18:00 Poster D1

Polarization behaviour of the exciton-polariton emission — •Chris Sturm, Helena Hilmer, Rüdiger Schmidt-Grund, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig

The formation and properties of exciton-polaritons in microresonators have been intensively investigated in the last years, since they can un-

dergo a Bose-Einstein condensation (BEC). In this work we present the polarization behaviour of the exciton-polariton emission of a ZnO based resonator and deduce information on the relaxation into the ground state, such as the scattering rates. The resonator was grown by pulsed laser deposition consisting of a wedge shape cavity in order to investigate the exciton-polariton properties at different detunings. The photoluminescence (PL) spectra show a strong polarization dependence of the emission of the lower polariton branch (LPB). A maximum energy splitting of about 5 meV between s- and p-polarized light is obtained for an emission angle of about 34 °, caused by the uncoupled cavity-photon mode. The occupation (connected with PL-intensity) of the LPB for the two different polarizations was analyzed and we found a larger bottleneck effect for the p- than for the s-polarized light. With increasing detuning the magnitude of the bottleneck effect decreases and also the splitting between the two polarizations, i.e. the relaxation into the ground state is enhanced. Therefore large positive detunings are preferred for ZnO based resonators in order to reach a BEC, which is in agreement with theory [1].

1. R. Johne *et al.*, Appl. Phys. Lett. **93**, 249902 (2008).

HL 61.34 Thu 18:00 Poster D1

Electroluminescence of doped and undoped AlN/SiC-heterojunctions — •Christoph Brüsewitz, Ulrich Vetter, and Hans Hofsäss — II. Physikalisches Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

AlN with its large and direct bandgap is a useful host for optoelectronic applications. Grown on 6H-SiC, a heterojunction is created, forming a diode. The light emitted by n-doped 6H-SiC via electroluminescence forms a broad band with a maximum at a wavelength of 475 nm. With the AlN layer on the surface, nitrogen atoms can diffuse into the 6H-SiC, creating new energy levels. Depending on the direction of the current and additonal dopants in the AlN layer, the carrier concentration changes and new levels are available, resulting in different colours. It is shown that in this heterojunction blue, red and white colours are feasible.

HL 61.35 Thu 18:00 Poster D1

Pump Dynamics of Nuclear Spins in GaAs Nanostructures — •Wieland Worthoff and Dieter Suter — Experimentelle Physik III, TU Dortmund

Photons carry angular momentum, which must be transferred to the material when they are absorbed. This conservation law can be used to polarize the spins of charge carriers in semiconductors by irradiating the material with circularly polarized light. Part of the electrons' spin polarization is transferred via Fermi contact hyperfine interaction to the nuclear spins of the material. This can be used to increase the sensitivity of nuclear magnetic resonance by many orders of magnitude or to reduce decoherence in spin-based quantum computers working on the basis of semiconductor nanostructures. We explore the dynamics of the optical pumping process when a cw laser beam is applied to a GaAs/AlGaAs heterostructure in the presence of a magnetic field. We resonantly create electron-hole pairs in single quantum wells and measure the build-up of the nuclear spin polarization as a function of time through the effect of the average hyperfine interaction on the electron spins (the 'nuclear field'). This feedback of the nuclear spin polarization on the electron spins results in a nonlinear dynamics of the coupled electron-nuclear spin system. We model these dynamics and compare the result with experimental data.

HL 61.36 Thu 18:00 Poster D1

The influence of self-assembled quantum dots on the electrical properties of an inverted 2DEG — •Dominik Scholz[1], Antonio Badolato[2], Dieter Schuh[1], Imke Gronwald[1], Christian Reichl[1], Werner Wehscheider[3], and Elisabeth Reiger[1] — [1]Institute for Applied and Experimental Physics, University of Regensburg, Germany — [2]Department of Physics and Astronomy, University of Rochester, US — [3]Laboratory for Solid State Physics, ETH Zurich, Switzerland

The combination of two-dimensional electron gases (2DEGs) with self-assembled quantum dots (sa-QDs) in the vicinity of the 2DEG would enable the realization of a quantum optical interface. In such a quantum interface a single electron spin located in a gate-defined QD in the 2DEG could be converted into a polarized photon via tunneling into the optically active sa-QD [1]. Studies on the influence of sa-QDs on a 2DEG have already been performed on conventional 2DEG systems [2], however, for the proposed quantum optical interface a structure based on inverted 2DEGs is more favorable.

We fabricated various samples consisting of an inverted 2DEG with sa-QDs grown close to the 2DEG, varying the (tunneling) distance between the sa-QDs and the 2DEG as well as the QD density. We determined the electron mobility as well as the carrier density by Hall-bar and van-der-Pauw measurements and correlated the results to the QD density and the tunneling distance. By this an optimized sample design for the quantum optical interface can be developed.

HL 61.37 Thu 18:00 Poster D1

Thermoelectric measurements on suspended 2DES — •Matthias Schmidt, Andrea Stemmann, and Wolfgang Hansen — Institut für Angewandte Physik, Universität Hamburg, Germany

Low-temperature magnetothermoelectric properties of free-standing two-dimensional electron systems are studied. A suspended lamella containing a 2DES is prepared from GaAs/AlGaAs heterostructures grown by molecular beam epitaxy. Electron-beam lithography is used to structure a micro Hall bar, evaporated AuGe contact leads, micro-scaled thermometers and a Joule heater on top of the thin, free-standing lamella. The lamella is attached to cold reservoirs. A thermal gradient along the lamella is generated by a heating current in the central region. We present first measurements on the heat conductivity, the thermal gradient and the magnetothermopower along the free-standing lamella.

HL 61.38 Thu 18:00 Poster D1

Cross-Section Scanning Tunneling Spectroscopy on a resonant-tunneling diode structure — Karen Teichmann[1], Martin Wenderoth[1], •Sergej Burbach[1], Rainer G. Ulbrich[1], Klaus Pierz[2], and Hans W. Schumacher[2] — [1]IV. Physikalisches Institut, Georg-August Universität Göttingen — [2]Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig

We investigated a resonant-tunneling diode structure by Cross-Sectional Scanning Tunneling Microscopy (STM) and Spectroscopy. The diode structure was grown by molecular-beam epitaxy on a n^+-doped GaAs (100) substrate and consists of self-assembled InAs quantum dots embedded in AlAs barriers (both 4 nm) each followed by undoped GaAs prelayers (15 nm) [1]. We use a low temperature STM working under UHV conditions at 5 K. The samples are cleaved in UHV to obtain a clean and atomically flat surface perpendicular to the diode-structure. Atomically resolved constant current topography images taken simultaneously at different bias voltages, (both positive and negative voltage) show the high quality of the heterostructure. Local *I(V)*-spectroscopy resolves the band edge alignment across the heterostructure. On negative bias voltage several peaks in the differential conductivity are observed. The voltage position of these peaks varies with distance from the interface. We attribute the origin of the enhanced differential conductivity peak to an interaction between the potential induced by the tip and the quantum dot layer. We acknowledge financial support by the DFG SPP 1285.

[1] I. Hapke-Wurst, *et al.*, App. Phys. Lett. **82**, 1209 (2003)

HL 61.39 Thu 18:00 Poster D1

Suppression of interfacial intermixing of MBE grown Heusler Alloy Ni_2MnIn on (001)InAs — •Sascha Bohse[1], Andriy Zolotaryov[1], Stefan Singer[1], Andreas Volland[1], Dieter Lott[2], Andrea Stemmann[1], Christian Heyn[1], and Wolfgang Hansen[1] — [1]Universität Hamburg, Institut für Angewandte Physik, Germany — [2]GKSS Forschungszentrum, Germany

We study MBE grown Heusler Alloy Ni_2MnIn films on (001)InAs in order to inject spin polarized currents into semiconductor heterostructures. Our previous investigations revealed an optimal growth temperature for deposition of Heusler films on (001)InAs in the favored $L2_1$ phase at 300°C[1]. However, at this temperature a strong interfacial intermixing is found that reduces the quality of the interface. We pursue two promising methods to overcome the intermixing and present first results. Firstly, the application of a thin MgO layer as a diffusion barrier embedded between the substrate and the Heusler film is investigated. The second method is to use at the interface a growth temperature of 80 °C, at which intermixing is negligible, and ramp up the temperature to 300 °C during Heusler film growth. The structural properties of films with thicknesses of 20, 60 and 100 nm are studied with atomic force microscopy (AFM) and X-ray reflectivity measurements (XRR). The composition is analyzed with energy dispersive X-ray spectroscopy (EDX). For magnetization measurements SQUID magnetometry has been used.

[1] A. Zolotaryov et al. , Journal of Crystal Growth 311 (2009)

2397-2404

HL 61.40 Thu 18:00 Poster D1

Energy Level Alignment at Si interfaces with photovoltaic oxides by ab-initio quasiparticle calculations — •Benjamin Höfling, André Schleife, Frank Fuchs, Claudia Rödl, and Friedhelm Bechstedt — European Theoretical Spectroscopy Facility and Institut für Festkörpertheorie und -optik, Friedrich-Schiller-Universität Jena, Germany

Transparent conducting oxides (TCOs) are widely used as transparent electrodes in solar cells and other optoelectric and photovoltaic devices. Consequently, their interfaces with silicon are of great interest for a wide range of technical applications. The electronic band structures at the Si-oxide interfaces are controversially discussed in literature. We employ modern quasiparticle theory based on hybrid functionals and the GW approximation to obtain electronic band structures including gaps with a high accuracy for silicon and the TCOs In2O3, ZnO and SnO2. The resulting quasiparticle electronic structures are used to derive band discontinuities by two different methods, a modified Tersoff method employing the branch-point energy as charge neutrality level and the Shockley-Anderson model via the electron affinity rule employing the vacuum level as reference energy for band alignment. For the resulting Si-oxide interfaces we observe a tendency for staggered or even misaligned type-II heterostructures.

HL 61.41 Thu 18:00 Poster D1

Nanomechanical Resonators — •Tommy Schönherr[1], Jochen Grebing[1], Takashi Sasaki[2], Matthias Wieser[1], and Artur Erbe[1] — [1]Division of Nanofunctional Films, Forschungszentrum Dresden-Rossendorf, Germany — [2]Division of Nanosystem Engineering, Tohoku University, Japan

Nanomechanical resonators offer multiple possibilities for the use as sensors and actors. The main challenges in this field of research are the understanding of the damping on the nanometer scale as well as reaching the quantum limit.

In order to measure the current transport in nanomechanical pendulums and vibrating nanowires reproducibly, arrays of nanometer sized structures have to be connected to micron sized contact pads in a reliable way. The pendulums should be designed in such a manner that they transport only single or few electrons during each oscillation. The fabrication of these devices made of silicon by using the techniques of electron-beam lithography, metal evaporation, lift-off and reactive ion etching is presented.

The temperature and magnetic field dependence of the damping of freely suspended silicon nanowires with eigenfrequencies in the order of several 100 MHz as well as measurement data on vertical nanomechanical pendulums between two electrodes are shown.

HL 61.42 Thu 18:00 Poster D1

Gas-assisted focused electron beam etching for direct nanopatterning of GaAs — •Arkadius Ganczarczyk, Martin Geller, and Axel Lorke — Experimental Physics and CeNIDE, Universität Duisburg-Essen

Sputtering and gas assisted etching of semiconductors with a focused ion beam (FIB) is a very useful tool in the semiconductor preparation on the nanoscale, as it allows direct fabrication without the intermediary of resist [1]. However etching/sputtering of materials with the ion beam has it drawbacks, especially because Ga-ions cause defects in the surrounding material. Therefore, gas assisted etching with a focused electron beam is a powerful and less destructive tool as demonstrated e.g. for Si substrates [1]. We demonstrate here the possibility of gas assisted focused electron beam etching of GaAs. We use a scanning electron microscope (SEM) in a dual beam FIB together with an iodine precursor gas that can be injected by a needle directly onto the sample surface. We demonstrate that the etching rate strongly depends on beam current and acceleration voltage as well as step size and dwell time. Furthermore, we consider the detrimental effects of the surface oxide and discuss possible strategies for oxide removal and surface passivation before the etching step.

[1] I. Utke et al., J. Vac. Sci. Technol. B 26, 4, (2008)

HL 61.43 Thu 18:00 Poster D1

Quantification of Impurities in Cu2O — •Andreas Laufer[1], Swen Graubner[1], Hauke Metelmann[1], Bruno Karl Meyer[1], Sebastian Geburt[2], and Carsten Ronning[2] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany

Cuprous oxide (Cu_2O) is considered to be a promising material for thin film solar cell applications. P-type Cu_2O, for example, could be obtained by N-doping. The identification of impurities that could act as compensating donors is very important. Among the methods for impurity analysis, secondary ion mass spectrometry (SIMS) is very attractive due to the fact that the chemical identity of the elements can be determined directly, independent of factors such as the ionisation state or binding type. In addition, the sensitivities are very high enabling one to detect some elements in concentrations of as little as a few ppm. The quantification of SIMS data is possible using the method of relative sensitivity factors (RSF). Unfortunately, these factors vary for each host crystal and while there are RSF tables for Si and for compound semiconductors such as GaAs, InP or GaN, such a reference did not yet exist for Cu_2O. In the presented work, the RSF for a number of important elements have been determined using ion implanted standards, thus allowing one to quantify the impurity concentrations found. These factors have then been applied to sputtered Cu_2O thin films.

HL 61.44 Thu 18:00 Poster D1

An all-digital time differential γ-γ angular correlation spectrometer for the study of defects in semiconductors — •Matthias Nagl, Ulrich Vetter, Michael Uhrmacher, and Hans Hofsäss — Georg-August-Universität Göttingen, II. Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

The time differential perturbed angular correlation (PAC) technique permits the analysis of electric field gradients and magnetic fields at sites of radioactive probe atoms inserted into samples by means of implantation or diffusion. In this work a new all-digital PAC spectrometer is presented which overcomes some ot the limitations of earlier digital and analog setups and features improved time and energy resolutions. The application of the new spectrometer for the characterization of defects in semiconductors using isotopes that could not be efficiently used as probes before is discussed. Other possible applications of the methods developed for the spectrometer include positron annihilation, PET and time of flight studies as well as Lidar and Radar.

HL 61.45 Thu 18:00 Poster D1

Recoil Effect in Light Element Materials: a Hard X-Ray High Kinetic Energy Photoelectron Spectroscopy Study — •Mihaela Gorgoi and Franz Schäfers — BESSY II, Helmholtz Zentrum Berlin, Albert-Einstein-Str. 15, 12489 Berlin

Recoil effects originate from a well defined transfer of momentum from the photoemitted electron to the atom, they cause energy shifts and broadening of the photoemission lines and they were first observed in gas phase photoemission [3]. In soft x-ray photoemission performed on solids this effect was negligible due to the small momentum of the photoelectron. However, in hard x-ray high kinetic energy photoelectron spectroscopy (HX-HIKE or HAXPES) the recoil effects can not be neglected any further since the photoemitted electron has a considerable and well defined amount of momentum [1,2]. In this work recent HX-HIKE investigations of highly oriented pyrolitic graphite (HOPG) and SiC are presented. Evidence of core level shifts as a function of excitation energy has been found in both cases. The energy shifts are assigned to the recoil effect. Nevertheless surprisingly the recoil energies recorded for both SiC and HOPG show a non linear behavior as a function of energy regardless of the orbital from where the photoelectron originates. The found trends will be discussed in the light of a theoretical approach. [1] Y. Takata et al., Phys. Rev. B 75 (2007) 233404. [2] M. Vos et al., Phys. Rev. B 78 (2008) 024301. [3] E. Kukk et al., Phys. Rev. Lett. 95 (2005) 133001.