HL 51: Poster IV

Time: Thursday 16:30–19:00 Location: Poster D

HL 51.1 Thu 16:30 Poster D

Redistribution of excitonic photoluminescence transitions mediated by surface acoustic waves — •Stefan Völk[1,2], Jens Ebbecke[1,2,3], Achim Wixforth[1,2], Dirk Reuter[4], and Andreas Wieck[4] — [1]Institut für Physik der Universität Augsburg, Experimentalphysik I, 86159 Augsburg, Germany — [2]Center for NanoScience (CeNS), 80539 Munich, Germany — [3]School of Engineering and Physical Science, Heriot-Watt University, Edinburgh, EH14 4AS, UK — [4]Angewandte Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany

Quantum wells in semiconductor heterostructures can be populated optically by electron-hole pairs which form excitons at low temperatures. Recombination of excitons leads to emission of photoluminescence (PL) light. In earlier experiments there was shown that the PL of a single QW can be quenched by a surface acoustic wave (SAW).

We have investigated the excitation spectrum of a system consisting of different wide GaAs quantum wells. As the transition energies depend on two parameters - quantum well depth and width - the PL spectrum of our multi quantum well (MQW) system shows several peaks.

Surprisingly some of these peaks don't reveal the characteristic quenching when a SAW is applied. In some cases even an amplification of PL intensity can be observed. The explanation of this controversy effect is still under debate. Newer experiments on the MQW system suggest excitonic effects.

HL 51.2 Thu 16:30 Poster D

Determination of exciton mass in Cu_20 by two-phonon-spectroscopy — Jan Brandt[1], Dietmar Fröhlich[1], •Christian Sandfort[1], Manfred Bayer[1], and Heinrich Stolz[2] — [1]Institut für Physik, Technische Universität Dortmund, D-44221 Dortmund, Germany — [2]Fachbereich Physik, Universität Rostock, D-18051 Rostock, Germany

The 1S-paraexciton in Cu_2O is a pure spin-triplet state with Γ_2^+ symmetrie. Therefore it is optically forbidden to all orders. In a magnetic field, however, it mixes with the 1S-orthoexciton and gets quadrupole allowed. From two-phonon excitation spectroscopy involving an optical and acoustical phonon we derive by a purely kinematical analysis a very reliable value for the paraexciton mass ($m_p = 2.61\ m_0$). The resolution of this method is only limited by the linewidth of the exciting laser (< 20 neV). Furthermore we show that the experimental method is suited to test the parameters of the k^2-exchange interaction of the orthoexcitons and determine the sound velocity of acoustic phonons and the refractive index.

HL 51.3 Thu 16:30 Poster D

Optical investigations of hexagonal $Mg_xZn_{1-x}O$ thin layers in UV spectral range — •Alexander Müller, Gabriele Benndorf, Susanne Heitsch, Holger Hochmuth, Christoph Meinecke, and Marius Grundmann — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Linnéstr. 5, D-04103 Leipzig, Germany

Ternary alloys of $Mg_xZn_{1-x}O$ have been grown by pulsed laser deposition on a-plane sapphire substrates at different oxygen partial pressures between 1.6×10^{-2} and 5×10^{-5} mbar, using targets with MgO concentrations from 0 to 10 wt-%. The Mg content of the thin films varies between 0 % and 34 %.

The optical properties of the samples were investigated using photoluminescence (PL) measurements and transmission measurements. On selected samples, temperature dependent PL and transmission mesurements were performed.

The refraction index of $Mg_xZn_{1-x}O$ thin films in dependence on the wavelength of the transmitted light is not well known. Therefore, the transmission spectra were modeled using Model Dielectric Functions to obtain information about exciton energies and broadening parameters. Exciton-phonon-complexes are taken into account to describe the equally spaced dips which were found in some transmission spectra.

To support the results of the static measurements, time resolved PL measurements were performed.

HL 51.4 Thu 16:30 Poster D

Generation of a Single-cycle Terahertz Pulse through Shaped Ultrafast Laser Pulses — •Andreas Vaupel, Kapil Kohli, Sangam Chatterjee, and Wolfgang W. Rühle — Faculty of Physics, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany

We report the generation of a single-cycle terahertz pulse in a free-space terahertz time domain spectroscopy setup. Terahertz-radiation is generated via optical rectification and detected by utilizing the Pockels effect through electro-optical sampling in ZnTe crystals. A 4-f pulse-shaper setup with a spatial light modulator is used to generate two-colour pulses by manipulating the phase in the Fourier plane. We are able to directly control the timing between and the amplitude ratio of the two pulses. A genetic algorithm is used to obtain the best shaped single-cycle terahertz pulse. A flexible setup is presented which enables the generation of various terahertz pulse shapes.

HL 51.5 Thu 16:30 Poster D

Manipulation von Exitonen in III/V- und II/VI-Heterostrukturen mittels akustischer Oberflächenwellen — •Daniel Fuhrmann[1], Jens Ebbecke[1,2,3], Stefan Völk[1,2] und Achim Wixforth[1,2] — [1]Lehrstuhl für Experimentalphysik 1, Institut für Physik, Universität Augsburg, Universitätsstr. 1, 86159 Augsburg — [2]Center of Nanoscience, Geschwister-Scholl-Platz 1, 80539 München — [3]School of Engineering and Physical Sciences, Heriot-Watt University, Edinburgh, EH14 4AS, UK

Halbleiter-Heterostrukturen eignen sich ausgezeichnet für die Untersuchung von Exitonen mittels Photolumineszenzmessungen. Epitaktisch gewachsene, dünne Schichtfolgen von Halbleitern unterschiedlicher Bandlücken, ähnlicher Gitterkonstanten lassen zweidimensionale Ladungsträgersysteme entstehen. In diesen Systemen ist die Bindungsenergie der Exitonen um ein Vielfaches größer im Vergleich zum dreidimensionalen Fall.

Vorgestellt werden gezielte Manipulationen der Ladungsträger in III/V- und II/VI-Heterostrukturen, z.B. im lateralen dynamischen Piezopotential akustischer Oberflächenwellen. Beobachtet wird unter anderem die Dissoziation von Elektronen und Löchern in streifenförmige Domänen, sowie der Quantum Confined Stark Effect. Neben GaAs-Strukturen konnten wir weiterhin eine akustisch induzierte Dissoziation von Exitonen in ZnCdSe-Quantentöpfen detektieren. Dies ist dadurch besonders von Interesse, da die hohe Exitonenbindungsenergie von ca. 30 meV in diesem System im Prinzip auch Raumtemperaturanwendungen ermöglicht.

HL 51.6 Thu 16:30 Poster D

Calculations of the optical properties of ZnO microcavities for Bose-Einstein condensation — •Chris Sturm, Rüdiger Schmidt-Grund, Jan Sellmann, Helena Hilmer, Bernd Rheinländer, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig

Exciton-polaritons in ZnO based resonators are of interest since they are promising candidates for the realization of Bose-Einstein-Condensation (BEC) at room temperature and above. The exciton-polaritons are quasi-particles which are formed due to the coupling between light and excitons in microcavities embedded between two Bragg mirrors. The properties of the active medium of the microcavitiy determine the temperature at which BEC occurs. Due to its large exciton-binding energy of 60 meV and its large exciton oscillator strength ZnO is a promising material for the realization of BEC at temperature up to 560 K [1].

We calculate the reflectivity and the transmitivity of ZnO based resonators. The dielectric function, which is needed for the calculation, is taken from our ZnO films obtained by ellipsometry. The Rabi-splitting and the mode splitting were calculated. Based on these results the occupation of the exciton-polaritons in the momentum space was calculated and the critical exciton-polariton density and the corresponding excitation energy were estimated. These theoretical investigations were used to design the resonators.

[1] M. Zamfirescu *et al.*, Phys. Rev. B **65**, 161205R (2001).

HL 51.7 Thu 16:30 Poster D

Studies of linear absorption in weakly disordered semiconductors - Comparison of various approaches — •Noémi

Gögh[1], Walter Hoyer[1], Peter Bozsoki[2], Irina Kuznetsova[1], Mackillo Kira[1], Peter Thomas[1], and Stephan W. Koch[1] — [1]Department of Physics, Philipps Universität, Renthof 5, 35032 Marburg — [2]Department of Physics, Lancaster University, LA14YB Lancaster, UK

A one-dimensional model of a disordered semiconductor is treated in k-space and real space. In the k-space approach the 2nd Born approximation for disorder scattering with and without Markov approximation is applied within a correlation expansion. In real space on the basis of a disordered tight-binding model configurational averaging without any further approximation is performed. Characteristic differences are observed and discussed.

HL 51.8 Thu 16:30 Poster D

Investigation of the optical properties of phase change alloys — •Konstantin Shportko, Stephan Kremers, Michael Woda, Wojciech Wełnic, and Matthias Wuttig — Institute of Physics (IA), RWTH University of Technology Aachen, Aachen, Germany

Phase change materials (PCM) have a unique potential as materials for an emerging non-volatile electronic memory [1]. The aim of this study is to investigate the permittivity dispersion and dispersion of refractive and extinction indexes of the certain alloys of group V and group VI elements. Reflectance spectra have been measured in the UV-VIS/IR range. The spectra have been simulated using SCOUT software. The thickness of the PCM layer has been determined independently. We have analyzed and compared the difference between the spectra of the amorphous and crystalline phases. Our experiments reveal very remarkable findings. Dispersion of the refractive and extinction indexes of both phases show pronounced contrast. The analysis of computations and experimental data reveal the correlation between local structural changes and optical properties as well as the origin of the optical contrast in these materials. The change in optical properties cannot be attributed to a smearing of transition energies as commonly assumed for amorphous semiconductors: the optical contrast between the two phases can only be explained by significant changes in the transition matrix elements [2]. [1] M. Wuttig, N. Yamada, Nature Materials 6, 824 (2007). [2] Welnic W., Botti S., Reining L., Wuttig M. Physical Review Letters 98 (23), 236403, (2007).

HL 51.9 Thu 16:30 Poster D

FTIR and Raman study of AIIBV2 single crystals at low temperatures. — •Konstantin Shportko[1,2], Reinhard Rückamp[1], Matthias Wuttig[1], Yurij Pasechnik[2], Vladimir Trukhan[3], and Tatiana Haliakevich[3] — [1]Institute of Physics (IA), RWTH University of Technology Aachen, Germany — [2]Dragomanov National Pedagogical University, Kyiv, Ukraine — [3]Joint Institute of Solid State and Semiconductor Physics NASB, Minsk, Belarus

AIIBV2 compounds are promising materials for the construction of the new devices for solid state electronics [1]. Presently the data for the dielectric permittivity dispersion of AIIBV2 crystals are still incomplete [2]. FTIR and Raman spectroscopy have been employed to determine the phonon and plasma contribution to the permittivity and to obtain the permittivity model of AIIBV2 single crystals in the far infrared (FIR). IR reflectance and Raman spectra have been measured in the temperature range from 4 to 300 K. The anisotropy of the phonon contribution to the AIIBV2 single crystals dielectric permittivity shows itself in reflection and Raman spectra in the FIR. At low temperature phonon peaks in the both types of the spectra become narrower. Characteristics of the phonon and plasmon modes were obtained in the temperature range from 4 K to 300 K. The temperature dependence of the oscillator parameters has been determined. [1] V.M. Trukhan, A.U. Sheleg, I.V. Fekeshgazi. Photoelectronics. 15 (2004) 13. [2] J. Baran, Yu. A. Pasechnik, K.V. Shportko, M. Trzebitowska-Gusowska, E.F.Venger, Journal of Molecular Structure, 792-793, (2006), 239-242.

HL 51.10 Thu 16:30 Poster D

Über lineare Response-Theorie hinausgehende Behandlung zeitabhängiger Störungen: Anwendung auf HL-Quantenpunkte — •Jakob Ebeling und Gerd Czycholl — Institut für Theoretische Physik, Universität Bremen

Optische Übergänge zwischen Einteilchenzuständen werden üblicherweise mit Hilfe der linearen Response-Theorie berechnet, welche zeitabhängige Störterme lediglich in linearer Ordnung berücksichtigt. Alternativ bietet sich - zumindest im Fall eines endlich-dimensionalen Hilbertraums - eine exakte Aufintegration der von-Neumann-Gleichung an, um auch nicht-lineare Beiträge zu berücksichtigen. Wir benutzen diesen Zugang zur Berechnung optischer Eigenschaften eines Systems mit wenigen Energieniveaus. Konkret berechnen wir die Wechselwirkung der niedrigsten Elektron- und Lochzustände eines Halbleiterquantenpunktes mit einem elektromagnetischen Feld.

HL 51.11 Thu 16:30 Poster D

Electroluminiscence study of site-selective grown self-assembled InAs quantum dots — •Minisha Mehta, Dirk Reuter, Alexander Melnikov, and Andreas D. Wieck — Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstraße 150, D-44780 Bochum, Germany

Self-assembled InAs quantum dots (QDs) are envisioned as building blocks for the realization of novel nanoelectronic devices. For this purpose, the site-selective growth of InAs QDs is highly desirable. We present the results on site-selective growth of self-assembled InAs QDs on GaAs surface patterned by in-situ focused ion beam (FIB) implantation. Under well optimized conditions, a selective growth of single QD in the patterned holes with more than 50 % probability is achieved. Carrier injection and subsequent radiative recombination from site-selective grown InAs/GaAs self-assembled QDs is investigated by embedding the QDs in the narrow intrinsic region of a p-i-n structure. Electroluminescence spectra taken at 77 K show excited state interband transitions up to n=5 from the QDs. Financial support by the BMBF via the NanoQuit program is gratefully acknowledged.

HL 51.12 Thu 16:30 Poster D

Rolled-up Metal Semiconductor Tubes as Building Blocks for Metamaterials — Nils Gerken, •Stephan Schwaiger, Markus Broell, Detlef Heitmann, and Stefan Mendach — Institut für Angewandte Physik, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Materials which are composed of artificially designed building blocks and which can be described by effective parameters i.e. the permeabilitiy μ and the permittivity ϵ are called metamaterials. A lot of research is presently put into tailoring the effective optical parameters of different kinds of metamaterials. Typically, a wide range of values for the permittivity ϵ and permeability μ can be achieved by constructing metamaterials which exhibit resonances in both ϵ and μ [1]. Realising the desired combination of ϵ and μ at a certain wavelength is then basically a task of shifting these two resonances to the corresponding spectral position. By means of finite difference time domain calculations we here investigate the possibility to employ flexible rolled-up metal semiconductor tubes [2] as building blocks for metamaterials with in-situ tuneable permeability and permittivity. We show that the magnetic resonance of a metal semiconductor tube with 1 μm diameter can be shifted between 24 and 32 THz by mechanical deformation. We gratefully acknowledge support by the DFG through SFB 508 and GRK 1286. [1] J.B. Pendry, IEEE Transactions on Microwave Theory and Techniques, Vol. 47, 2075 (1999) [2] O. Schumacher et al., Applied Physics Letters 86, 143109 (2005)

HL 51.13 Thu 16:30 Poster D

Raman scattering on a series of phase-change material (GeTe, Sb_2Te_3, $Ge_{15}Sb_{85}$, and $Ge_xSb_yTe_z$) — •Judith Hinterberg[1], Reinhard Rückamp[1], Michael Woda[2], Matthias Wuttig[2], Gernot Güntherodt[1], and Markus Grüninger[3] — [1]2. Physikalisches Institut, RWTH Aachen — [2]1. Physikalisches Institut, RWTH Aachen — [3]2. Physikalisches Institut, Universität zu Köln

The phase-change material $Ge_xSb_yTe_z$ (GST) are widely used for optical data storage, but also their potential for so-called phase-change (PC)-RAMs is promising. However, their local structure – in particular in the amorphous phase – and the ion displacements across the phase transition are not well understood. In order to reveal the local structure we investigate the phonon spectra of various compounds of the pseudo-binary line from Sb_2Te_3 to GeTe as a function of temperature by means of Raman spectroscopy. In particular, we compare Raman spectra of the amorphous, the metastable, and the stable phases of GST 124, GST 224, GST 214, GST 225, GeTe, Sb_2Te_3, and $Ge_{15}Sb_{85}$. Near the phase transition, we find a remarkable similarity between GST and Sb_2Te_3. In contrast to recent claims in the literature [1], the ordering process in GST is not only dominated by the Ge atoms.

[1] A.V. Kolobov *et al.* Nature Mater. **3**, 703-708 (2004)

HL 51.14 Thu 16:30 Poster D

Kinetics of high density excitons in a potential trap — •Rico

Schwartz[1], Nobuko Naka[2], Dietmar Fröhlich[3], Jan Brandt[3], Christian Sandfort[3], and Heinrich Stolz[1] — [1]Institut für Physik, Universität Rostock, D-18051 Rostock, Germany — [2]Department of Applied Physics, The University of Tokyo, Tokyo 113-8656, Japan — [3]Institut für Physik, Universität Dortmund, D-44221 Dortmund, Germany

At sufficiently high densities and low temperatures excitons are expected to form a BEC. In the past, there have been several claims of observation of excitonic BEC, which, however, could not stand against critical tests. In order to exclude any coherent stimulation by the excitation laser it is necessary to separate the excitation from the detection spatially and spectrally. This criterion is ideally fulfilled by a trap. We report experiments on excitons in Cu_2O confined in a stress-induced trap [1, 2]. The paraexcitons were created by resonant excitation of orthoexcitons followed by ortho-para conversion [3]. The pulsed excitation laser has a linewidth of 1 GHz, a repetition rate of 1 kHz and a pulse length of about 100 ns. The paraexciton density was deduced via the phonon assisted Γ_5^+ sideband similar to [3]. In the experiments the sample temperature and the excitation power were varied, and the temporal evolution of the exciton population was determined.

[1] D. P. Trauernicht, J. P. Wolfe, and A. Mysyrowicz, Phys. Rev. B 34, 2561 (1986). [2] N. Naka and N. Nagasawa, Phys. Rev. B 65, 075209 (2002). [3] J. I. Jang, K. E. O'Hara, and J. P. Wolfe, Phys. Rev. B 70, 195205 (2004)

HL 51.15 Thu 16:30 Poster D

Second-Harmonic Generation in Gallium Selenide (GaSe) as Investigated with cw Diode Lasers — •Peter Karich[1], Lothar Kador[1], Kerim R. Allakhverdiev[2,3], Tarik Baykara[2], and Eldar Salaev[3] — [1]Institute of Physics and BIMF, University of Bayreuth, D–95440 Bayreuth, Germany — [2]Marmara Research Centre of TÜBITAK, Materials Institute, P. K. 21, TR–41470 Gebze/Koçaeli, Turkey — [3]Azerbaijan National Academy of Sciences, Insitute of Physics, 370073 Baku, Azerbaijan

A simple custom-built set-up for investigating optical second-harmonic generation in gallium selenide (GaSe) is presented. The high $\chi^{(2)}$ coefficient of the material (86 pm/V) permits the use of small cw diode lasers with output powers in the milliwatt range. The spatial homogeneity of different GaSe crystals is investigated with Maker fringe experiments. Multiple reflections between sample surface and glass substrate and absorption of the second-harmonic wave in the crystal give rise to clearly visible effects in the Maker fringe data [1].

[1] W. N. Herman and L. M. Hayden, J. Opt. Soc. Am. B **12**, 416 (1995).

HL 51.16 Thu 16:30 Poster D

Investigating transport properties of crystalline chalcogenide phase change alloys — •Stephan Kremers, Kostiantyn Shportko, Michael Woda, and Matthias Wuttig — I. Physikalisches Institut (IA), RWTH Aachen, Deutschland

Many chalcogenide alloys show a pronounced optical and electrical contrast between the amorphous and crystalline phase. The origin can be understood refer to W. Welnic (2007). Within this class of materials, phase change alloys stand out by their ability to rapidly and reversibly switch between these two metastable states. Rewritable CDs / DVDs are already taking advantage of these properties and the Phase-Change-Random-Access-Memory (PRAM) is going to enter the market, substituting flash memory in the near future.

We present Ellipsometry measurements of optical properties in the range of 0.7-3.0 eV for chalcogenide alloys. Two mechanisms dominate an optical spectra: interband transitions and free carriers. The focus of our investigations is on the free carriers which can be decribed by Drude's theory. In principle the resistivity, carrier concentration and mobility can be deduced. We show the opportunities and limits of optical techniques regarding transport phenomena.

HL 51.17 Thu 16:30 Poster D

Towards efficient detection of single photons at telecommunication wavelengths — •Gesine Steudle[1], Sander Dorenbos[2], Ingmar Müller[1], Elisabeth Reiger[2], Val Zwiller[2], and Oliver Benson[1] — [1]Humboldt-Universität zu Berlin, AG Nano-Optik, Hausvogteiplatz 5-7, 10117 Berlin, Germany — [2]TU Delft, Kavli Institute of Nanoscience, Lorentzweg 1, 2628 CJ Delft, Netherlands

One of the main challenges of fiber-based single photon devices is the efficient and feasible detection of single photons at telecommunication wavelengths. A promising approach is the use of superconducting detectors. In our case these detectors consist of a small superconducting wire which is arranged in a meander. The wire structure is made of thin NbN layers by electron beam lithography. To provide optimal coupling to the experimental setup a 1.55 μm single mode fiber is glued directly on the detector area. The main advantages of this type of detectors are high count rates of the order of 1 Ghz, a time resolution below 100 ps and quantum efficiencies of 10 - 15 % at 1.55 μm. Further on one can improve the quantum efficiency by adding a cavity structure and increase the count rate using an array of parallel meanders.

HL 51.18 Thu 16:30 Poster D

Annealing effects on the crystalline resistivity of phase change materials — •Michael Woda, Stephan Kremers, Kostiantyn Shportko, and Matthias Wuttig — I. Insitute of Physics (IA), RWTH Aachen University, Germany

Phase change materials (PCM) show a pronounced property contrast (electrical resistivity, optical reflectivity) between the amorphous and the crystalline state and fast crystallization processes. Suitable PCM can be reversibly switched between the states with either a current or laser pulse on a ns timescale. They are utilized in rewritable optical data storage and the emerging non-volatile memory PRAM. The latter is expected to replace Flash memory in the near future. The electrical conduction properties of different PCM have to be characterized and understood in order to find superior PCM for promising PRAM applications. In this study the effect of different annealing conditions on the electrical resistivity of various PCM in the crystalline state is investigated. Our data are compared with other techniques including x-ray reflectometry and x-ray diffraction to understand the nature of the resistance changes observed upon annealing.

HL 51.19 Thu 16:30 Poster D

Surface plasmon polaritons in metal-semiconductor hybrid structures — •Patrick Scholz, Stephan Schwieger, David Leipold, and Erich Runge — Technische Universität Ilmenau, Institut für Physik, 98693 Ilmenau

We present Finite Difference Time Domation (FDTD) and finite element simulations of nanostructured metal-semiconductor hybrid structures illuminated by visible and near IR light. Such structures will be important for novel optical devices, as they allow to confine the electromagnetic field in subwavelength dimensions and control the life time and the dispersion of the optical excitations. The considered systems consist of nanostructured metal layers (e.g. an array of nanometer-sized metal wires) embedded in a multilayer system that contains different semiconductor layers. We discuss the influence of the geometry of the semiconductor layers on surface plasmon polaritons excited at the metal nanostructures.

HL 51.20 Thu 16:30 Poster D

Wigner-cystalline order and massless Dirac fermions in 2 DES at high magnetic fields — •Guenther Meissner — Theoretische Physik, Universitaet des Saarlandes, Postfach 15 11 50, D-66041 Saarbruecken

A many-body approach for studying the nature of novel liquid and solid phases of interacting two dimensional (2D) electrons in high magnetic fields is reexamined. Effects on collective excitations from including weak random disorder and from considering various quasi particles of composites of electrons and magnetic flux quanta are discussed in view of microwave resonance and inelastic light scattering experiments on high quality 2D electron systems. Modifications resulting from the behavior of electrons in graphene as massless Dirac fermions are pointed out. The insulator terminating the series of fractional quantum Hall liquids at high magnetic fields is identified with the electron quantum solid being related to the Wigner crystal.

HL 51.21 Thu 16:30 Poster D

Magnetotransportuntersuchungen an gekrümmten zweidimensionalen Elektronensystemen in Halbleiter-Mikroröllchen mit spezieller Kontaktgeometrie — •Karen Peters, Olrik Schumacher, Andrea Stemmann und Wolfgang Hansen — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstrasse 11, 20355 Hamburg

Wir stellen Magnetotransportuntersuchungen an zweidimensionalen Elektronensystemen in Halbleiter-Mikroröllchen vor, deren Herstellung auf der Ausnutzung von Relaxationsprozessen in dünnen verspannten Halbleiterschichten basiert. Bei den aufgerollten Systemen handelt

es sich um Strukturen, die in einer speziellen H-förmigen Kontaktgeometrie präpariert wurden. Es werden insbesondere Messungen und Simulationen in Längsgeometrie präsentiert, bei denen die Richtung des eingeprägten Stroms entlang der Röllchenkrümmung liegt und die Messung des Widerstands parallel zur Modulation des Magnetfelds verläuft. Es zeigt sich eine gute Übereinstimmung der Simulation mit den winkelabhängigen Messungen. Liegt zwischen den Kontakten kein Nulldurchgang der senkrechten Magnetfeldkomponente vor so können die Ergebnisse ebenfalls mit Hilfe des Randkanalbilds erklärt werden.

HL 51.22 Thu 16:30 Poster D

Micromechanical cantilever magnetometer with in situ tunable sensitivity on a rotational stage — •Wolfgang Krenner, Xuting Huang, Tjark Windisch, Marc A. Wilde, and Dirk Grundler — Physik Department E10, Technische Universität München, James-Franck-Str. 1, D-85748 München

We report on a micromechanical cantilever magnetometer (MCM) mounted on a rotational sample stage incorporating a piezoceramics nanopositioning system. The MCM is read out by measuring the capacitance between the metalized backside and a fixed counter electrode. By tuning the piezoceramics we optimize the MCM's sensitivity at 300 mK in situ and in a magnetic field B of up to 16 T. With this setup we investigate the de Haas-van Alphen (dHvA) effect of 2D electron systems in III-V semiconductor heterostructures. At low temperature T the magnetization $M = -\frac{\partial U}{\partial B}$ provides direct information on U, the ground state energy. We discuss InAs-based and Mn-doped heterostructures where spin-orbit interaction is expected to induce beating patterns in the dHvA oscillations. The ability to rotate the sample allows us to adjust perpendicular and in-plane magnetic field components, which affect the Landau and Zeeman splitting differently. By this means we intend to investigate the spin splitting mechanisms in detail. First results will be presented.
We thank O. Roesler for technical assistance, A. Fontcuberta i Morral, Ch. Heyn, T. Schaepers, and W. Wegscheider for providing samples and the DFG for financial support via the "Nanosystems Initiative Munich (NIM)"and SPP 1285 Halbleiter Spinelektronik.

HL 51.23 Thu 16:30 Poster D

De Haas-van Alphen effect in two-component two-dimensional electron systems — •X. Huang[1], T. Windisch[1], S. Dasgupta[2], M. A. Wilde[1], A. Fontcuberta i Morral[2], M. Grayson[2,3], G. Abstreiter[2], and D. Grundler[1] — [1]Physik-Department E10, Tech. Univ. München, D-85747 Garching — [2]Walter Schottky Institut, Tech. Univ. München, D-85747 Garching — [3]Department of Electrical Engineering and Computer Science, Northwestern University, Evanston, Illinois 60208, USA

Two-component electron systems can be realized, e.g., in AlAs quantum wells, in which electrons occupy two X valleys in the ground state, or in Si/SiGe quantum wells [1] with two occupied Δ_2 valleys. Applying a magnetic field in the direction perpendicular to the quantum wells leads in both cases to spin splitting and, in addition, to a valley splitting in the energy spectrum. A further example is the tunneling-coupled double-layer electron system in a GaAs heterostructure, where the layer degree of freedom plays the role of the pseudo-spin degree of freedom. To investigate the characteristics of the two-dimensional electron systems (2DESs) confined to a modulation-doped AlAs quantum well, we have studied the de Haas-van Alphen (dHvA) effect at 300 mK using highly sensitive micromechanical cantilever magnetometer (MCM).

We acknowledge financial support of the German Excellence Initiative via the "Nanosystems Initiative Munich (NIM)"and GR1640/1.

[1]M. A. Wilde, M. Rhode, Ch. Heyn, D. Heitmann, U. Zeitler, F. Schaeffler, R. J. Haug and D. Grundler, Phys. Rev. B 72, 165429 (2005)

HL 51.24 Thu 16:30 Poster D

Fiber optical interferometer for ultra-sensitive displacement detection in cryogenic and high magnetic field environment. — •Martin Borowski, Tjark Windisch, Marc A. Wilde, and Dirk Grundler — Physik Department E10, Technische Universität München, James-Franck-Str. 1, 85748 Garching, Germany

A fiber optical interferometer with sub-Å resolution and in-situ four-axis nanopositioning sample holder for cryogenic (300 mK) and high magnetic field (15 T) applications is presented.

By probing the magnetization $M = -\frac{\partial U}{\partial B}|_{N,T}$ at low temperatures information can be gained about the ground state energy of a low dimensional electron system. For this we use micromechanical GaAs-based cantilever magnetometers (MCMs) with integrated or flip-chip mounted electron systems. This technique is established for large-area two-dimensional electron systems. The study of micron-sized samples e.g. graphene flakes, however calls for miniaturized cantilevers and a setup, where the sensitivity can be optimized in situ. The challenge is to achieve a sufficiently small footprint to fit the setup into a commercially available ^{3}He cryostat. The realization and characterization of the magnetometer will be reported.

We thank Jan Ivo Springborn and Niels Ruhe for technical assistance and the German Excellence Initiative for financial support via the "Nanosystems Initiative Munich (NIM)".

HL 51.25 Thu 16:30 Poster D

Magnetotransport measurements on a GaAs/GaAlAs high mobility sample — •Lina Bockhorn[1], Frank Hohls[1], Werner Wegscheider[2], and Rolf J. Haug[1] — [1]Institut für Festkörperphysik, Universität Hannover — [2]Institut für Experimentelle und Angewandte Physik, Universität Regensburg

We study the fractional Quantum-Hall effect in a high mobility two-dimensional electron system (2DES). The Hall geometry is created by photolithography on a GaAs/GaAlAs heterostructure containing a 2DES. The mobility and the density of electrons are manipulated by illuminating the sample with an infrared LED and by using a topgate. Driving a constant current along the Hall bar we measure the longitudinal and the transversal resitance depending on an external magnetic field and we observe Shubnikov-de Haas (SdH) oscillations. For a given density of electrons we study the SdH oscillations for different temperatures.

HL 51.26 Thu 16:30 Poster D

Long-lived hole spin dynamics in a 2D system at sub-Kelvin temperatures — •Anton Wagner, Tobias Korn, Robert Schulz, Andreas Maurer, Michael Hirmer, Dieter Schuh, Werner Wegscheider, and Christian Schüller — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, Germany

The spin dynamics of holes in semiconductors have, so far, been less intensely studied than the electron spin dynamics. We performed time-resolved Faraday rotation (TRFR) measurements on a 2D hole system within a 15nm wide, modulation-doped GaAs/AlGaAs quantum well grown on a [001] substrate. In the TRFR measurements, the sample is excited by a circularly-polarized laser pulse tuned to the exciton energy. An in-plane magnetic field up to 10 T is applied, causing a precession of the photocreated carriers. At 4.5 K temperature only the fast electron spin precession is observed, whereas a second, long period precession, superimposed on the electron spin precession, appears and gets more intense as the temperature is lowered from 1.2 K to 0.4 K. We identify this signal as the hole spin precession, which has a low frequency due to the small g-factor of holes along the [001] direction. The hole g-factor is highly anisotropic, which we measured by varying the angle of incidence of the pump beam relative to the sample plane. The appearance of the long-lived hole spin precession only at very low temperatures indicates that the hole spin lifetime is increased by localization. Surprisingly, while the hole spin lifetime increases drastically at lower temperatures, the electron spin lifetime is reduced. We acknowledge financial support by the DFG via SFB 689 and SPP 1285.

HL 51.27 Thu 16:30 Poster D

Phonon-induced carrier relaxation and hot phonon dephasing dynamics in graphene — •Frank Milde, Stefan Butscher, Ermin Malic, Matthias Hirtschulz, and Andreas Knorr — TU Berlin, Hardenbergstr. 36, D-10623 Berlin, Germany

We investigate the influence of the electron-phonon coupling (EPC) in graphene within the density-matrix formalism. To determine the EPC matrix elements Kohn anomalies in the phonon dispersions are used [1].

Our approach is used to microscopically calculate the relaxation dynamics of photoexcited electrons in graphene. Similar to recent experiments in graphite [2], hot phonons lead to a delayed decay of the electronic temperature. Our numerical simulations reproduce these observations [3] and give new insight into the ultrafast dynamics of the first 500 fs after excitation not yet accessible by the experiment. At these times an initially ultrafast energy dissipation and a non-thermal phonon occupation of the highest optical phonon modes are found. We also calculate the temporal evolution of the electronic temperature and find good agreement with recent experimental results [2].

[1] Piscanec et al., Phys. Rev. Lett. 93, 185503 (2004)
[2] Kampfrath et al., Phys. Rev. Lett. 95, 187403 (2005)
[3] Butscher et al., Appl. Phys. Lett. 91, 203103 (2007)

HL 51.28 Thu 16:30 Poster D

On the doping of Si nanowires grown by molecular-beam epitaxy — •Pratyush Das Kanungo, Otwin Breitenstein, Peter Werner, Nikolai Zakharov, and Ulrich Goesele — Max Planck Institute of Microstructure Physics, Weinberg 2, Halle D06120, Germany

Silicon nanowires (NWs) are potential candidates as building blocks for new semiconductor devices and sensors. Because of their quasi one-dimensional structure, high surface-to-volume ratio and low number of defects, Si NWs are expected to have specific electrical properties. As an example, the resistivity might be influenced by quantum confinement effects as well as by surface states. In order to make devices based on NWs it is necessary to dope them as well as to form p-n or p-i-n junctions. We describe two different techniques to dope Si NWs and methods to determine their electrical behavior.

First, in-situ doping of Si NWs with boron (B) was successfully done in a molecular beam epitaxy (MBE) chamber. By controlling the B flux it was possible to dope the whole NW, as well as make p-n and p-i-n junctions with the substrate. Second, we also demonstrated an ex-situ doping by the spin-on-glass technique. In-situ electrical measurements of the NWs were performed to confirm the desired behavior.

HL 51.29 Thu 16:30 Poster D

Charge accumulation in a type-II Ge/Si-heterostructure — Christoph Henkel[1], Gisela Biehne[1], Marius Grundmann[1], Gerald Wagner[2], Mathieu Stoffel[3], Oliver Schmidt[4], and •Heidemarie Schmidt[5] — [1]Universität Leipzig, Institut für Experimentelle Physik II — [2]Universität Leipzig, Institut für Mineralogie, Kristallographie und Materialwissenschaft — [3]MPI für Festkörperforschung, 70569 Stuttgart — [4]IFW Dresden, Institut für Integrative Nanowissenschaften — [5]Forschungszentrum Dresden-Rossendorf e.V., Institut für Ionenstrahlphysik und Materialforschung

The main motivation for mixing a small amount of Ge into Si for example by the self-organized growth of a stack of Ge dots into Si [1], is the controlled modification of the electronic band structure in strained Si namely charge carrier mobility and optical transition probabilities. We report on charge accumulation in fivefold stacks of Ge quantum dots embedded in the n-region of a p+n-Si diode. By means of thermal admittance spectroscopy, capacitance voltage and deep level transient spectroscopy measurements [2] electron confinement in the type II Ge/Si-heterostructures, barrier effects of the quantum wells and wetting layers and defect states in the n-region of the sample associated with the surrounding Si-matrix have been probed. By relating these results to the self consistently modeled electronic band-structure and capacitance voltage characteristic charge accumulation in quantum confined electron states in the investigated type II Ge/Si-heterostructures is clearly revealed. [1] A. Malachias et al., Thin Solid Films 515, 5587 (2007)[2] M. Gonschorek et al., Phys. Rev. B 74, 115312 (2006)

HL 51.30 Thu 16:30 Poster D

MBE-growth and analysis of Si and Ge nanowires and corresponding heterostructures — •Andreas Wolfsteller, Pratyush Das Kanungo, Trung-Kien Nguyen-Duc, Gerhard Gerth, Nikolai Zakharov, Peter Werner, and Ulrich Gösele — Max Planck Institute of Microstructure Physics, Weinberg 2, D-06120 Halle (Saale), Germany

Nanowires (NW) are expected to be building blocks for future electronic and optical devices, e. g. new field-effect transistors or chemical sensors. The most common growth mechanism for the synthesis of epitaxial free-standing nanowires is the vapour-liquid-solid (VLS) mechanism, which can in principle also be applied to grow Si NW and nanowire-based SiGe heterostructures by molecular beam epitaxy (MBE) as it has been reported earlier [1]. Now also Ge NW have been grown and the use of Au colloids with 15-18 nm diameter as precursors for NW growth instead of the former deposition of a thin Au film drastically decreased the thickness of both the Si and Ge NW due to the prevention of Ostwald-ripening. Concerning the nanowire-based SiGe heterostructures, by varying the temperature during growth the maximum Ge concentration in selected layers within the NW could be improved from 10% to 26%. Furthermore we present the results from electrical (I-V) and optical (PL) measurements on Si and Ge NW and corresponding nanowire-based heterostructures. The morphology, crystal structure and chemical composition was analyzed by TEM, SEM, and EDX.

[1] N. D. Zakharov et al., J. Cryst. Growth 290 (2006) 6

HL 51.31 Thu 16:30 Poster D

I-V - Characteristics of chalcogenide glasses during threshold switching — •Hanno Volker, Carl Schlockermann, Gunnar Bruns, and Matthias Wuttig — 1. Physikalisches Institut 1A, RWTH Aachen, Germany

Phase Change Memories (PCMs) use the contrast in electrical conductivity between the amorphous and the crystalline phase of nanoscale cells of various chalcogenides. This memory technology has very promising scaling properties in contrast to the established flash memories. Switching from the crystalline to the amorphous phase (RESET) is achieved by applying a short, but high, current pulse. This heats the material above the melting temperature. Subsequent rapid quenching creates an amorphous phase. Switching from the amorphous phase to the crystalline phase (SET) is performed by applying a lower, but longer current pulse which heats up the material above the crystallization temperature.

This current can be applied at voltages of the same order of magnitude as for the reset pulse due to an effect called threshold-switching: At a specific threshold voltage, the amorphous material switches from a low-conductive (OFF) state to a high-conductive (ON) state. Several competing models which describe the conduction mechanism in the amorphous state can explain this effect.

Using an extremely fast measurement setup, we have gained a deeper insight both in the life time and I-V properties of this highly non-linear behavioir.

HL 51.32 Thu 16:30 Poster D

Pressure-induced phase transition in Cu_3N — •Komalavalli Thirunavukkuarasu[1], Dieter Rau[2], Rainer Niewa[2], and Christine A Kuntscher[1] — [1]Experimentalphysik II, Universität Augsburg, D-86159 Augsburg, Germany — [2]Department Chemie, Technische Universität München, 85474 Garching, Germany

Cu_3N has attracted a lot of attention since the 1980ies because of its possible application prospect as an optical storage medium [1]. Cu_3N decomposes into Cu and N_2 at temperatures 300 - 470°C and undergoes a semiconductor-to-metal transition; therefore, it can be used as a write-once optical recording material upon heating. The relatively low decomposition temperature of this compound indicates weak Cu-N bonding and therefore high sensitivity with respect to pressure modifications. Furthermore, the relatively small band gap of 1 eV suggests that a pressure-induced metallization could be induced at modest pressures. Indeed, a semiconductor-to-metal transition induced at around 5 GPa is observed by pressure-dependent resistivity measurements [2,3]. We performed pressure-dependent transmittance measurements on Cu_3N powder samples in the infrared-visible frequency range for pressures up to 11 GPa. The evidence for a pressure-induced semiconductor-to-metal transition in the optical properties of this compound is discussed. *We acknowledge the ANKA Angströmquelle Karlsruhe for the provision of beamtime and the DFG for financial support.*

[1] T. Maruyama et al., Appl. Phys. Lett., **69**, 890 (1996).
[2] L. X. Yang et al., Chin. Phys. Lett., **23**, 426 (2006).
[3] J. G. Zhao et al., phys. stat. sol (b), **243**, 573 (2006).

HL 51.33 Thu 16:30 Poster D

High pressure investigations of the Mott insulator GaV_4S_8 — Xin Wang[1], •Martin K. Forthaus[2], Karl Syassen[1], Ingo Loa[1], Dirk Johrendt[3], and Mohsen M. Abd-Elmeguid[2] — [1]Max-Planck-Institut für Festkörperforschung, Stuttgart, Germany — [2]II Physikalisches Institut, Universität zu Köln, Köln, Germany — [3]Department Chemie and Biochemie der Ludwig-Maximilians-Universität München, München, Germany

AM_4X_8 (A=Ga; M=V, Mo, Nb, Ta; X=S, Se) compounds with the cubic fcc $GaMo_4S_8$ type structure represent a new class of Mott insulators in which the electronic conduction originates from hopping of localized electrons ($S = 1/2$) among widely separated tetrahedral M_4 metal clusters. Current research on $GaNb_4Se_8$ and $GaTa_4Se_8$ show that their ground state is closely related to a structural instability: at ambient pressure they are nonmagnetic insulators, but under pressure transform to a metallic and superconducting state. In contrast, GaV_4S_8 is a ferromagnetic insulator ($T_C = 10$ K) at ambient pressure.

For a better understanding of the electronic correlations, we have investigated the effect of pressure on the electrical transport, crystal structure, Raman modes, and infrared response of the Mott insulator GaV_4S_8. We discuss our observation of a pressure-induced insulator

metal transition above 18 GPa and its possible connection to a structural instability, Raman modes and infrared response.

HL 51.34 Thu 16:30 Poster D

Anomalously localized states at the metal-insulator transition in the Anderson model of localization — •Philipp Cain and Michael Schreiber — Institut für Physik, Technische Universität, D-09107 Chemnitz

Exceptional statistical fluctuations of the disordered potential lead to very strongly localized states. These so-called anomalously localized states (ALSs) appear also among the critical eigenstates at the metal-insulator transition (MIT) and might influence the behaviour of the critical properties. We identify ALSs for the Anderson model of localization at the MIT in the band centre of three-dimensional disordered samples. From the study of the multifractal correlation exponent $z(q)$ and the correlation dimension D_2 we can conclude that ALSs affect the critical properties at the MIT. Therefore the ALSs should be excluded from the ensemble in order to achieve a better characterization of the critical behaviour. However, in our investigation the improvement is not as good as it has been found in the 2D symplectic case.

HL 51.35 Thu 16:30 Poster D

Investigations of the Quality of $Mg_xZn_{1-x}O$-ZnO Quantum Well Interfaces grown by pulsed laser deposition — •Martin Lange, Susanne Heitsch, Gabriele Benndorf, Holger Hochmuth, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, D-04103 Leipzig, Germany

$Mg_xZn_{1-x}O$-ZnO single quantum wells with $x \sim 0.2$ and nominal thickness of 4 nm have been grown on a-plane sapphire substrates by pulsed laser deposition. The samples were grown at an oxygen pressure of 2×10^{-3} mbar and a temperature of ∼620 °C. Before and after the deposition of the quantum well, growth interruptions with a duration of up to 10 minutes were performed. During the growth interruption the growth parameters have been kept constant. The samples have been investigated with photoluminescence at room temperature and at 2 K and atomic force microscopy. At low temperature a small blueshift as well as an increase of the full width at half maximum value of the quantum well peaks were observed for longer interruptions. The roughness of the interfaces within each sample was estimated by calculating a roughness parameter from the peak position and the width of the peak. A quantum well with finite barrier height was used as a model. Possible reasons for the blueshift will be suggested.

HL 51.36 Thu 16:30 Poster D

White luminescence of vanadium implanted ZnO PLD films — •Sven Müller[1], Carsten Ronning[1], Michael Lorenz[2], Christian Czekalla[2], Gabriele Benndorf[2], Holger Hochmuth[2], Marius Grundmann[2], and Heidemarie Schmidt[3] — [1]II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, 04103 Leipzig, Germany — [3]Forschungszentrum Dresden-Rossendorf e.V., Bautzner Landstraße 128, 01328 Dresden, Germany

Pulsed laser deposited ZnO films were implanted with vanadium ions using ion energies between 30 and 250 keV in order to create a box-like doping profile. Different fluences yielded into vanadium concentrations of 0.8, 2.5 and 5 at.%, and a reference sample was implanted with Ar. After annealing under oxygen ambient at 800°C, broad yellow, green, and blue photoluminescence bands were observed for all V-implanted ZnO samples whereas the Ar-implanted ZnO sample exhibits a red-yellow luminescence band. The green luminescence band of V-implanted ZnO shows a modulated fine structure and the complete luminescence reveals a white color in the eye of the beholder. Therefore, the light emission was quantified using the color space map of the Commission internationale de l'Éclairage (CIE). The origin of the red-yellow and green luminescence as well as the luminescence emission properties will be discussed in the presentation.

HL 51.37 Thu 16:30 Poster D

Structural properties of ZnO Nanorods before and after Ga-Implantation in a Focused-Ion-Beam-System — •Michael Dürrschnabel[1], Daniel Weissenberger[1], Dagmar Gerthsen[1], Anton Reiser[2], Günther Prinz[2], Martin Feneberg[2], Klaus Thonke[2], and Rolf Sauer[2] — [1]Laboratorium für Elektronenmikroskopie, Universität Karlsruhe, D-76128 Karlsruhe, Germany — [2]Institut für Halbleiterphysik, Universität Ulm, D-89081 Ulm, Germany

The structural properties of ZnO nanorods grown by the vapor-liquid-solid technique on sapphire were studied by transmission electron microscopy. Implantations were carried out in a focused-ion-beam system with 30 keV Ga^+ ions and doses D from 10^{11} to 10^{16} cm^{-2}. The nanorods are almost free of defects before implantation. Small defects with extensions below 9 nm and a density of 5x10^{15} cm^{-3} are found for $10^{11} \leq D \leq 10^{12}$ cm^{-2}. At D = 10^{14} cm^{-2}, dislocation loops with diameters up to 20 nm and a concentration of 1.8x10^{17} cm^{-3} are formed. The dislocation loops bind stacking faults which consist of inserted or missing (0002) planes oriented perpendicular to the [0001] nanorod axis. At D = 10^{16} cm^{-2}, the planar defects agglomerate and form three-dimensionally defective regions. Energy dispersive X-ray analysis yield a Ga-concentration of about 1 % for D = 10^{16} cm^{-2} leading to a resistivity decrease from 0.04 Ωcm before implantation to 0.003 Ωcm after implantation despite the high defect density which strongly lowers the mobility.

HL 51.38 Thu 16:30 Poster D

Magneto transport properties of codoped ZnCoO — •Christoph Knies[1], Matthias T. Elm[1], Jan Stehr[1], Peter J. Klar[1], Detlev M. Hofmann[1], Tom Kammermeier[2], Andreas Ney[2], and Nikolai Romanov[3] — [1]I. Physikalisches Institut, Justus-Liebig Universität Giessen, Heinrich-Buff-Ring 16, D-35392 Giessen, Germany — [2]Univ. Duisburg-Essen, Germany — [3]Ioffe Institute, St. Petersburg, Russia

Current models predict that ZnO with ferromagnetic properties can be obtained by alloying the material with Co. Additionally a co-doping with shallow donors is needed to mediate the exchange interaction. We have prepared thin film of such materials by colloid chemical methods with Co concentrations up to 30%. For Co concentrations higher than 15 % the formation of secondary phases becomes evident from X-ray diffraction. All samples are high resistive in the as grown state and can be converted to n-type conduction by an annealing step in Zn vapour (450 °C, for 10 min.), which is believed to create Zn interstitial shallow donors. This process is reversible, subsequent annealing in air or O2 causes high resistivity again. The conducting films are suitable for temperature dependent magneto-transport measurement in order to investigate a possible spin-polarisation of carriers. We find the usual weak negative magneto-resistive effect in the ZnO reference sample. In the Co doped samples this effect is superimposed by a positive magneto-resistive effect at temperatures below 40 K. It is due to the alloy scattering caused by the Co ions. The results of further detailed characterisation of the co-doped ZnCoO will be discussed.

HL 51.39 Thu 16:30 Poster D

Tunnelling process in ZnSe/ZnMnSe double-quantum-well structures — •Stephanie Jankowski, Tobias Niebling, and Wolfram Heimbrodt — Phillipps-University Marburg, Department of Physics and Matrial Science Center, Renthof 5, 35032 Marburg

Asymmetric ZnSe/ZnMnSe double-quantum-well (DQW) structures with different barrier width have been grown between ZnMnSe cladding layers on a (100) GaAs substrate with a ZnSe buffer. The ZnSe wells are under tensile strain in these DQW structures yielding the light-hole exciton states to be the energetically lowest lying states. This is different to earlier papers , where tunnelling of carriers and excitons have been studied in DQW structures made of diluted magnetic semiconductors with heavy hole excitons to be the lowest lying states. In an external magnetic field we were able to manipulate the barrier height due to Giant Zeeman effect of the ZnMnSe barriers. Hence we can study the tunnelling processes in these structures in dependence of the height and width of the barrier by photoluminescence, photomodulated reflectivity as well as time resolved measurements. Surprisingly, very different results to heavy hole tunnelling have been found. The obtained results and differences will be discussed in detail.

HL 51.40 Thu 16:30 Poster D

Epitaxial ferroelectric BTO/ZnO heterostructures — •Brandt Matthias[1], Holger Hochmuth[1], Michael Lorenz[1], Nurdin Ashkenov[1,2], Matthias Schubert[3], Venkata Voora[3], and Marius Grundmann[1] — [1]Universität Leipzig, Institut für ExperimentellePhysik II, Leipzig, Germany — [2]Now at Opteg GmbH, Leipzig, Germany — [3]Department of Electrical Engineering, University of Nebraska-Lincoln, Lincoln, U.S.A.

Ferroelectrics are a material class of increasing importance in electronics, including ferroelectric switches, capacitors, non–volatile memory

elements, optical switches and thin film transistors. While the polarization in ferroelectric materials is switchable by external electric fields, wurtzite ZnO exhibits a permanent spontaneous polarization. Previously, polarization coupling effects have been observed by us in experiments on Pt/BTO/ZnO/Pt structures on Si [1]. Asymmetric current-voltage (I–V), capacitance-voltage (C–V) and field dependent polarization P(E) hysteresis loops were demonstrated [2]. Detailed investigations on the homogeneity of fabricated wafers have been carried out, and were compared to data obtained on Pt/BTO/Pt samples. Further a model of the polarization exchange coupling was developed, and is applied to analyze the experimental data. The model is tested on experimental P(E) curves obtained at different voltages and probe frequencies.

[1] B. N. Mbenkum et al.: Appl. Phys. Lett. **86**, 091904 (2005).
[2] N. Ashkenov et al.: Thin Solid Films **486**, 153-157 (2005).

HL 51.41 Thu 16:30 Poster D

Magneto-transport measurements on artifically structured ZnO epitaxial layers — •Matthias T. Elm, Stefan Lautenschläger, Torsten Henning, and Peter J. Klar — Institute of Experimental Physics, Justus-Liebig-University of Giessen, Germany

ZnO layers with a thickness of about 1000 nm were grown homoepitaxically on ZnO substrate by chemical vapor deposition. The layers are n-type with electron concentrations of about 10^{17} cm^{-3}. Different parts of the as grown samples were artificially structured by photolithography. The patterns consist of regular arrays of holes with different hole diameters and spacings, which were transferred into the layer by chemical etching. In some of the samples the holes were filled in an additional preparation step with a metal, e.g. Au or Al, by either sputtering or electron beam evaporation. These structures were investigated by magneto-transport measurements in a temperature range from 2 to 280 K in external magnetic fields up to 10 T. The differences in the temperature-dependent behavior as well as in the magneto-resistance between samples with and without metal content are discussed.

HL 51.42 Thu 16:30 Poster D

Epitaxially grown artificially structured ZnO layers investigated by thermoelectric measurements — •Gert Homm[1], Jörg Teubert[1,2], Stefan Lautenschläger[1], Torsten Henning[1], Peter J. Klar[1], and Bruno K. Meyer[1] — [1]Institute of Experimental Physics I, Justus-Liebig-University Gießen, Germany — [2]Department of Physics and Science Center, Philipps-University Marburg, Germany

ZnO layers of about 1000 nm thickness were grown homoepitaxially on ZnO substrates by chemical vapor deposition. The layers are n-type with electron concentrations of about 10^{17} cm^{-3}. Stripes of the as grown samples were artificially structured by photolithography. The patterns consist of regular arrays of holes with different spacings and hole diameters. The patterns were transferred either by wet-chemical etching or by ion-beam etching. The Seebeck coefficient is measured in the temperature range of 50 to 300 K. The influence of the artificial structuring on the Seebeck coefficient is discussed.

HL 51.43 Thu 16:30 Poster D

Empirical pseudopotential calculation of strain induced birefringence in ZnO — Daniel Fritsch[1] and •Heidemarie Schmidt[2] — [1]Leibniz Institute for Solid State and Materials Research IFW Dresden, PO Box 270116, D-01171 Dresden, Germany — [2]Forschungszentrum Dresden-Rossendorf e.V., PO Box 510119, D-01314 Dresden, Germany

One big challenge in the fabrication of ZnO-based heterostructure devices is the lattice mismatch between ZnO films and substrates and the different thermal expansion coefficients inducing biaxial strain. There is currently also much interest in ZnO doped with 3d transition metal ions for spintronics applications and the detection of ferromagnetic signatures by magneto-optical measurements of ordering induced birefringence being most intense around the critical point structure of the dielectric function. A quantitative understanding of Zeeman splitting far away from the center of Brillouin zone is still an open question and requires a separation of strain and magnetic field induced modifications of the electronic band structure. We report on the effect of strain on the birefringence in ZnO films grown on Al_2O_3 or on SiC substrates. The imaginary part of the dielectric function has been calculated by means of the empirical pseudopotential method. Thereby we also accounted for relativistic effects in form of the spin-orbit interaction, for the energy-dependence of the crystal potential through the use of nonlocal model potentials, and for excitonic contributions to the dielectric function due to discrete excitonic states and Coulomb-enhanced band-to-band transitions.

HL 51.44 Thu 16:30 Poster D

Artificially structured epitaxially grown ZnO layers investigated by transport measurements — •Markus Piechotka[1], Matthias T. Elm[1], Sebastian Eisermann[1], Achim Kronenberger[1], Thomas Wassner[2], Torsten Henning[1], Martin Eickhoff[2], Peter J. Klar[1], and Bruno K. Meyer[1] — [1]Institute of Experimental Physics I, Justus Liebig University, Heinrich Buff Ring 16, D 35392 Giessen, Germany — [2]Walter Schottky Institut, Technische Universitaet Muenchen, Am Coulombwall 3, D-85748 Garching, Germany

Several n-type ZnO layers were grown heteroepitaxially on Al_2O_3 substrates either by MBE with a thickness of 300 nm to 400 nm on a 20 nm MgO buffer layer or by cathode sputtering with a thickness of 1100 nm. Stripes of the as grown samples were artificially structured by photolithography. Each pattern consists of two contact pads with a regular array of wires of the same width in between. The wire thickness varies throughout the series of patterns from 4 μm to 1000 μm whereas the total cross section area of the wires is kept constant. The patterns were transferred either by wet-chemical etching or by ion-beam etching. The resistance of the wire patterns was measured in the temperature range from 2 to 300 K and in magnetic fields of 0 to 10 T. The analysis of the resistivity as a function of wire width yields information about the depth of the surface damage caused during the etch process.

HL 51.45 Thu 16:30 Poster D

Zeitaufgelöste Photolumineszenz an Zinkoxidnanoröhren: Einfluss der Oberfläche und Identifikation einer Oberflächensignatur — •Alexej Chernikov[1], Swantje Horst[1], Sangam Chatterjee[1], Wolfgang Rühle[1], Peter K. Klar[2] und Michael Tiemann[3] — [1]Fachbereich Physik, Philipps-Universität Marburg, Germany — [2]Institute of Experimental Physics I, JLU, Giessen, Germany — [3]Institute of Inorganic and Analytical Chemistry, JLU, Giessen, Germany

Es wurde zeitaufgelöste Photolumineszenz (PL) an doppelt invertierten Zinkoxidnanoröhren mit unterschiedlicher Oberfläche und an Zinkoxidvolumenmaterial gemessen. Zur Anregung wurde ein gepulster Titan-Saphir-Laser mit 80MHz in Kombination mit einem Frequenzverdreifacher verwendet. Die Pulslänge betrug 100fs und die Photonenergie nach der Verdreifachung 4,28eV. Detektiert wurde die PL nach spektraler Zerlegung durch ein Spektrometer mit einer Streakkamera. Es zeigt sich bei der PL der Nanoröhren eine Bande, deren Intensität abhängig von der Oberflächengröße ist und bei den PL-Spektren des Volumenmaterials nicht auftritt.

HL 51.46 Thu 16:30 Poster D

n-type doped ZnO nanorods for heterostructure application — •Janos Sartor, Hujuan Zhou, Johannes Fallert, Felix Stelzel, Roman J. B. Dietz, Mario Hauser, Claus Klingshirn, and Heinz Kalt — Institut für Angewandte Physik, Universität Karlsruhe(TH), Germany

ZnO is considered as a promising material for blue/ultraviolet (UV) light emitting diode (LED) or laser diode (LD) structures. Due to the difficulty of the growth of reproducible p-type ZnO, heterojunctions of n-type ZnO grown on p-type material are under intense investigation. We have reported in earlier work the growth of ordered, vertically aligned, dense arrays of single crystal ZnO nanorods with a chemical vapor transport method. In this work we present the growth of highly indium doped n-type ZnO nanorods on GaN thin films. Low temperature photoluminescence measurements show predominant emission in the UV region. Compared with the nominally undoped ZnO nanorods, the indium relevant donor bound exciton is overwhelming in the In-doped nanorods, while the A-free exciton can be observed, indicating the good crystal quality of the rods. Investigations on the luminescence properties as well as the possible lasing behavior from heterostructures are in progress.

HL 51.47 Thu 16:30 Poster D

Density-Functional Tight-Binding Calculations on Functionalized ZnO Surfaces — •Ney Henrique Moreira, Andreia Luisa da Rosa, and Thomas Frauenheim — BCCMS, Universität Bremen, Am Fallturm 1, 28359, Bremen, Germany

Organic coated semiconductor materials have attracted a lot of at-

tention due to their possible applications in electronic and optoelectronic devices, since organic molecules can induce significant changes on the electronic and optical properties of nanostructures when attached to their surfaces. Zinc oxide is usually recognized as one of the most promising materials for optoelectronics due its wide bandgap (3.3 eV), large excitonic binding energy, low cost and environmental friendly processability. Recent Density Functional Theory (DFT) based theoretical investigations [1-3] had enlightened the understanding of the geometry and electronic structure of bare ZnO surfaces and nanowires. In our present work we use the Density-Functional based Tight-Binding method to investigate polymer-functionalized ZnO surfaces. We demonstrate how the presence of organic molecules can change their physical properties when compared with bare surfaces.

[1] Xu H., Rosa AL., Frauenheim Th., et al. Appl. Phys. Lett., 91, Art. No. 031914 (2007).
[2] Fan W., Xu H., Rosa AL., Frauenheim Th., et al, Phys. Rev. B, 76, Art. No. 073302 (2007).
[3] Xu H., Zhang RQ., Zhang X., Rosa AL., and Frauenheim Th., Nanotech., 18, 485713(2007).

HL 51.48 Thu 16:30 Poster D

Polarisation dependence of the free discrete exciton luminescence in ZnO microwires — •Rüdiger Schmidt-Grund, Helena Hilmer, Christian Czekalla, Bingqjang Cao, Chris Sturm, and Marius Grundmann — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Inst. für Exp. Physik II, Linnéstr. 5, 04103 Leipzig

We report on the polarisation dependence of the free discrete exciton luminescence recorded from unstrained single-crystal ZnO microwires at temperatures between 10 K and room temperature. The threefold split topmost valence band in ZnO gives rise to the formation of three excitons (labeled A, B, C for increasing energy) with different energies and different selection rules for the coupling to light polarised parallel (pc) or perpendicular (sc) to the ZnO optical axis, specified by the symmetry of the valence bands. The sign of the spin-orbit and crystal field interaction and therefore the symmetry order of the three valence bands for ZnO is still a subject under debate. For our samples, at temperatures larger than 180 K, the emission from the A- and B-excitons was found to dominate the photoluminescence spectra for polarisation sc, while the C-exciton is more pronounced in the spectra for polarisation pc. This finding is concordant with predictions made for a valence band order Γ_7-Γ_9-Γ_7. At very low temperatures, no luminescence of the C-exciton for any polarisation could be detected, but the luminescence from the A- and B-excitons is suppressed for the polarisation pc. As the intensity of the C-exciton luminescence increases with increasing temperature, we attribute this finding to be caused in the temperature dependence of the occupation function of the exciton states.

HL 51.49 Thu 16:30 Poster D

Magneto-optical properties of ZnO with Mn ion-beam implantation — Limei Chen[1], Samer Al-Azzaui[1], •Wolfram Heimbrodt[1], Daniel Stichenoth[2], Sven Müller[2], and Carsten Ronning[2] — [1]Department of Physics, Philipps Universtiy of Marburg, Renthof 5, 35032 Marburg — [2]II. Institute of Physics, Georg-Augusta University of Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

We studied optical and magneto-optical properties of a series of (Zn,Mn)O samples with various Mn contents. The samples were prepared by ion-beam implantation with ^{55}Mn into ZnO substrates. Multiple ion energies ranging from 20 to 450 keV were used in order to create a box-like homogeneous distribution of the implanted ions. By choosing different ion fluencies, samples with Mn concentrations from 0.1 % to 4 % were obtained. Post-implantation annealing procedures were performed at different temperatures and various lengths of time to remove the implantation-introduced damage and to reduce the Mn killer center density. The evolution of optical and magneto-optical properties as a function of Mn concentration and the effect of annealing process were studied in order to obtain better understanding of Mn incorperation into ZnO.

HL 51.50 Thu 16:30 Poster D

CVD growth of ZnMgO — •Sebastian Eisermann, Stefan Lautenschläger, Joachim Sann, Niklas Volbers, Markus Piechotka, Peter J. Klar, and Bruno K. Meyer — I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen, Germany

ZnMgO thin films and heterostructures grown by MOCVD usually require quite high substrate temperatures (approx. 800°C - 900°C), at high growth temperatures both, n-type and p-type doping, is quite difficult. It was our aim to explore the growth of ZnMgO thin films using a CVD process at much lower substrate temperatures. The growth temperature was between 550°C and 700°C. We used metallic precursors (Zn, Mg) and NO_2 as oxygen precursor. The grown thin films have been investigated by low temperature photoluminescence, the magnesium content was determined by SIMS and EDX. We were able to produce samples with a homogenious Mg concentration as well as samples with a linear gradient of the Mg concentration (0% - 3%) over the thin film surface. The band-edge photoluminescence shows a linear dependence on the Mg content, same for the shift of the Raman modes. The maximum magnesium content in our samples was 14 +/- 2 %.

HL 51.51 Thu 16:30 Poster D

Magneto-optic photoluminescence and spin flip Raman spectroscopy on $Cd_{1-x}Mn_xTe/Cd_{1-y}Mg_yTe$ quantum well samples — •Christian Kehl, Georgy Astakhov, Jean Geurts, and Wolfgang Ossau — Universität Würzburg, Physikalisches Institut, Experimentelle Physik III, Am Hubland, 97074 Würzburg

Using magneto-optic photoluminescence and spin flip Raman spectroscopy up to 4.5 tesla at 1.7 Kelvin, $Cd_{1-x}Mn_xTe$ quantum wells (QW) embedded in $Cd_{1-y}Mg_xTe$ barriers were investigated. The PL spectra show excitonic and trionic excitations of the quantum well. For the Raman study of paramagnetic resonance spin flips of Mn-ions resonant excitation of excitons in the QW was applied. In this way, multiple spin flips up to the fourth order were observed. We studied the effect of additional carriers in the QW both by increasing the illumination intensity at the excitonic level and by additional illumination beyond the barrier gap.

The results are discussed in terms of (i) the increase of trion intensity at the expense of the excitons, (ii) the influence of the photogenerated carriers on the multiple spin flip intensities and on the Mn g-factor. Thus, we gain insight into the effect of additional free carriers on the Mn-Mn-exchange interaction.

HL 51.52 Thu 16:30 Poster D

Characterisation of deep defects in ZnO thin films by means of optical deep level transient spectroscopy — •Martin Ellguth[1], Robin Weirauch[1], Matthias Schmidt[2], Holger von Wenckstern[1], Rainer Pickenhain[1], and Marius Grundmann[1] — [1]Universität Leipzig, Leipzig, Germany — [2]Forschungszentrum Dresden–Rossendorf e.V., Dresden, Germany

We investigated Schottky diodes on ZnO thin films grown by pulsed laser deposition using thermal admittance spectroscopy (TAS), deep level transient spectroscopy (DLTS), optical DLTS (ODLTS), and photocurrent spectroscopy (PC). The typically occuring impurities E1, L2, E3, E4, and E5 were found in DLTS and/or TAS measurements.

ODLTS measurements in the spectral range from 0.4 to 3.5 eV indicated that E1, L2, and E3 are optically inactive. For some samples we detected an optically active impurity by ODLTS which was not accessible to thermal capacitance spectroscopical methods due to its high binding energy. The experimentally determined optical capture cross section reveals that this impurity causes a high lattice distortion. Furthermore, there are at least three states generated by this defect which are situated 50 meV below the conduction band edge, in the mid–gap, and several meV above the valence band edge. ODLTS spectra showed a broad absorption band around 2.4 eV which coincides with the green luminescence in ZnO known from photo luminescence measurements. A configuration coordinate diagram for these defect states is presented.

HL 51.53 Thu 16:30 Poster D

Study of the solubility limits and secondary phase formation for ZnO:TM (TM = V, Fe, Co, Ni) mixed crystals by Raman spectroscopy — •Martin Koerdel[1], Marcel Schumm[1], Fabian Bach[1], Huijuan Zhou[2], Wojciech Szuszkiewicz[3], Sven Mueller[4], Carsten Ronning[4], and Jean Geurts[1] — [1]Physikalisches Institut, Universität Würzburg, Am Hubland, 97074 Würzburg — [2]Institut für angewandte Physik, Universität Karlsruhe — [3]Polish Academy of Science, Warsaw — [4]II. Physikalisches Institut, Universität Göttingen

For ZnO alloyed with transition metal (TM) ions the possibility of room temperature ferromagnetism is predicted if the TM ions occupy cation sites. To investigate the incorporation of various TM ions (V, Fe, Co, Ni) and to check their solubility limits in the ZnO crystal lattice we study the ZnO:TM and possible TM-oxide vibrations by Raman spectroscopy. Three ZnO:TM systems are compared: (i) lay-

ers prepared by sol-gel technique from nanocrystals, (ii) ion implanted layers and (iii) bulk crystals grown (900°C) by vapor phase transport. TM ion concentration ranges up to 20 at.%. An annealing sequence (700°C, 900°C) is applied to systems (i) and (ii). Each annealing step significantly improves the crystal order. Below the solubility limit the incorporation of the TM ions only activates symmetry-forbidden ZnO host lattice phonon modes proportional to the TM ion fraction incorporated in the ZnO lattice. No TM local vibration modes are observed. TM solubility limits are typically below 10% and, moreover, depend strongly on the sample growth method. TM-oxides are identified not only by their phonons but also by magnetic excitations.

HL 51.54 Thu 16:30 Poster D

Sputter deposition of ZnO thin films at high substrate temperatures — •Achim Kronenberger, Sebastian Eisermann, Andreas Laufer, Swen Graubner, Angelika Polity, and Bruno K. Meyer — I. Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

For the use of sputter deposited ZnO thin films in semiconductor devices, not only the electrical behaviour but also to maintain high crystal quality of the deposited films is important.

Pure ZnO thin films have been prepared on quartz glass and sapphire substrates by radio-frequency (RF) sputtering using a ceramic ZnO target. The substrate-temperature during the deposition could be adjusted from RT up to 735 °C. Argon was used as sputter-gas and oxygen as reactive-gas to change the stoichiometry of the deposited thin films.

The crystallinity of the deposited films has been analysed by XRD measurements. For optical and electrical characterisation optical transmission and Hall-effect measurements have been performed. To investigate impurities the films have been analysed by EDX and SIMS.

The focus was set on the electrical and optical properties of the deposited ZnO thin films and their changing behaviour in the cause of the different deposition parameters such as gas pressures, substrate temperature and rf-power. The aim was to gain control over changing the resistivity in a wide range, while keeping the films transparent in the visible region of the electromagnetic spectra and simultaneous maintain a high crystal quality.

HL 51.55 Thu 16:30 Poster D

Polycrystalline Mn-alloyed indium tin oxide films — •Camelia Scarlat[1], Heidemarie Schmidt[1], Qingyu Xu[1], Mykola Vinnichenko[1], Andreas Kolitsch[1], Manfred Helm[1], and Felicia Iacomi[2] — [1]Forschungszentrum Dresden-Rossendorf e.V., Bautzner Landstraße 128, 01328 Dresden, Germany — [2]Al. I. Cuza University, Faculty of Physics, Carol I, 700506, Iasi, Romania

Magnetic ITO films are interesting for integrating ITO into magneto-optoelectronic devices. We investigated n-conducting indium tin oxide (ITO) films with different Mn doping concentration which have been grown by chemical vapour deposition using targets with the atomic ratio In:Sn:Mn=122:12:0, 114:12:7, and 109:12:13 [1]. The average film roughness ranges between 30 and 50 nm and XRD patterns revealed a polycrystalline structure. Magnetotransport measurements revealed negative magnetoresistance for all the samples, but high field positive MR can be clearly observed at 5 K with increasing Mn doping concentration. Spectroscopic ellipsometry (SE) has been used to prove the existence of midgap states in the Mn-alloyed ITO films revealing a transmittance less than 80%. A reasonable model for the ca. 250 nm thick Mn-alloyed ITO films has been developed to extract optical constants from SE data below 3 eV. Depending on the Mn content, a Lorentz oscillator placed between 1 and 2 eV was used to model optical absorption below the band gap.[1]C. Baban et al. E-MRS 2007, Straßbourg.

HL 51.56 Thu 16:30 Poster D

The structural impact of Mn implantation on a ZnO host lattice and the magnetic interaction of the implanted Mn ions studied by Raman scattering and Electron Paramagnetic Resonance — •Marcel Schumm[1], Martin Koerdel[1], Sven Mueller[2], Hayo Zutz[2], Carsten Ronning[2], Jan Stehr[3], Detlev M. Hofmann[3], and Jean Geurts[1] — [1]Physikalisches Institut, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany — [2]II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [3]Physikalisches Institut, Universität Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

We study the magnetic and structural properties of Mn implanted ZnO by Raman scattering and Electron Paramagnetic Resonance for Mn contents from 0.1% to 4%. EPR reveals that the Mn ions substitutionally occupy Zn sites in the ZnO Wurtzite lattice. The Mn ions in the implanted layer show an antiferromagnetic dipolar interaction which results in broad, unstructured EPR spectra. No secondary phases are detected with EPR, Raman, TEM, or XRD. In the low temperature Raman spectra, scattering from a magnetic excitation is observed and studied for temperatures 5K < T < 200K. Raman spectroscopy also yields detailed information on the Mn incorporation and the induced disorder. Spectral features related to the Mn implantation exhibit a strong dependence on the Mn content and the applied annealing steps (up to 900°C). They allow the distinction between implantation damage and impurity induced disorder, and identification of one peak as a candidate for a localized vibration mode of Mn in ZnO.

HL 51.57 Thu 16:30 Poster D

Effect of Se predeposition on the electronic and structural porperties of n-ZnSe layers grown on n-GaAs(001) by molecular beam epitaxy — •Alexander Frey, Suddhosatta Mahapatra, Claus Schumacher, Laurens W. Molenkamp, and Karl Brunner — Universität Würzburg

We have fabricated n-doped ZnSe layers on n-GaAs(001) wafers by molecular beam epitaxy with different conditions employed at the II-VI growth start. The samples have been studied by RHEED, HRXRD, defect etching, temperature dependent I-V measurements through the n-ZnSe/n-GaAs interface and electrochemical C-V profiling. It is found that controlled deposition of selenium in the fractional monolayer range reduces the conduction band offset at the heterointerface from 470meV (Zn-rich interface) down to 65meV, while at the same time improving the structural quality of the layers. Such structures with low offset could be employed for efficient spin injection from ZnSe based dilute magnetic semiconductors into GaAs.

HL 51.58 Thu 16:30 Poster D

Investigation and analysis of ZnS substrates — •Oliver Graw[1], Stefan Lautschläger[1], Joachim Sann[1], Niklas Volbers[1], Swen Graubner[1], Andreas Laufer[1], Dietrich Schwabe[1], Bruno K. Meyer[1], Jürgen Bläsing[2] und Alois Krost[2] — [1]I. Physics Institute, Justus-Liebig-University, Giessen, Germany — [2]Institut for Experimental Physics, Otto-von-Guericke University, Magdeburg, Germany

ZnS with its direct bandgap of 3.6 eV at room temperature and its cubic crystal structure is an suitable candidate material for optoelectronic devices in the UV region. It has some advantages compared to its direct opponents ZnO and GaN for example its lack of crystal field or piezo electricity. We investigated commercially available ZnS single crystals, obtained from different suppliers, regarding to structural quality, photoluminescence, impurity content and electric properties. Comparisons with single crystals grown in our institute have been undertaken.

HL 51.59 Thu 16:30 Poster D

Donor doping of ZnO with group VII elements — •Melanie Pinnisch[1], Joachim Sann[1], Niklas Volbers[1], Andreas Laufer[1], Sebastian Zöller[1], Stefan Lautenschläger[1], Kay Potzger[2], and Bruno K. Meyer[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Heinrich-Buff-Ring 16, 35392 Gießen, Germany — [2]Institute of Ion Beam Physics and Materials Research, Forschungszentrum Rossendorf, P.O. Box 51 01 19, 01314 Dresden, Germany

In order to produce ZnO-based devices not only p-type doping, but also controlled n-type doping is essential. For the group VII elements F, Cl, Br, I substituting O neither their donor levels nor their influence on photoluminescence spectra have been intensely studied. In this work we doped ZnO single crystals with F, Cl, Br or I by diffusion through the surface and by ion implantation with fluences of about 10^{14} ions/cm^2. The samples have been investigated by Secondary Ion Mass Spectroscopy to verify the dopant incorporation. Low temperature high resolution photoluminescence measurements have been performed to identify the respective donor bound exciton recombination. We will make a correlation between doping and PL-recombinations.

HL 51.60 Thu 16:30 Poster D

Determination of charge state in Co- and Mn-doped ZnO films — •Daniel Markó[1], Kay Potzger[1], Karsten Küpper[1], Qingyu Xu[1], Shengqiang Zhou[1], Heidemarie Schmidt[1], Jürgen Fassbender[1], Michael Lorenz[2], Elke Arenholz[3], and Jonathan D. Denlinger[3] — [1]Forschungszentrum Dresden-Rossendorf e.V., Institut für Ionenstrahlphysik und Materialforschung, Bautzner Land-

str. 128, D-01328 Dresden, Germany — [2]Universität Leipzig, Institut für Experimentelle Physik II, Abteilung Halbleiterphysik, PO Box 100920, D-04009 Leipzig, Germany — [3]Advanced Light Source, Lawrence Berkeley National Laboratory, 1 Cyclotron Road, Berkeley, CA 94720, USA

We have investigated Co- and Mn-alloyed ZnO films grown by pulsed laser deposition (PLD) on a-plane sapphire substrates. X-ray absorption spectroscopy (XAS) and X-ray magnetic circular dichroism (XMCD) measurements have been performed at beamline 8.0.1 and beamline 6.3.1 at the Advanced Light Source in Berkeley, USA. From XAS spectra, recorded in both total electron yield and total fluorescence yield mode, the valence states of Mn and Co have been determined. No ferromagnetic properties have been observed by means of XMCD at 20 K at the $L_{2,3}$-absorption edges of Mn and Co, respectively. This observation agrees with the purely paramagnetic response of those Co- and Mn-alloyed ZnO films from SQUID magnetometry and Hall effect measurements.

HL 51.61 Thu 16:30 Poster D

Characterization of $Mg_xZn_{1-x}O$-layers grown by plasma assisted molecular beam epitaxy — •Bernhard Laumer, Thomas A. Wassner, Stefan Maier, Jochen Bruckbauer, Martin Stutzmann, and Martin Eickhoff — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany

In order to reduce the large lattice mismatch, an optimized MgO-ZnO double buffer structure was employed to grow $Mg_xZn_{1-x}O$ layers on (0001)-sapphire by plasma assisted molecular beam epitaxy. The Mg concentration x was varied between 0 and 0.3. Structural analysis was carried out by high resolution X-ray diffraction (HRXRD) to extract the lattice parameters as well as the density of edge- and screw-type dislocations as a function of the Mg-content. The c-lattice parameter was found to decrease with increasing Mg content, whereas the a-lattice parameter remained constant. The influence of Mg-incorporation on the optical properties was investigated by temperature-dependent photoluminescence and absorption spectroscopy. With increasing Mg content effects due to disorder introduced by the Mg incorporation like a pronounced Stokes-shift and alloy broadening were observed. The background charge carrier concentration as determined by Hall measurements decreased with increasing Mg incorporation from $5 \cdot 10^{18}$ to $7 \cdot 10^{17}$ cm^{-3}.

HL 51.62 Thu 16:30 Poster D

Comparison of the crystalline and optical properties of VLS- and VS-grown ZnO nanopillars — •Anton Reiser, Vahid Raeesi, Dalia Omar Zayan, Günther M. Prinz, Martin Schirra, Martin Feneberg, Klaus Thonke, and Rolf Sauer — Institut für Halbleiterphysik, Universität Ulm, D-89069 Ulm

Zinc oxide (ZnO) nanostructures were grown by two different methods, and their crystalline and luminescence properties are compared. In one series of experiments the vapor-liquid-solid (VLS) carbo-thermal mechanism was used to grow ZnO nanowires with gold particles acting as catalyst. In another series, a uniform basic zinc acetate (BZA)/ZnO nanocrystalline seed-layer was used as a template for the vapor-solid (VS) growth of the ZnO nanowires. In the first case, we observe real VLS and VLS-initiated growth of well-aligned ZnO nanowire arrays, where real VLS growth is defined by Zn-Au alloy droplets sitting directly on top of the wires. The related photoluminescence (PL) spectra show near-band edge features as typical for bulk ZnO. Line widths of below 0.7 meV for the donor-bound exciton transitions stand for good crystal quality. In the second case, we also observe well-aligned ZnO nanowire arrays, however with line widths down to 250 μeV.

HL 51.63 Thu 16:30 Poster D

Arsenic-doping of ZnO — Niklas Volbers[1], Stefan Lautenschläger[1], •Thomas Leichtweiss[1], Andreas Laufer[1], Swen Graubner[1], Bruno K. Meyer[1], Kay Potzger[2], and Shengqiang Zhou[2] — [1]1. Physics Institute, Justus-Liebig University Giessen, Heinrich-Buff-Ring 16, 35392 Giessen, Germany — [2]Institute for Ion Beam Physics and Materials Research, Forschungszentrum Dresden-Rossendorf, PO Box 51 01 19, D-01314 Dresden, Germany

Arsenic is considered a potential candidate for p-type doping of zinc oxide (ZnO). Most of the publications on this topic discuss the electrical or optical properties. However, it is not always clear whether the formation of secondary phases, e.g. arsenic oxide clusters, might be the source for the observed effects.

To gain further insight into this topic, we have studied the incorporation of arsenic into zinc oxide using two different approaches.

The first series of samples consisted of zinc oxide single crystals implanted with ^{75}As ions with high doses of $10^{16}cm^{-2}$ at an energy of 200 keV. We have investigated the influence of annealing using Rutherford backscattering in channeling geometry (RBS/C), secondary ion mass spectrometry (SIMS), X-ray diffraction (XRD) and X-ray photospectroscopy (XPS). The results discuss the diffusion of the arsenic and of the impurities and the formation of secondary phases.

The second series of samples was grown using chemical vapour deposition (CVD), as this method can provide defect-free films of high crystalline quality. The samples were analysed regarding their homogenity and composition.

HL 51.64 Thu 16:30 Poster D

Structure, phase stability, and gaps of wurtzite MgZnO and CdZnO alloys — •Matthias Eisenacher[1], André Schleife[1], Lara Kühl Teles[2], Jürgen Furthmüller[1], and Friedhelm Bechstedt[1] — [1]Institut für Festkörpertheorie und -optik, Friedrich-Schiller-Universität and European Theoretical Spectroscopy Facility (ETSF), Max-Wien-Platz 1, 07743 Jena, Germany — [2]Departamento de Física, Instituto Tecnológico de Aeronáutica, Comando-Geral de Tecnologia Aeroespacial, 12228-900 São José dos Campos, SP, Brazil

Recently II-VI compounds became more and more important as materials with potential applications in optoelectronic devices. For pseudomorphic heterostructures it is highly desirable to adjust the material properties carefully. Alloys allow to tailor a certain material property. Also from a theoretical point of view the investigation of mixed crystals is a challenge.

We apply density functional theory and the generalized quasichemical approximation together with a cluster approximation to study MgZnO and CdZnO alloys in the wurtzite structure. The combination of these *ab initio* approaches enables us to study the thermodynamics of these systems as well as the structural and electronic properties with varying composition. We construct phase diagrams versus composition and temperature and calculate bond lengths as well as gap-bowing parameters for the two alloys versus average composition.

HL 51.65 Thu 16:30 Poster D

Optimization of PLD grown ZnO thin films using in-situ RHEED — •Alexander Hirsch, Christian Wille, Frank Ludwig, and Meinhard Schilling — TU Braunschweig, Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, Hans-Sommer-Straße 66, D-38106 Braunschweig, Germany

Due to its wide and direct band gap ZnO is an interesting semiconducting material. For application in combination with other oxides a smooth surface is indispensible. In-situ reflection high energy electron diffraction (RHEED) is a powerful tool for optimizing thin film quality.

The ZnO thin films were grown using pulsed laser deposition (PLD) technique. All targets were prepared by standard ceramics synthesis. As substrates Al_2O_3 in (0001) orientation was used. To obtain atomically flat sapphire surfaces an annealing treatment was applied. The epitaxial growth of the films is investigated by in-situ RHEED supplemented by X-ray diffraction and atomic force microscopy.

The dependence of the PLD parameters on the growth conditions is analyzed. To investigate the influence of the temperature, five thin films at deposition temperatures between 110 °C and 820 °C were prepared and analyzed. Deposition temperatures of 300 °C and 820 °C lead to high quality crystalline films with rms roughnesses of approx. 1 nm. Besides, the impact of Al doping on the structural film quality was investigated at a deposition temperature of 300 °C. Four thin films with Al concentrations between 0 % and 2 % were grown under equal conditions. In addition, using in-situ RHEED characterization, the effect of interval deposition on the thin film quality was analyzed.