HL 46: Poster 2

Time: Thursday 15:00–17:30 Location: Poster A

HL 46.1 Thu 15:00 Poster A

Studies of diamond surfaces and metallization for detector applications — •Robert Lovrincic[1], Eleni Berdermann[2], Michal Pomorski[2], and Annemarie Pucci[1] — [1]Kirchhoff-Institut für Physik der Universität Heidelberg — [2]Gesellschaft für Schwerionenforschung Darmstadt

Diamond single crystals have several very favourable characteristics as detector material in high- and low-energy physics experiments. The diamond surface termination and reconstruction play a key role in the device performance. E.g., hydrogen termination gives rise to surface p-conductivity, which is undesirable for detector applications. The surface reconstruction influences the electron affinity and hence the Schottky barrier height of a metal-diamond interface. These properties were studied by means of Fourier transform infrared (FTIR) spectroscopy and low-energy electron diffraction. Another decisive step towards good detector performance is the metallization. Plenty, partially contradictory proposals for the fabrication of electrodes on diamond are published. In the case of diamond detectors however, Chromium-Gold, Titanium-Platinum-Gold and pure Aluminium electrodes are frequently applied. We studied* therefore, chromium film growth on diamond (100) single crystal surfaces by FTIR spectroscopy under ultra high vacuum conditions. This enables us to derive the electrical conductivity of the metal film and of the metal film-diamond interface in a non-destructive, non-contact way.

*Supported by EC Integrated Infrastructure Initiative Hadron Physics, Project RII3-CT-2004-506078

HL 46.2 Thu 15:00 Poster A

Pulsed laser deposition growth and characterisation of aligned graphitic nanostructures on LiNbO3 — •Dominikus Kölbl, Jens Ebbecke, and Achim Wixforth — Universität Augsburg, Universitätstr. 1, 86159 Augsburg

Low dimensional electronic structures attract high interest both for scientific research and possible applications in electrochemical devices and ICs.

We report on aligned structures of graphite growing along certain crystal directions of LiNbO3 by pulsed laser deposition. Scanning electron microscopy analysis showed strong alignment during growth of theses “carbon nano sticks” (CNS) due to pyroelectric fields induced by thermal gradients across the substrate. These CNS reaching aspect-ratios up to 65 (L = 5,7um; d = 88nm) are appropriate onedimensional electronic systems similar to famous carbon nano tubes. We investigated detailed characterization of these CNS grown at different PLD parameters. Furthermore the CNS have been contacted by e-beam lithography in order to perform electrically conduction measurements.

HL 46.3 Thu 15:00 Poster A

Infrared spectroscopy on rotor-stator compounds C_{60}-C_8H_8 and C_{70}-C_8H_8 under pressure — •K. Thirunavukkuarasu[1], C.A. Kuntscher[1], Gy. Bényei[2], I. Jalsovszky[2], G. Klupp[3], K. Kamarás[3], É Kováts[3], and S. Pekker[3] — [1]Experimentalphysik II, Universität Augsburg, D-86159 Augsburg, Germany — [2]Department of Organic Chemistry, Eötvös Loránd University, P.O.Box 32, Budapest, Hungary H 1518 — [3]Research Institute for Solid State Physics and Optics, Hungarian Academy of Sciences, P.O.Box 49, Budapest, Hungary H 1525

The fullerene-cubane molecular crystals C_{60}-C_8H_8 and C_{70}-C_8H_8 are the first members of the rotor-stator crystal family [1]. Static C_8H_8 molecules occupy the octahedral voids of the fullerene fcc structure and act as bearings for the rotating fullerene molecules. On cooling, C_{60}-C_8H_8 undergoes an orientational ordering phase transition at 140 K, while C_{70}-C_8H_8 undergoes transitions at around 390 K and 150 K. Under pressure C_{60}-C_8H_8 shows orientational ordering at 0.8 GPa [2]. We performed further pressure-dependent transmittance measurements on both C_{60}-C_8H_8 and C_{70}-C_8H_8 molecular crystals over a broad frequency range (FIR-VIS), for pressures up to 10 GPa. The pressure-induced changes in the vibrational modes of the fullerene and cubane molecules and the shift of the band gap are reported.

Supported by the DFG.

[1] S. Pekker et al., Nature Materials **4**, 764 (2005).

[2] C. A. Kuntscher et al., Phys. Stat. Sol. (b) **243**, 2981 (2006).

HL 46.4 Thu 15:00 Poster A

Transport Measurements through Graphene — •P. Barthold, T. Lüdtke, and R.J. Haug — Institut für Festkörperphysik, Abteilung Nanostrukturen, Gottfried Wilhelm Leibniz Universität Hannover, D-30167 Hannover

We present transport measurements through graphene in dependence of magnetic field and temperature.

We obtained graphene by micromechanical cleavage of natural graphite similar to the technique described in Ref.[1]. An optical microscope and a SEM were used to localize the graphene layers that are deposited on top of SiO_2. These flakes were further investigated with an AFM to select suitable samples and determine their height. By using electron beam lithography we are able to contact the samples. During the measurements the device is situated in a He^4 bath cryostat allowing measurements at temperatures between 1.4 K and 300 K. By varying the magnetic field we characterize the sample. As we apply a backgate voltage we see a peak in the resistivity that we contribute to a field effect.

[1] K. S. Novoselov et al., Proc. Natl. Acad. Sci. USA, vol. 102, p.10451 (2005)

HL 46.5 Thu 15:00 Poster A

High purity single step catalyst particle preparation for the carbon nanotube synthesis — •Franziska Schäffel, Christian Kramberger, Mark Rümmeli, Daniel Grimm, Thomas Gemming, Thomas Pichler, Bernd Büchner, Bernd Rellinghaus, and Ludwig Schultz — IFW Dresden, P.O. Box 270116, D-01171 Dresden, Germany

Many applications of carbon nanotubes (CNTs) are impeded by a lack of control in positioning and orienting CNTs on substrates. Advances have been made by using catalyst thin films prepared and patterned by shadow masking [1] or lithography [2]. Yet, such thin film techniques do not offer concurrent control of the size, size distribution, and areal density of the catalyst particles. We present a versatile route to prepare individual nanoparticles in the gas phase by sputtering from a high purity iron target. The route is advantageous in that the preparation of the catalyst particles is accomplished in a single step. The achievable degree of purity is very high as compared to processes where the catalyst preparation requires a series of chemical procedures (see, e.g., [3]). The separate preparation of catalyst and CNTs allows for an effective control of the particle size and density and offers the opportunity to characterize the starting material which cannot be so readily achieved in more conventional CVD processes where the catalyst particles form *in situ*. [1] L. Delzeit et al., J. Phys. Chem. B 106 (2002) 5629. [2] J. Kong et al., Nature 395 (1998) 878; A.J. Hart et al., J. Phys. Chem. B 110 (2006) 8250; M.S. Kabir et al., Nanotechnology 17 (2006) 790. [3] R.D. Bennett et al., Adv. Mater. 18 (2006) 2274.

HL 46.6 Thu 15:00 Poster A

Phosphorus-doped silicon under uniaxial tensile strain — •Nicole Santen and Reiner Vianden — HISKP Universität Bonn, Nußallee 14-16, D-53115 Bonn

The recent application of strained silicon into transistor design has led to significant progress in increasing the performance of devices. However, up to now, little is known about the mechanical behaviour of the strained Si layers and the elastic properties of the deformed semiconductor lattice. The perturbed angular correlation method is ideally suited to study strain related local phenomena in silicon using the acceptor ^{111}In as probe.

In the past, the influence of external uniaxial strain on In acceptors in pure Si and on donor-acceptor pairs in silicon has been investigated intensively. In the course of these studies it was found that the unpaired indium probes on regular lattice sites showed an unexpected reaction to uniaxial strain, which depended on the dopant species. In our current experiments, a strain induced EFG in P-doped silicon has been observed for the first time. In addition, it was found that the reaction of the P-doped silicon lattice to tensile strain applied along different crystal axes showed strong differences.

HL 46.7 Thu 15:00 Poster A

Photo-electric properties of 4H- and 6H-SiC investigated by resonant SCW excitation — •Burkhard Hilling[1], Michaela

Lemmer[1], Mirco Imlau[1], Manfred Wöhlecke[1], and Mikhail Petrov[2] — [1]Department of Physics, University of Osnabrück, Germany — [2]Ioffe Physico-Technical Institute, St. Peterburg, Russia

Polytypes of 4H- and 6H-SiC have been investigated with the nonlinear phenomenon of resonant space-charge wave (SCW) excitation at a wavelength of $\lambda = 488$ nm. SCW are eigenmodes of spatial-temporal oscillations of a space-charge density appearing in semi-insulating semiconductors in an external electric field. SCW excitation was performed with an oscillating interference pattern with a frequency of $10 \leq \Omega \leq 3000$ Hz and an externally applied electric field E_0 up to 9 kV/cm. Resonant excitation was found if Ω equals the eigenfrequency of the generated SCW mode. Both amplitude and frequency of the resonance depend primarily on the applied electric field E_0 and the spatial frequency K of the interference pattern. We show that the experimentally obtained dependences on K, E_0 and Ω are in good agreement with the theoretical concept for so-called low-frequency SCW (trap recharging waves). This enables us to determine important material properties from the analysis for both SiC polytypes. These are the effective trap density N_{eff}, the product of mobility and lifetime $\mu\tau$ of the photo-excited charge carriers, and the maxwell relaxation time τ_M. Strengths and disadvantages of SCW excitation for purposes of semiconductor analysis are discussed.
Supported by the DFG (projects GRK 695 and 436 RUS 17/15/07)

HL 46.8 Thu 15:00 Poster A

Influence of anisotropic in-plane strain on the optical properties of (0001)-oriented GaN and ZnO films — •Marcus Röppischer[1], Carsten Buchheim[1], Rüdiger Goldhahn[1], Gerhard Gobsch[1], Florian Furtmayr[2], Thomas Wassner[2], and Martin Eickhoff[2] — [1]Technical University Ilmenau, Institute of Physics — [2]Technical University Munich, Walter-Schottky Institute

The growth of hexagonal (0001)-oriented GaN films on a-plane sapphire substrates causes an anisotropic in-plane strain. It originates from the different lattice constants and thermal expansion coefficients of the substrate parallel and perpendicular to the c-axis. Under those conditions the optical response of the GaN films depends on the light polarization within the surface plane. We have applied photoreflectance spectroscopy in order to study the polarization dependence of the oscillator strength for the free A and B excitonic transitions. The experimental results are in good agreement with theoretical calculations based on the Bir-Pikus strain Hamiltonian and the experimentally determined lattice constants. Corresponding investigations of ZnO films reveal a much lower polarization anisotropy.

HL 46.9 Thu 15:00 Poster A

PL characteristics of site-controlled InGaN nanostructures — •Theodoros Tsifotidis, Michael Jetter, and Peter Michler — Institut für Strahlenphysik, Universität Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

InGaN emits in dependence on the Indium concentration light in the blue-green spectral range. The tendency for developing structures in the Stranski-Krastanov growth mode to realise QDs in this material system is quite weak. One possible solution can be a selective growth of GaN/InGaN nanostructures by MOVPE. To realise this a new masking method was applied by using small sized microspheres to produce a capable aperture mask. SEM measurements confirmed hexagonal grown micropyramids at the selected positions. CL measurements on them showed low emission energies in the region of their edges and dots caused by different Indium compositions on the surface. By varying the growth parameters one can influence the Indium distribution on the various surfaces. To deduce capable growth parameters we examined several samples fabricated with varied Indium flow, growth time and growth temperature. Time-integrated and time-resolved ensemble- and *-PL measurements were performed. Additionaly temperature and excitation power dependent experiments were done. This gave us informations about charge carrier dynamics and subsequent the dynamics of Indium composition during the growth process.

HL 46.10 Thu 15:00 Poster A

Characterisation of deep defects in undoped GaN layers with PICTS — •Carsten Baer, Hartmut Witte, Andre Krtschil, Armin Dadgar, and Alois Krost — Institut für Experimentelle Physik, Abteilung Halbleiterepitaxie, Otto-von-Guericke-Universität Magdeburg, 39016 Magdeburg

Undoped semiinsulating GaN layers are already commercially used in FET devices. The device performance of these FETs is strongly influenced by active deep defects which change essential parameters such as cut-off frequency, break down voltage, or temperature dependent behavior of the output characteristics.

In this contribution we describe in detail thermal emissions of deep defects and their dependence on excitation conditions in different highly resistive GaN layers analyzed by Photo-Induced Current Transient Spectroscopy (PICTS). All samples were grown by metal-organic vapor phase epitaxy on silicon or sapphire substrates.

All emission spectra below 300 K were influenced by different excitation wavelengths and intensities. The peak shift of some defects in the calculated spectra is found to be controlled by excitation parameters such as filling rate of the traps, the thermal capture rates, or the life times of the carriers, sometimes resulting in relatively high activation energies. Furthermore, we observe quenching behavior of traps induced by additional illumination with intrinsic light of 690nm. The PICTS spectra are compared with reference results from TSC and nano-DLTS measurements performed at the same samples.

HL 46.11 Thu 15:00 Poster A

Infrared Ellipsometry of cubic and hexagonal InN — •Christian Napierala[1], Pascal Schley[1], Rüdiger Goldhahn[1], Gerhard Gobsch[1], Jörg Schörmann[2], Donat J. As[2], Klaus Lischka[2], Martin Feneberg[3], and Klaus Thonke[3] — [1]Institut für Physik, TU Ilmenau — [2]Department Physics, Universität Paderborn — [3]Institut für Halbleiterphysik, Universität Ulm

Recent experimental studies revealed for both, hexagonal and cubic InN, a band gap below 0.7 eV. Despite the progress in growth, the epitaxial layers suffer from the still high electron density. Under those conditions, the non-parabolicity of the conduction band becomes important when the absorption properties around the gap are discussed or the plasmon excitations in the phonon range are analysed. Using ellipsometry and reflectance measurements we have determined the dielectric function (DF) of the InN polytypes for the two spectral regions. Compared to previous studies a refined analysis of the DF shape is presented. In particular we show how the non-parabolicity influences the plasma frequency and thus the phonon-plasmon coupling. It is demonstrated in addition that the high-frequency dielectric constant is in fact not constant, but depends on the carrier-induced Burstein-Moss shift of the absorption edge.

HL 46.12 Thu 15:00 Poster A

Untersuchungen zur Temperaturstabilität von InGaN/GaN-Quantenfilmen mit hohem Indiumgehalt — •Holger Jönen, Daniel Fuhrmann, Lars Hoffmann, Heiko Bremers, Carsten Netzel, Uwe Rossow und Andreas Hangleiter — Institut für Angewandte Physik, TU Braunschweig

Beim Wachstum von InGaN/GaN-Quantenfilmstrukturen werden die InGaN-QWs während des nachfolgenden GaN-Wachstums hohen Temperaturen ausgesetzt. Insbesondere bei Proben mit hohem Indiumgehalt ($x_{In} \approx 30\%$) ist dadurch eine Verschlechterung der optischen Eigenschaften zu befürchten. Zur Überprüfung der thermischen Stabilität von InGaN-QWs mit unterschiedlichem In-Gehalt ($10\% \leq x_{In} \leq 35\%$) haben wir einerseits die Wachstumstemperatur der GaN-Deckschicht T_{cap} variiert und zudem die Proben nach dem Wachstum getempert. Die von uns untersuchten Proben werden mittels Niederdruck-MOVPE gewachsen und mit Hilfe von XRD, TEM und AFM charakterisiert. Zur Messung der optischen Eigenschaften und zur Bestimmung der IQE benutzen wir temperatur- und leistungssabhängige PL. Bei den PL-Messungen zeigen die Proben nach dem Tempern eine Abnahme der Intensität, die abhängig ist von der Probenstruktur (x_{In}, T_{cap}) sowie von der Temperatur und der Dauer des Heizvorgangs. Einige Proben weisen darüber hinaus eine Blauverschiebung der Peaklage auf. Eine solche Blauverschiebung sowie eine Abnahme der Oszillatorstärke erhält man auch durch Modellrechnungen, unter der Annahme, dass Indium aus dem QW ins umliegende Material diffundiert und die Grenzflächen aufweichen.

HL 46.13 Thu 15:00 Poster A

Einfluss der Wachstumsbedingungen auf die strukturelle Qualität von AlGaN-Schichten — •Lars Hoffmann, Daniel Fuhrmann, Heiko Bremers, Uwe Rossow und Andreas Hangleiter — TU Braunschweig, Inst. f. Angewandte Physik

Die Effizienz UV-emittierender GaN/AlGaN QWs hängt entscheidend von der Qualität der AlGaN-Pufferschicht ab. In dieser Arbeit werden der Einfluss der Wachstumsbedingungen auf die strukturelle Qualität von AlGaN-Schichten und Wege zur Optimierung aufgezeigt. Dazu wurden mittels MOVPE AlGaN-Schichten auf Saphir-

Substrat gewachsen. Es wurden die Wachstumsbedingungen einer AlN-Nukleationsschicht variiert und anschließend, bei optimierter AlN-Nukleation, die Wachstumsbedingungen des AlGaNs variiert. Diese Schichten werden dann mittels XRD, TEM, PL und AFM untersucht und es werden Rückschlüsse auf die Qualität der Schichten, ihre Defektdichten, ihre Grenz- und Oberflächen und ihren Verspannungsgrad gezogen. Insbesondere wird herausgestellt, dass der Al-Gehalt (x_{Al}) der AlGaN-Schicht entscheidend von der Wachstumstemperatur abhängt und ihre Qualität mit ihr korrelliert. Es zeigt sich, dass bei gleichbleibenden Wachstumsbedingungen, aber bei tieferer Temperatur gewachsene AlGaN-Schichten, der x_{Al} erhöht ist ($-200°C$: $+5\%$ x_{Al}) und sich die Rocking-Breiten der AlGaN-Schichten mit zunehmendem x_{Al} vergrößert. Ferner lässt sich feststellen, dass die AlGaN-Schichten mit H_2 als Trägergas tendenziell schmalere Rocking-Breiten als die mit N_2 aufweisen. Allerdings zeigen die N_2 Schichten unter dem AFM glattere Oberlächen.

HL 46.14 Thu 15:00 Poster A

Gd- and Eu-implanted GaN — •Fang-Yuh Lo[1], Andreas Ney[2], Alexander Melnikov[1], Dirk Reuter[1], Andreas D. Wieck[1], Stefan Potthast[3], Klaus Lischka[3], Sebastián Pezzagna[4], and Jean-Yves Duboz[4] — [1]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstr. 150, D-44780 Bochum — [2]Experimentalphysik, Universität Duisburg-Essen, Lotharstr. 1, D-47057 Duisburg — [3]Optoelektronischer Halbleiter, Universität Paderborn, Warburger Straße 100, D-33098 Paderborn — [4]Centre de Recherche sur l'Hétéro-Epitaxie et ses Application, CNRS, Sophia Antipolis, F-06560 Valbonne

GaN is a wide band gap semiconductor, which has vast applications in optoelectronics. Recently, GaN-based diluted magnetic semiconductors have attracted great interest because theoretical work predicted Curie temperatures above 300K. Experimentally, the realization has been different. Very recently, it has been reported that Gd-doped wurzite GaN is ferromagnetic at room temperature. This is independent if the Gd is incorporated during molecular beam epitaxy or implanted afterwards. We will present studies on Gd-implanted wurzite and cubic GaN as well as GaN-based heterostructures. We find that the magnetic properties are better for wurzite GaN. In addition, we have also implanted Eu into wurzite GaN and studied the magnetic properties.

HL 46.15 Thu 15:00 Poster A

Analysis of the Current-Voltage Characteristics and Electroluminescense of GaN-based Light Emitting Diodes — •T. Kolbe[1], J.-R. v. Look[1], M. Kneissl[1,2], A. Knauer[2], V. Hoffmann[2], S. Einfeldt[2], and M. Weyers[2] — [1]TU Berlin, Institute of Solid State Physics, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Ferdindand-Braun-Institut für Höchstfrequenztechnik, Gustav-Kirchhoff-Str. 4, 12489 Berlin, Germany

Light Emitting Diodes (LEDs) based on III-nitride semiconductors have attracted great interest in recent years. One of the key challenges in making high brightness blue-violet LEDs is efficient current injection into the active regions of GaN-based p-n junctions. Carrier confinement, series resistance of the p-doped layers, as well as ohmic metal contacts, are particularly problematic in these materials. In this work we present an analysis of the current-voltage characteristics and electroluminescense (EL) of different GaN-based heterostructures in order to optimize current-injection and LED efficiencies. The devices in our investigation were grown by MOVPE on (0001) sapphire substrates. EL measurements are carried out to determine electrical and optical properties which are used as a feedback for the optimisation of the epitaxial growth process. By measuring the forward and reverse bias current-voltage characteristics, leakage currents, diode series resistance and ideality factors can be determined. This allows us to explore the correlation between these parameters and the heterostructure design, e.g. GaN pn-homojunctions and InGaN multiple quantum well (MQW) heterostructures with and without a p-AlGaN electron blocking layers.

HL 46.16 Thu 15:00 Poster A

Near field measurements on 405 nm GaN laser diodes with different ridge widths — •Dominik Scholz[1], Harald Braun[1], Ulrich T. Schwarz[1], Christian Rumbolz[2], Stefanie Brüninghoff[2], Alfred Lell[2], and Uwe Strauss[2] — [1]Naturwissenschaftliche Fakultät II - Physik, Universität Regensburg — [2]Osram Opto Semiconductors GmbH, Leibnizstr.2, 93055 Regensburg

We examine the waveguide mode dynamics of blue (405 nm) gallium nitride (GaN) based laser diodes with different ridge widths from 2 μm to 10 μm. We are able to do time resolved measurements of laser pulses and their dynamics in the near field and in the far field. Therefore we use a self-built scanning near field optical microscope (SNOM). The distance between tip and sample surface is controlled by a servo loop via damping of the resonance curve of a tuning fork attached to the tip. We get a distance of about 50 nm and a lateral resolution of 100 nm which is limited by the optical aperture of the tip. This resolution, in combination with time resolved measuring is good enough to measure the time evolution of laser pulses. We examine the dynamics of lateral modes, filamentation effects and beam steering. Depending on various ridge widths and different current densities we examine mode dynamics and the occurring filamentation effects. Beam steering can be observed in measurements from near field towards the far field.

HL 46.17 Thu 15:00 Poster A

Gain measurements of 405 nm (In, Al)GaN laser diodes using the Hakki-Paoli Method — •Tobias Meyer[1], Harald Braun[1], Ulrich T. Schwarz[1], Marc Schillgalies[2], Christoph Eichler[2], Stephan Lutgen[2], and Uwe Strauss[2] — [1]Naturwissenschaftliche Fakultät II - Physik, Universität Regensburg — [2]Osram Opto Semiconductors GmbH, Leibnizstr. 2, 93055 Regensburg

We use a high spectral resolution setup to measure the electroluminescence (EL) spectra of 405 nm (In, Al)GaN quantum well laser diodes. The Hakki-Paoli method is employed to estimate the optical gain spectrum by analyzing the modulation of the Fabry-Perot modes of the laser resonator below lasing threshold. To obtain the internal loss of the waveguide, the gain spectrum is evaluated at energies below peak gain. We use a theoretical model to simulate the gain spectrum, using the homogeneous and inhomogeneous broadening as fitting parameters. By measuring EL spectra for different carrier densities, we get the differential gain, and the shift of the longitudinal modes leads to the carrier-induced change of the refractive index. We use these parameters to calculate the antiguiding factor. Furthermore, the high spectral resolution allows us to study the mode spectrum evolution at and above the threshold. In addition, we compare our results for diodes with different composition and structure.

HL 46.18 Thu 15:00 Poster A

Study of normal mode coupling in vertical-cavity surface-emitting laser structures by modulation spectroscopy — •Björn Metzger[1], Peter Klar[2], and Wolfram Heimbrodt[1] — [1]Department of Physics and Material Sciences Center, Philipps-University of Marburg, Germany — [2]Physics Institute, Justus-Liebig-University of Giessen, Germany

Modulation spectroscopic methods are particularly suitable for characterizing vertical-cavity surface-emitting laser (VCSEL) structures. Many VCSEL structures studied so far show only a weak coupling between the cavity mode and the lowest quantum well exciton in the active region. The spectral line shapes of the corresponding $\Delta R/R$ signals in and off resonance are well understood. However, there are less reports about modulation spectroscopic studies of VCSEL structures with normal mode coupling in the vicinity of resonance and in the strong coupling regime. Here we present contactless electroreflectance (CER) results in the vicinity of resonance on a VCSEL structure with 12 strain-compensated (Ga,In)As/Ga(P,As) quantum wells in the active region of a 2 λ-cavity exhibiting normal mode coupling. The cavity detuning was varied by changing the sample temperature. The CER spectra obtained will be discussed and analyzed in the framework of model calculations and will be compared to those measured on VCSELs in the weak coupling regime.

HL 46.19 Thu 15:00 Poster A

Energy transfer between N-related localized states in $GaP_{1-x}N_x$ — •Tobias Niebling[1], Wolfram Heimbrodt[1], Bernardette Kunnert[1], Kerstin Volz[1], Wolfgang Stolz[1], Peter Jens Klar[2], and John Franz Geisz[3] — [1]Fachbereich Physik und Wissenschaftliches Zentrum für Materialwissenschaften, Philipps-Universität, Renthof 5, D-35032 Marburg, Germany — [2]I. Physikalisches Institut, Justus-Liebig-Universität, Heinrich-Buff-Ring 16, D-35392 Gießen, Germany — [3]National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, Colorado 80401, USA

Time-resolved photoluminescence results of a series of $GaP_{1-x}N_x$ samples with x up to 0.02 will be presented. The temperature dependence, the concentration dependence as well as the temporal behavior indicate that the photoluminescence is dominated by excitation transfer processes between the various localized N-related states, such as the

isolated N-impurity, various N-pair states and higher N-clusters. The excitation transfer processes in conjunction with the concentration-dependent statistics of the various N-related states alone are sufficient to explain the observed red-shift of the luminescence of $GaP_{1-x}N_x$ with increasing x as well as the spectral dependence of the PL decay times. However, this implies that the photoluminescence data alone do not give any conclusive evidence that a transformation from an indirect to a direct-gap semiconductor takes place in Ga(N,P) with increasing N up to 2% as often stated.

HL 46.20 Thu 15:00 Poster A

PAC Untersuchungen mit Seltenen Erden Sonden in Halbleitern mit großer Bandlücke — •Ronan Nedelec[1], Reiner Vianden[1] und ISOLDE Kollaboration[2] — [1]HISKP Universität Bonn, Nußallee 14-16, D-53115 Bonn — [2]ISOLDE, CERN, Schweiz

Die Bedeutung der Gruppe III-Nitride und anderer Halbleiter mit großer Bandlücke wie ZnO in der Forschung wie in der Anwendung hat in den letzten Jahren stetig zugenommen. Dabei geht es vorrangig um die Herstellung von Material, das für die Optoelektronik bei kurzen Wellenlängen geeignet ist. Durch die große Bandlücke sind auch Hochtemperaturanwendungen denkbar. In Verbindung mit Seltenen Erden können Lumineszenzeffekte beobachtet werden, die das gesamte sichtbare Spektrum abdecken. Das flexibelste Herstellungsverfahren für solche Komponenten ist die Ionenimplantation, durch die allerdings Gitterschäden enstehen. Diese müssen zunächst durch eine geeignete Behandlung der Proben beseitigt werden. Die PAC Methode ist ins besondere zur Untersuchung von Fragestellungen in Bezug auf Gitterdefekte sehr gut geeignet. Wir untersuchen die Materialien GaN und ZnO mit dem Sondenkern ^{172}Lu(^{172}Yb) auf ihr Ausheilverhalten, sowie auf das temperaturabhängige Verhalten des elektrischen Feldgradienten am Kernort. Die dabei auftretenden Einflüsse der $4f$ Elektronen und des Gitterfeldgradienten werden diskutiert.

HL 46.21 Thu 15:00 Poster A

Optical Spectroscopy on Ga(N,As,P)/GaP QW structures for III-V lasers on Si substrates — •Christian Karcher[1], Gunnar Blume[1], Peter Jens Klar[2], Bernardette Kunert[1], Stefan Oberhoff[1], Kerstin Volz[1], Wolfgang Stolz[1], and Wolfram Heimbrodt[1] — [1]Dept. Physics and WZMW, Philipps-University of Marburg, Germany — [2]1. Physics Institute Justus Liebig University of Giessen, Germany

Recently lasing was achieved at 280K in GaP based laser structures employing highly strained Ga(N,As) and Ga(N,As,P) single quantum wells in between GaP barriers in the active region. The laser structures have been grown on (100) GaP substrates. This opens actually the field for achieving III-V lasers on Si substrate as the lattice-mismatch between GaP and Si is small. We studied those laser structures and related multiple quantum well structures of different well width and with varying well composition by photoluminescence, photomodulated reflectance, electroreflectance, and high-pressure experiments. The obtained spectra will be discussed and analysed in order to determine fundamental electronic properties like e.g. the band alignment as function of strain and composition. These results are essential for improving the performance of room-temperature laser structures grown on silicon.

HL 46.22 Thu 15:00 Poster A

Time-Resolved Photoluminescence of Nitrogen-Cluster States in Dilute Ga(NAs)/GaAs Heterostructures — •David Köhler[1], Kristian Hantke[1], Swantje Horst[1], Sangam Chatterjee[1], Peter J. Klar[1], Wolfgang Stolz[1], Antonio Polimeni[2], Mario Capizzi[2], and Wolfgang W. Rühle[1] — [1]Faculty of Physics and Material Sciences Center, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany — [2]CNISM and Dipartimento di Fisica, Sapienza Universitá di Roma, P. le A. Moro 5, I-00185 Roma, Italy

We measured time-resolved photoluminescence on GaN_xAs_{1-x}/GaAs epitaxial layers grown by metal-organic vapour-phase epitaxy (MOVPE). The nitrogen concentration x for the as-gown samples varied between 0.049% and 0.238%. Additionally, the effective nitrogen content of the x=0.111% sample was reduced to $0\% \leq x_{eff} \leq 0.111\%$ by post-growth hydrogenation. We find distinct PL signals at lower energies than the band-to-band transition. These are attributed to nitrogen-related cluster states formed below the Γ-like conduction-band edge. Higher nitrogen concentrations lead to a redshift of the CB towards the cluster states that are fixed in energy. Furthermore, we present a profound dependence of the PL rise-time on the transition energy. The cluster states show a very long rise time of the PL intensity whereas a fast PL rise-time is found for the band-to-band transition. Therefore, we attribute the PL features at lower energies to zero-phonon nitrogen-cluster states. This is confirmed by TRPL experiments at various temperatures and excitation densities.

HL 46.23 Thu 15:00 Poster A

Annealing of implantation defects in GaN by swift heavy ion irradiation — Anne-Katrin Nix[1], Sven Müller[1], Carsten Ronning[1], Andrey Kamarou[2], Elke Wendler[2], Werner Wesch[2], Christina Trautmann[3], and •Hans Hofsäss[1] — [1]II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Festkörperphysik, Universität Jena, Max-Wien-Platz 1, 07743 Jena, Germany — [3]Gesellschaft für Schwerionenforschung, Planckstasse 1, 64291 Darmstadt, Germany

Direct implantation of ions into semiconductors for doping allows concentration and depth modelling, but results in lattice defects. Thermal annealing is used for recrystallisation, but surface melting and dopant diffusion hampers the annealing effect. Here, we present an annealing method which can avoid these effects. During ion beam irradiation, the material is locally heated during a timespan of 10-12 seconds, surrounding material stays unaffected. The energy of the ions used for annealing should be in the MeV regime because the resulting nuclear energy loss must be low to avoid cluster formation. In addition to this it is necessary that the resulting electronic energy loss is lower than the threshold value for track formation. Mg ions with 100 keV were implanted into GaN with fluences of $3x10^{13}$ ions/cm^2 and 10^{14} ions/cm^2. These samples were irradiated with 578 MeV Cr and 140 MeV Kr, the fluences were $5x10^{11}$ ions/cm^2 and $5x10^{12}$ ions/cm^2 . Directly after implantation and after irradiation, the photoluminescence was examined at low temperature (12 K), the obtained spectra are compared to well known spectra of GaN and GaN:Mg.

HL 46.24 Thu 15:00 Poster A

Doping dependence of vacancy formation kinetics on III-V semiconductor surfaces — •Sebastian Landrock, Philipp Ebert, and Knut Urban — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich

We observed by variable-temperature STM the formation of anion and cation vacancies on GaAs and InP (110) surfaces. The formation rates of vacancies are classically described by a pre-exponential factor times the Boltzmann factor, containing the activation barrier and the temperature. The pre-exponential factor arises from vibrational excitations of the crystal lattice and is thus in the order of the Debye frequency, i.e. 10^{12} to 10^{13} Hz. We found, however, striking deviations from this expectation as well as differences between n-type GaAs and p-type GaAs/InP: On p-type GaAs and InP (110) surfaces anion vacancies exhibit pre-exponential factors in the order of 0.001 to 10 Hz (and a barrier of 0.3 to 0.5 eV), while for n-type GaAs we found a pre-exponential factor roughly 10 to 15 orders of magnitudes larger for Ga vacancies. We show that the ultra-low pre-exponential factors on p-type material arise from a rate limiting process, which is a one dimensional adatom diffusion mediating the desorption of anions as di-atom molecules. In contrast, on n-type GaAs the Ga vacancies are formed by atomic desorption.

HL 46.25 Thu 15:00 Poster A

Herstellung und Implantation von ^{172}Lu(^{172}Yb) in GaN — •Riccardo Valentini und Reiner Vianden — Helmholtz - Institut für Strahlen- und Kernphysik der Universität Bonn, Nußallee 14-16, 53115 Bonn, Deutschland

Für optoelektronische Bauteile werden Halbleiter mit großer Bandlücke verwendet, die mit Seltenen Erden dotiert sind. Um deren Verhalten nach der Implantation zu untersuchen, hat sich die Methode der γ-γ-Winkelkorrelation (PAC) bewährt. Ein geeignetes Isotop zur Untersuchung solcher Halbleiter ist ^{172}Yb.

Bisher wurde das Mutterisotop ^{172}Lu am CERN (ISOLDE Facility) hergestellt und implantiert. Die relativ starke Kontamination des ISOLDE-Strahls mit Molkülen gleicher Masse, die 7- bis 10-tägige Dauer des Probentransport zum Messort und die seltene Verfügbarkeit des Isotops an ISOLDE haben uns dazu bewegt das ^{172}Lu vor Ort herzustellen und zu implantieren. Durch Bestrahlung einer Thulium-Folie mit ^{4}He, ^{169}Tm(α,n)^{172}Lu, erfolgt so die Herstellung am Bonner Isochron-Zyklotron und die Implantation am Bonner Isotopenseparator.

Wir führen Testmessungen von ^{172}Lu(^{172}Yb) in GaN durch, um den Herstellungsprozess am Bonner Zyklotron und Isotopenseparator zu optimieren. Die Messungen werden auf einer PAC-Anlage durch-

geführt, die das Material LSO als Szintillator benutzt. Dadurch soll eine bessere Energieauflösung, eine höhere Anisotropie und eine kürzere Messzeit erzielt werden.

HL 46.26 Thu 15:00 Poster A

MOVPE-Growth of GaN-nanowires on various III-V-Substrates — •M. Shirnow[1], V. Gottschalch[1], J. Bauer[1], H. Paetzelt[1], G. Wagner[2], and J. Lenzner[3] — [1]Institut für Anorganische Chemie, Universität Leipzig, Johannisallee 29, D-04103 Leipzig — [2]Institut für Mineralogie, Kristallographie und Materialwissenschaften, Universität Leipzig, Linnéstr. 3, D-04103 Leipzig — [3]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstr. 3, D-04103 Leipzig

GaN nanoscale structures (nanowires) have great potential for realizing new optoelectronic devices. We compare the growth of freestanding GaN wires on various substrates and templates using two precursor combinations; 1.1-Dimethylhydrazine (DMHy)/Trimethylgallium (TMGa) and NH_3/Triethylgallium (TEGa). The precursor combination DMHy/TMGa was used for the growth of GaN at low substrate temperatures. By variation of the growth temperature and partial pressure (DMHy/TMGa) a small range of anisotropic growth was found, where cubic GaN wires can grow directly on GaAs substrates. GaN wires deposited on an intermediate BP layer above 750°C show the Wurtzite structure. We grew GaN wires on (0001) and (10-12) Al_2O_3 surfaces using the precursors TEGa and NH_3 and N_2 as the carrier gas in a temperature range from 900 to 1000°C. We used Ni and Au as initiators for vapour-liquid-solid (VLS) wire growth.

HL 46.27 Thu 15:00 Poster A

VLS Growth of III-V compounds — •A. Vogel[1], V. Gottschalch[1], J. Bauer[1], G. Wagner[2], M. Shirnow[1], H. Paetzelt[1], J. Lenzner[3], and W. Schmitz[2] — [1]Institut für Anorganische Chemie, Universität Leipzig, Johannisallee 29, D-04103 Leipzig — [2]Institut für Mineralogie, Kristallographie und Materialwissenschaften, Universität Leipzig, Linnéstr. 3, D-04103 Leipzig — [3]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstr. 3, D-04103 Leipzig

The vapour-liquid-solid (VLS) growth method is well-established in fabrication of freestanding III-V-nanowires using metal-organic vapour-phase epitaxy. Some aspects of VLS growth are not yet well understood. The crystalline structure as well as the chemical composition of the catalyst may have great influence on the structure of the grown one-dimensional nanostructures. For this reason we deposited thin gold films varying from 6 to 26 nanometres on GaAs (-1-1-1), c-plane and r-plane sapphire and Si (111). Those films were analyzed using a texture goniometer, atomic force microscopy, transmission electron microscopy, conventional and temperature-sensitive X-ray diffraction offering the opportunity to capture in-situ scans up to 900°C. We discuss the observed possible interactions between substrate, gold and precursor material. The stages of nanowire growth are discussed in detail.

HL 46.28 Thu 15:00 Poster A

BP and $B_xGa_{1-x-y}In_yP$ layer structures grown by MOVPE — •K. Schollbach[1], V. Gottschalch[1], G. Leibiger[2], H. Paetzelt[1], G. Wagner[3], J. Bauer[1], and D. Hirsch[4] — [1]Institut für Anorganische Chemie, Universität Leipzig, Johannisallee 29, D-04103 Leipzig — [2]Freiberger Compound Materials GmbH, D-09599 Freiberg — [3]Institut für Mineralogie, Kristallographie und Materialwissenschaften, Universität Leipzig, Linnéstr. 3, D-04103 Leipzig — [4]Leibniz-Institut für Oberflächenmodifizierung e.V., D-04318 Leipzig

BP, ternary $B_xGa_{1-x}P$ and related quaternary alloys like $B_xGa_{1-x-y}In_yP$ are novel indirect transition type materials for light emitters or detectors in the visible spectral range but systematic investigations are rare or missing completely.
We have studied the metal-organic vapor-phase epitaxial growth of BP, $B_xGa_{1-x}P$ and $B_xGa_{1-x-y}In_yP$ thin films on GaP, GaAs and Si substrates using the standard precursor Triethylboron, Trimethylgallium, Trimethylindium and Phosphine. The mole fraction of Boron in the epitaxial alloy-layers was varied from x = 0 to 0.04. The properties of the deposited thin film were determined using double-crystal X-ray diffraction, spectroscopic ellipsometry, chemical-etching techniques, transmission electron microscopy, photoluminescence, Raman scattering, and Secondary Ion Mass Spectroscopy. The influence of the growth conditions on structural quality, boron incorporation, interface quality, and optical properties is discussed.

HL 46.29 Thu 15:00 Poster A

Ausheilverhalten von AlN nach der Implantation von ^{111}In — •Julianna Schmitz, Jakob Penner und Reiner Vianden — Helmholtz - Institut für Strahlen- und Kernphysik der Universität Bonn, Nußallee 14-16, 53115 Bonn

Nach der Implantation des Isotops ^{111}In in AlN-Filme auf Saphir wurde ein isochrones Ausheilprogramm durchgeführt und die einzelnen Ausheilstadien mit der Methode der gestörten Winkelkorrelation (PAC) untersucht. Bereits in einem niedrigen Temperaturbereich zwischen 200 und 500°C zeigen sich deutliche Veränderungen: Der Anteil von Sonden mit einer weitgehend ungedämpften Wechselwirkung ($\nu_Q = 28$ MHz) steigt bis auf 50%. Orientierungsmessungen bestätigen die Ausrichtung des zugehörigen elektrischen Feldgradienten entlang der c-Achse, wie er für Indium auf einem ungestörten Al-Gitterplatz erwartet wird.

Weitere 40% der Sonden erfahren eine Wechselwirkung, deren Frequenz nach Tempern oberhalb 500°C bis auf ca. 300 MHz steigt. Gleichzeitig nimmt die Dämpfung stark ab. Diesen Anteil könnte man einem Defekt zuordnen. Allerdings zeigt sich bei der Untersuchung der Temperaturabhängigkeit, dass diese Frequenz immer langsamer wird, bis sie oberhalb von 600°C der Gitterfrequenz entspricht. Dieses Verhalten ist reversibel.

Die Resultate werden mit dem bereits gut untersuchten Verhalten von ^{111}In in GaN verglichen.

HL 46.30 Thu 15:00 Poster A

Tunneling Transport Involving Evanescent States in III-V Semiconductors — S. Loth[1], M. Wenderoth[1], •S. Siewers[1], K. Teichmann[1], L. Winking[1], R. G. Ulbrich[1], S. Malzer[2], and G. H. Döhler[2] — [1]Universität Göttingen, IV. Physikalisches Institut, Germany — [2]Universität Erlangen-Nürnberg, Max-Planck-Research Group, Institute of Optics, Information, and Photonics, Germany

Shallow acceptors near the {110} cleavage surfaces of III-V semiconductors are investigated with a Cross-Sectional Tunneling Microscope at 8K. For certain tunneling conditions the acceptors appear as distinct triangular protrusions in the STM images. Energetically and spatially resolved spectroscopies show that the pronounced anisotropic contrast pattern are due to a tunneling process involving evanescent states in the fundamental band gap of the semiconductor. The dopant atom enhances this transport channel via the resonant tunneling device geometry and provides an energy filter. The lateral resolution of the STM gives access to the spatial and directional dependence of this transport process. To study the properties of this transport mechanism the electronic configuration around the acceptor atom is varied by changing the doping surroundings and using different host materials. Our data indicate that not only the real part but also the complex part of the bulk band structure together with large k-dependent splittings have to be taken into account in the interpretation of STM data.

This work was supported by the DFG, SFB 602, and the German National Academic Foundation.

HL 46.31 Thu 15:00 Poster A

Observation of InN(0001) surface and bulk properties during oxidation — •C. Friedrich[1], T. Schenk[1], M. Drago[1], W. Braun[2], W. Richter[1,4], N. Esser[1,3], P. Vogt[1], and M. Kneissl[1] — [1]TU Berlin, Institute of Solid State Physics, Hardenbergstr. 36, 10623 Berlin, Germany — [2]BESSY GmbH, Albert-Einstein-Str. 15, 12489 Berlin, Germany — [3]ISAS Berlin, Albert-Einstein-Str. 9, 12489 Berlin, Germany — [4]Universita Tor Vergata, Via della Ricera Scientifica 1, 00133 Rome, Italy

The determination of the InN electronic bandgap is still not completely solved but is most likely related to quality and purity of the investigated material. The incorporation of oxygen in sputtered InN films was already reported, but the influence on the crystal, optical and electronic properties remains unclear. Here we present a soft x-ray photoemission (SXPS) study of the surface and bulk deoxidation of MOVPE grown InN(0001)/sapphire through thermal annealing. SXPS reveals composition and binding configuration within the surface layers which gives rise to clear C1s and O1s core-level contributions. Thermal annealing at 300°C is sufficient to remove most of these components. Only a stable O1s oxide contribution could not be removed even at 460°C. These results are compared to ellipsometric measurements in different gaseous environments. We could identify surface oxidation occurring in humid ambient below 150°C as well as bulk oxidation around 450°C in dry air. These two different oxidation effects are in good agreement with the SXPS measurements. These results can be

used for the optimization of InN surface morphology.

HL 46.32 Thu 15:00 Poster A

InGaAs/GaAsSb tunnel junction in an InP(100)-based low band gap tandem solar cell — •Ulf Seidel, Erol Sagol, Ulrike Bloeck, Klaus Schwarzburg, and Thomas Hannappel — Hahn-Meitner-Institute, Glienicker Str. 100, 14109 Berlin, Germany

III-V multi-junction (m-j) solar cells are currently the most efficient PV devices worldwide. In a m-j solar cell multiple absorbers with different band gaps are connected in series. At present, the world record m-j solar cell was epitaxially grown lattice-matched to GaAs(100) or rather to Ge(100). Regarding the highest theoretical efficiencies there is a lack of an appropriate material with a band gap in the range of 1eV. Therefore, a monolithic low band gap tandem solar cell on the lattice constant of InP(100) was designed with band gaps regarding a 4- or 5-junction solar cell. It can be combined with a high band gap tandem or triple cell via different techniques. The lattice-matched InGaAs (E_g = 0.73 eV) was utilized for the lowest band gap absorber and also lattice-matched InGaAsP for the absorber material around 1 eV. The two sub cells were connected by a new tunnel junction including n-InGaAs and p-GaAsSb. With regard to the sharpness of the InGaAs/GaAsSb interface, we investigated the growth of the GaAsSb layer on different InGaAs surface reconstructions in-situ with reflectance difference spectroscopy (RDS) and in ultra high vacuum with X-ray PES (XPS) and LEED. A significant difference was measured for the Sb to As surface stoichiometry at the GaAsSb layer, indicating that the more established growth of GaAsSb on an As-rich InGaAs surface resulted in a too low Sb-content in the first monolayers of GaAsSb.

HL 46.33 Thu 15:00 Poster A

Optical and structural properties of MOVPE grown InGaN films with varying indium content — •Joachim Stellmach, Martin Leyer, Massimo Drago, Markus Pristovsek, and Michael Kneissl — Technische Universität Berlin, Institut für Festkörperphysik, Hardenbergstr. 36, Germany

High indium containing InGaN films and quantum wells are of great interest for a number of device applications, laser diodes and LEDs with emission in the particular blue and green wavelength range and beyond. We have systematically studied the temperature dependence of indium incorporation into thick InGaN layers.

The layer were grown on a GaN/sapphire templates with metal-organic vapour phase epitaxy (MOVPE). In order to alter the indium incorporation the growth temperature was varied between 650°C and 850°C. Dependent on the growth temperature the indium content varied between 1,5% – 43%. The layers were analyzed with x-ray diffraction (XRD), atomic force microscopy (AFM), photoluminescence (PL) and transmission spectroscopy.

We observed the lowest indium incorporation at a temperature of 850°C and an increase of the indium content and surface roughness with decreasing temperature. The XRD measurements showed a double peak structure for the sample grown at 750°C, possibly indicating the onset of phase separation in the InGaN films under these growth conditions.

HL 46.34 Thu 15:00 Poster A

Untersuchung des optischen Gewinns an GaAsSb Quantenfilmen — •Michael Schwalm[1], Christoph Lange[1], Sangam Chatterjee[1], Christina Bückers[1], Angela Thränhardt[1], Stephan W. Koch[1], Wolfgang W. Rühle[1], Shane R. Johnson[2], Jiangbo Wang[2] und Young-Hang Zhang[2] — [1]Fachbereich Physik, Philipps-Universität Marburg — [2]Center for Solid State Electronics Research & Department of Electrical Engineering, Arizona State University

Ein Hauptforschungsziel im Bereich der Optoelektronik besteht darin, Emitter im Wellenlängenbereich von 1,3μm bis 1,55μm für glasfaserbasierte oder aber jenseits von 2μm für freie Kommunikation auf Basis des leicht zu handhabbaren Substrats GaAs herzustellen. Eine Möglichkeit, um die Emissionswellenlänge zu erhöhen, ist der Einbau von Antimon in GaAs-Quantenfilme. Untersucht wurde die optische Verstärkung an einer Probenreihe von 7nm dicken GaAs0.64Sb0.36 Quantenfilmen, welche in verschieden dicke GaAs-Barrieren eingebettet sind. Mit Hilfe der Strichlängenmethode, bei der die Probe entlang eines Strichs variabler Länge optisch angeregt und die Emission entlang des gepumpten Kanals spektral aufgelöst gemessen wird, ist der optische Gewinn für eine quasi Dauerstrichanregung direkt zugänglich. Die spektrale Breite der Photolumineszenz und die Emissionseffizienz werden mit zunehmender Dicke der Barrieren größer. Bei allen Proben wird Verstärkung mit einer Brandbreite im Bereich von 200nm und einem Maximalwert bis zwischen 140/cm für 0nm Barrierendicke bis zu 220/cm bei 9nm Barrierendicke beobachtet.

HL 46.35 Thu 15:00 Poster A

MOMBE epitaxial growth of InN on (0001) Sapphire GaN template or LT InN layer — •Jörg Hisek[1], Uwe Rossow[2], Heiko Bremers[2], Daniel Fuhrmann[2], Jochen Aderhold[3], Jürgen Graul[1], and Andreas Hangleiter[2] — [1]LFI, Leibniz Universität Hannover, Schneiderberg 32, 30167 Hannover — [2]Institut für Angewandte Physik, TU Braunschweig, Mendelssohnstr. 2, 38106 Braunschweig — [3]Fraunhofer Wilhelm-Klauditz-Institut, Bienroder Weg 54 E, 38108 Braunschweig

To date the epitaxial growth of high quality InN is still a challenge. Investigations of structural properties require an exact understanding of a re-producible growth mechanism of the used fabrication method.

Epitaxial InN has been grown on c-plane sapphire by means of MOMBE. Herby the metalorganic vapour fluxes have been adjusted by pressure control applying a MFC calibration with nitrogen. A comparison was made between InN layers grown on templates with a thicker GaN buffer layer (grown by MOVPE) and InN grown directly onto prenucleated substrate. The latter method was split into the usage of GaN or InN as nucleation seeds. GaN buffer layer quality sets limitations if the InN is grown on top by an in-situ method. The optimisation of the seeding buffer layer is reported. The most crucial growth parameters found, are substrate temperature and the III/V flux ratio.

Studies by RHEED, HRXRD, AFM, SEM and PL evaluated the morphological and optical properties of the as-grown InN. The without templates grown InN was hexagonal and dominantly N-polar. Electrical measurements revealed high electron mobility.

HL 46.36 Thu 15:00 Poster A

Post growth annealing beahaviour of GaMnAs grown on (001), (311) and (110) GaAs substrates — •Hirmer Michael, Ursula Wurstbauer, Dieter Schuh, and Werner Wegscheider — Universität Regensburg

We report a detailed study of post growth annealing experiments of thin GaMnAs films grown by low temperature molecular beam epitaxy (LT-MBE) on (001), (311) and (110) semi-insulating GaAs substrates with layer thickness ranging from 5 nm to 300 nm. Since the ferromagnetism of this zener-like diluted magnetic semiconductor is hole mediated, the ferromagnetic transition temperature T_C can be increased corresponding to $T_C \quad x_{eff} p^{1/3}$ (x_{eff}: effective Mn concentration, p: carrier density) by post growth annealing. This reduces the Mn-interstitial lattice defects, which act as a double donor. We have increased T_C in first annealing experiments at about 190°C for 100h in air from 85K to 150K for layers grown on (001) GaAs, from 75K to 110K for layers on (311)A and from 55K to 89K for layers on (110) oriented substrates [1]. In these experiments, T_C was determined by temperature dependent sheet resistivity measurements and the carrier density by measurements of the anomalous Hall Effect. To further improve the annealing process and to find the optimal annealing parameters (temperature, time, environment...) dependent on Mn concentration, layer thickness and growth direction we in situ monitor the sheet resistivity during the annealing process. We acknowledge the support by the DFG via SFB 689. [1] U. Wurstbauer, M. Sperl, D. Schuh, G. Bayreuther, J. Sadowski, W. Wegscheider, accepted to JCG

HL 46.37 Thu 15:00 Poster A

Measurements of the absolute external luminescence quantum efficiency of ZnO — •Mario Hauser, Alexander Hepting, Robert Hauschild, Felix Stelzl, Johannes Fallert, Markus Wissinger, Huijuan Zhou, Heinz Kalt, and Claus Klingshirn — Universität Karlsruhe (TH), Karlsruhe, Germany

The prospects of ZnO in light emitting devices such as high power blue and UV laser diodes depend crucially on the luminescence quantum efficiency.

The absolute external luminescence quantum efficiency is measured using a temperature controlled integrating sphere (Ulbricht sphere). Temperature dependant and spectrally resolved measurements are carried out from 10 K up to room temperature on commercially available ZnO nanocrystalline powders and laboratory bulk samples. At low temperatures the former show a typical quantum efficiency of 8 to 10 %. The quantum efficiency of the latter varies from 5 to 20 %. Over the considered temperature range a decrease of quantum efficiency of about one order of magnitude depending on sample quality can be observed. A fit to the temperature dependant quantum efficiency of

the near band edge emission shows that there is an activated process with an activation energy on the order of 10 meV in all samples. The spectral evolution with temperature of deep defect and near band edge luminescence is discussed.

HL 46.38 Thu 15:00 Poster A

Optical Spectroscopy on Metastable Zincblende Mn-CrS/ZnSe Heterostructures — •Limei Chen[1], Wolfram Heimbrodt[1], Peter Jens Klar[2], Lorraine David[3], Christine Bradford[3], and Kevin Prior[3] — [1]Department of Physics and Material Sciences Center, Philipps-University Marburg, Germany — [2]I. Institute of Physics, Justus-Liebig-University Giessen, Germany — [3]School of Engineering and Physical Sciences, Heriot-Watt university, Edinburgh, UK

A series of zinkblende MnS/ZnSe heterostructures with varying thickness from 1.8 to 8.6nm and a series of MnCrS/ZnSe heterostructures with different Cr contents up to 50% were grown by molecular beam epitaxy on (100) GaAs substrates with a growth temperature of 240°C. The optical properties of the heterostructures were studied using time-resolved photoluminescence spectroscopy with time scales from microseconds to milliseconds at low temperature(10K). The photoluminescence is dominated by the $^4T_1$ to $^6A_1$ internal transition of the Mn^{2+} ($3d^5$) cations at 590 nm. The decay times of the internal luminescence of MnS layers show only a weak size dependence and do not vary when using different excitation energies, i.e. 355 nm (3.49 eV) exciting above the ZnSe band gap or 532 nm (2.33 eV) excitation exciting directly into the Mn $3d^5$ absorption but below the ZnSe and MnS band gaps. The decay times of the MnCrS layers show no clear size and Cr concentration dependence and are faster than those of the Cr-free MnS layers indicating an energy transfer from the Mn 3d-shell to Cr internal transitions.

HL 46.39 Thu 15:00 Poster A

Optical Characterization of Nanocrystalline ZnO Powders — •Felix Stelzl, Johannes Fallert, Robert Hauschild, Alexander Urban, Huijuan Zhou, Markus Wissinger, Mario Hauser, Claus Klingshirn, and Heinz Kalt — Universität Karlsruhe (TH), Karlsruhe, Germany

In recent times there has been an increasing interest in nanocrystalline ZnO powders, since they promise the future realisation of miocrolasers based upon random lasing [1]. Several commercially available powders have been investigated, as they offer a cheap and reproducible light emitting source in the ultraviolet range. These powders have different average particle sizes which vary from below 100 nm up to above 1 μm. Apart from stationary photoluminescence measurements, time resolved investigations have been conducted to reveal the luminescence dynamics. Furthermore numerical calculations of carrier densities and diffusion properties have been carried out to compliment the experimental results.
[1] H. Cao et al., APL 76, 2997 (2000)

HL 46.40 Thu 15:00 Poster A

Unambiguous identification of the PL-I9-line in zinc oxide — Sven Müller[1], Daniel Stichtenoth[1], Michael Uhrmacher[1], Hans Hofsäss[1], Jens Röder[2], Anjeschka Kulinska[3], and •Carsten Ronning[1] — [1]II. Physikalisches Institut, Georg-August Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany — [2]Institut für Physikalische und Theoretische Chemie, TU Braunschweig, Hans-Sommer-Str.10, D-38106 Braunschweig, Germany — [3]H. Niewodniczanski Institute of Nuclear Physics, Polish Academie of Science, Radzikowskiego 152, 31-342 Krakow, Poland

The intense luminescence of zinc oxide (ZnO) is usually dominated by transitions of donor bound excitons. The identity of the respective causing donors is in the most cases unknown, but a clear identification can be achieved using radioactive dopants, which undergo an element transition upon decay. Thus, luminescence lines, which vary their intensities with the specific half-life of the respective isotope with increasing measuring time, can be unambiguous assigned to specific elements. We have implanted radioactive ^{111}In with an ion energy of 400 keV into ZnO single crystals. The isotope ^{111}In decays into stable ^{111}Cd with an half-time of 2,8 days; thus, an element transition from a donor to an isoelectronic element within the ZnO crystal occurs upon time. The annealing process (in air,700°C) was monitored by perturbed angular-$\gamma\gamma$-spectroscopy (PAC). The samples were characterised by photoluminescence spectroscopy over a time period of 3 weeks. The obtained results together with additional ion implantation studies with stable ^{115}In and varying ion fluences will be discussed.

HL 46.41 Thu 15:00 Poster A

Optical characterization of acceptors implanted into ZnO — •Joachim Dürr[1], Daniel Stichtenoth[1], Sven Müller[1], Carsten Ronning[1], Lars Wischmeier[2], Chegnui Bekeny[2], and Tobias Voss[2] — [1]II. Institute of Physics, University of Göttingen, Friedrich-Hund-Platz 1, 37073 Göttingen, Germany — [2]Institute for Solid State Physics, University of Bremen, Bibliothekstraße 1, 28359 Bremen, Germany

Nitrogen and phosphorus are the most promising candidates for p-type doping of ZnO. We doped ZnO bulk crystals using ion implantation because this technique offers several advantages compared to other growth methods, e.g. precise control of the lateral and vertical dopant concentration even beyond solubility limits. After implantation and annealing of the introduced defects we performed photoluminescence measurements in order to monitor the optical activation of the dopants. Temperature- and power-dependent measurements reveal that a new line appearing at 3.23 eV for the N-implanted samples is due to Donor-Acceptor-Pair (DAP) transitions. We investigated the dependence of this feature on co-implantation as well as on the implantation and annealing temperature. First experiments on phosphorus-implanted ZnO will also be presented.

HL 46.42 Thu 15:00 Poster A

Comparison of giant Faraday effects in ZnMnSe and ZnMnO studied by magneto-optic ellipsometry — •Mario Saenger[1], Lars Hartmann[2], Heidemarie Schmidt[2], Michael Hetterich[3], Michael Lorenz[2], Holger Hochmuth[2], Marius Grundmann[2], Tino Hofmann[1], and Mathias Schubert[1] — [1]Nebraska Center for Materials and Nanoscience, Department of Electrical Engineering, University of Nebraska-Lincoln, NE 68588-0511, U.S.A. — [2]Institute for Experimental Physics II, Faculty of Physics and Geosciences, University of Leipzig, Linnéstr. 5, D-04103 Leipzig, Germany — [3]Institute of Applied Physics and Center for Functional Nanostructures (CFN), University of Karlsruhe, Wolfgang-Gaede-Str. 1, D-76131 Karlsruhe Germany

The diluted magnetic semiconductors ZnMnSe and ZnMnO are promising materials to create spin aligners for possible application in future spintronic devices. At room temperature $Zn_{1-x}Mn_xSe$ is paramagnetic, and reveals giant Faraday magneto-optical effects in the visible spectral range. In contrast, a very weak Faraday effect in $Zn_{0.9}Mn_{0.1}Se$ was found. We report a quantitative analysis of the anisotropic complex dielectric functions for $Zn_{1-x}Mn_xSe$ in external magnetic field using a modified critical-point dielectric function model. Magneto-optic generalized ellipsometry in the Faraday configuration was applied to investigate a series of $Zn_{1-x}Mn_xSe$ samples (x=0, 0.02, 0.14, 0.28) grown by MBE on GaAs (001) substrate, and a $Zn_{0.9}Mn_{0.1}O$ sample grown by PLD on a-plane sapphire substrate. The studied spectral range was from 2 to 3 eV and for magnetic fields up to 1.2 T.

HL 46.43 Thu 15:00 Poster A

Simulation of capacitance - temperature measurements on ZnO Schottky diodes — •Matthias Schmidt, Holger von Wenckstern, Rainer Pickenhain, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Halbleiterphysik, Linnéstraße 5

We investigate theoretically and experimentally the temperature-dependent capacitance of ZnO Schottky diodes. For the experiments we used ZnO single crystals and epitaxial ZnO thin films grown by pulsed laser deposition. The capacitance was measured with an Agilent 4294A capacitance bridge at different temperatures (15K - 300K) and frequencies (5kHz - 1MHz). To explain the experimental results we use a model that considers the binding energy, the electron capture cross section and the concentration of the dominant donor.

HL 46.44 Thu 15:00 Poster A

Electrical properties of ZnO nanorods and layers — •Eva Schlenker[1], Thomas Weimann[2], Peter Hinze[2], Andrey Bakin[1], Ole Peters[1], Augustine Che Mofor[1], Bianca Postels[1], Hamid El-Shaer[1], Hergo-Heinrich Wehmann[1], and Andreas Waag[1] — [1]Institut für Halbleitertechnik, TU Braunschweig, Germany — [2]Physikalisch-Technische Bundesanstalt (PTB), Braunschweig, Germany

ZnO has attracted a lot interest in the scientific community due to its outstanding properties. With a band gap of 3.37 eV and an exci-

ton binding energy of 60 meV it is a promising candidate for micro- and optoelectronic applications. The growth of ZnO nanostructures and epitaxial layers is well under control and their optical and structural properties are already thoroughly characterized. However, due to contacting difficulties, less reports exist on the electrical properties of single ZnO nanostructures.

In this contribution we present various contacting methods in order to explore the electrical properties of individual nanorods either grown by aqueous chemical growth or vapor phase transport. Current-voltage characteristics were obtained by using an atomic force microscope (AFM) with a conductive tip or by patterning contacts with e-beam lithography. The results are compared to the ones obtained from measurements on epitaxially grown ZnO layers and first applications are presented.

HL 46.45 Thu 15:00 Poster A

Synthesis and optical properties of ordered ZnO nanostructures — •Markus Wissinger[1], Huijuan Zhou[1], Johannes Fallert[1], Felix Stelzl[1], Daniel Weissenberger[2], Mario Hauser[1], Robert Hausschild[1], Dagmar Gerthsen[2], Claus Klingshirn[1], and Heinz Kalt[1] — [1]Institut für angewandte Physik, Universität Karlsruhe (TH), Karlsruhe, Germany — [2]Laboratorium für Elektronenmikroskopie, Universität Karlsruhe (TH), Karlsruhe, Germany

In this work we present the controlled growth of ordered ZnO nanostructures by a vapor phase transportation method in a horizontal tube furnace. The ordered ZnO nanostructures are grown using pre-structured gold catalyst patterns, which are produced by electron beam lithography as well as by gold evaporation through a mask of self organized polystyrene balls. The growth is conducted at different temperatures (from 500 to 800 °C) under a constant pressure of several hundred mbar and a constant N_2 flow.

The morphology of the ZnO nanostructures is found to be very sensitive to the substrate material and growth parameters. A GaN substrate appears to be more suitable for perpendicular growth of ⟨0001⟩ ZnO than Si or Sapphire. Low temperature photoluminescence measurements show predominant emission in the UV region of the spectra, indicating high sample quality. Typically three donor bound excitons, $I_4, I_{5/6}, I_9$ and the A-free exciton are observed. The corresponding donors are assumed to be hydrogen, aluminum, and indium, respectively.

HL 46.46 Thu 15:00 Poster A

Growth of ZnO Nanopillars in an Optical Furnace — •Tobias Röder, Günther M. Prinz, Anton Reiser, Martin Schirra, Martin Feneberg, Raoul Schneider, Klaus Thonke, and Rolf Sauer — Institut für Halbleiterphysik, Universität Ulm, 89069 Ulm

First results of ZnO nanopillar production in a new kind of optical furnace are presented. The furnace consists of two largely independent heating zones and allows heating rates of up to 1000°C/min with a maximum temperature around 1100°C. This enables us to investigate the influence of heating rates during the growth of ZnO nanostructures. The pillars are grown on a-plane sapphire substrates by a thermal-carbon process, in which a mixture of zinc oxide and graphite powder is used as source material. We obtained well aligned pillars of different densities with a variety of growth types such as vapor-liquid-solid (VLS) and vapor-solid (VS). The ZnO pillars were investigated by scanning electron microscopy (SEM), photoluminescence (PL) and spatially resolved cathodoluminescence spectroscopy (CL).

HL 46.47 Thu 15:00 Poster A

Electrical Characterization of ZnO Microcrystals — •Andreas Rahm, Holger von Wenckstern, Jörg Lenzner, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Fakultät für Physikund Geowissenschaften, Institut für Experimentelle Physik II,Linnéstr. 5, 04103, Leipzig, Germany

We report on the electrical properties of ZnO microcrystals with InGa as well as W ohmic contacts. Nanowires carry charge efficiently and are potentially ideal building blocks for future (opto)electronics. Knowledge about (metal) contacts and electrical conduction properties of ZnO is essential. We have investigated the temperature dependence of ohmic I-V characteristics for several different microcrystals. They were carbothermally grown at 1100 ℃ and ambient pressure [1]. The measurements were performed with a semiconductor parameter analyzer (Agilent 4156C) in the dark in a helium cryostat. In the temperature regime from 200 K up to 300 K all samples show a strongly temperature dependent conduction. At low temperatures, i.e. in the freeze-out range there is an almost temperature-independent conductivity. Based on the assumption that the crystals exhibit a similar temperature dependence of the Hall mobility as bulk ZnO [2], it is possible to estimate the carrier concentration ($1.22\times10^{16} - 1.94\times10^{17}\,\mathrm{cm}^{-3}$) as well as the thermal activation energy (18 – 40 meV).

[1] M. Lorenz, J. Lenzner, E.M. Kaidashev, H. Hochmuth, and M. Grundmann, Ann. Phys. (Leipzig) **13**, 39 (2004), [2] H. v. Wenckstern, S. Weinhold, G. Biehne, R. Pickenhain, H. Schmidt, H. Hochmuth, M. Grundmann, Adv. in Sol. Stat. Phys., **45** (2005).

HL 46.48 Thu 15:00 Poster A

MBE growth of high mobility HgTe/HgCdTe heterostructures — •Christoph Brüne, Andreas Roth, Steffen Wiedmann, Joachim Schneider, Markus König, Charles Becker, Hartmut Buhmann, and Laurens Mohlenkamp — Physikalisches Institut, Lehrstuhl für Experimentelle Physik 3, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

Epitaxial grown HgTe/HgCdTe heterostructures became very interesting for electronic applications due to good electrical proberties and a very high Rashba spinorbit spin splitting effect. Up to now quantum well (QW) structures with carrier mobilities of some 10^5 cm^2/Vs at a rather high carrier concentration ($>10^{12}$ cm^{-2}) were available. Our recent work has been focused on the fabrication of high mobility and low carrier density HgTe/HgCdTe single QW structures for magneto transport measurements. Single HgTe QWs with thicknesses between 5 and 12 nm are grown by molecular beam epitaxy (MBE) in between $Hg_xCd_{1-x}Te$ barriers. Iodine doping was employed at a distance of 10 nm from the QW either on one or on both sides. Due to special investigations of the growth conditions mobilities up to 10^6 cm^2/Vs have been achieved for densities of a few 10^{11} cm^{-2}. Simultaneously, Rashba splitting energies with ΔE_R >10 meV have been observed on gated Hallbar structures.

HL 46.49 Thu 15:00 Poster A

Lithographical nanostructure fabrication of high mobility HgTe quantum well structures — •Andreas Roth, Steffen Wiedmann, Joachim Schneider, Markus König, Christoph Brüne, Charles Becker, Hartmut Buhmann, and Laurens Molenkamp — Physikalisches Institut, Lehrstuhl für Experimentelle Physik 3, Universität Würzburg, Am Hubland, 97074 Würzburg, Germany

Large Rashba energies and high carrier mobilities make HgTe quantum wells structures an interesting material for spintronics applications. However, standard nano fabrication processes can not easily be adapted for HgTe materials due to the low growth temperature. Here, we present a method for nanostructure fabrication using dry etching techniques. It turned out that dry etched samples exhibit superior transport properties compared to wet etched structures with an improved control of the structural dimensions. Thus, for the first time, it was possible to investigate side wall depletion effects in HgTe quantum wells structures, with lateral dimensions down to 100 nm.

HL 46.50 Thu 15:00 Poster A

Optical characterization of hexagonal $Mg_xZn_{1-x}O$ thin films grown by pulsed laser deposition — •Alexander Müller, Gabriele Benndorf, Susanne Heitsch, Holger Hochmuth, Chris Sturm, Rüdiger Schmidt-Grund, 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 (PLD) on *a*-plane sapphire substrates. The Mg content in the thin films was varied by using PLD-targets with MgO concentrations between 0 wt.% and 25 wt.% and by applying different oxygen partial pressures from 1.6×10^{-2} mbar to 5×10^{-5} mbar.
In order to characterize the optical properties and to optimize the growth conditions of the layers, we performed photoluminescence (PL) and spectroscopic ellipsometry measurements. The composition of the thin films was determined by Rutherford back scattering spectrometry. A lower O_2 partial pressure during the deposition leads to an increasing Mg content in the layer. Consistently, the band gap energy as well as the PL maximum is shifted to higher energies. PL emission was observed up to a Mg concentration of about 35 % in the thin films. The FWHM of the PL increases with higher Mg content. Furthermore, the dependence of the layer thicknesses and the optical properties on the O_2 partial pressure and target Mg concentration were examined.

HL 46.51 Thu 15:00 Poster A

Electrical Properties of Low Temperature ZnO Layers Grown by MOVPE on GaN/Sapphire Templates — H. Witte, S. Tiefenau, A. Krtschil, •S. Heinze, A. Dadgar, and A. Krost — Institute of Experimental Physics,Otto-von-Guericke-University-Magdeburg, 39016 Magdeburg

High-quality ZnO layers grown by metal-organic vapor phase epitaxy on GaN/sapphire templates typically use a low temperature (LT)-ZnO buffer layer grown at 450 ^{0}C to reduce the lattice mismatch. In general, the LT-ZnO shows high n-type conductivity properties with a donor concentration gradient from the GaN/LT-ZnO interface towards the surface as obtained from differences between the electron concentrations and the net donor concentrations measured by Hall-effect and by CV-characteristic, respectively. In internal photo-voltage spectra signals from near-band-gap (NBG) transitions in GaN as well as in ZnO were observed. These defect-to-band-transitions suggest an accumulation of ZnO- related defects with E_G- 0.03 eV, - 0.11 eV and - 0.2 eV in the near of the GaN/LT-ZnO-interface. They decrease after annealing of the samples at 900 ^{0}C for some minutes and by growing high temperature (HT) ZnO layers on the LT-ZnO buffer. Otherwise, the electron concentrations and the net donor concentrations of these LT-ZnO layers increase. In photo-current and photo-voltage spectra the defect-transition at E_G-0.11 eV dominates in samples annealed above 850 ^{0}C. Furthermore, intensive illumination of LT-ZnO layers decrease temporary the electron concentration drastically. This annealing behaviour of LT-ZnO is contrary to those of the HT-ZnO.

HL 46.52 Thu 15:00 Poster A

Magnetic circular dichroism of Co doped ZnO — •Christoph Knies[1], Swen Graubner[1], Jan Stehr[1], Detlev M. Hofmann[1], Tom Kammermeier[2], Andreas Ney[2], and Nikolai Romanov[3] — [1]University of Giessen, I. Physics Institute, Heinrich-Buff-Ring 16, D-35392 Giessen — [2]Universität Essen-Duisburg, MC-EXT "Maglomat", Experimetalphysik, Universität Duisburg-Essen, Lotharstr. 1, D-47057 Duisburg — [3]A. F. Ioffe Institute, St. Petersburg, Russia

Co doped ZnO is an interesting material for room temperature spintronic applications. Poly-crystalline ZnO samples doped with Co were synthesized in our group by a wet chemical synthesis using dip coating for the film formation. The magnetic properties of the samples were investigated by temperature and magnetic field dependent circular dichroism (MCD) measurements. We observe groups of optical transitions in the near infrared (∼0.9 eV) and visible (∼2.9 eV) spectral range which are caused by Co^{2+} internal excitations. At energies of above 3.0 eV is the onset of a Co^{2+} to Co^{+} charge transfer transition located. The MCD results are discussed in respect to magnetisation measurements which show a hysteresis like behaviour for samples doped with 2% and 5% Co.

HL 46.53 Thu 15:00 Poster A

The local environment of isolated ZnSe:Mn nanparticles — •Andreas Hofmann[1,2], Christina Graf[1,2], Christine Boeglin[3], Vladimir Korsounski[4], Reinhard Neder[4], and Eckart Rühl[1,2] — [1]Freie Universität Berlin, Institut für Chemie und Biochemie, D-14195 Berlin — [2]Universität Würzburg, Institut für Physikalische Chemie, D-97074 Würzburg — [3]Institute de Physique et Chimie des Materiaux de Strasbourg, F-67034 Strasbourg — [4]Universität Würzburg, Institut für Mineralogie, D-97074 Würzburg

The synthesis and characterization of diluted magnetic semiconductor nanoparticles made substantial progress in the last years and it is expected that the combination of the electronic characteristics of semiconductor nanoparticles with the magnetic properties of ferromagnets leads to novel spintronic materials.

ZnSe nanoparticles doped with 0.1-0.3% Mn with respect to Zn were prepared using a high temperature organic approach. Photoluminescence- and electron paramagnetic resonance measurements give strong evidence for an incorporation of Mn inside the ZnSe crystal lattice. The crystal structure of the particles was studied by high resolution transmission electron microscopy and X-ray diffraction. For a more profound study of the local environment of the Mn ions, ZnSe:Mn quantum dots were investigated in X-Ray magnetic circular dichroism experiments. A comparison of the present results with experimental and theoretical data for single Mn shows that the quantum dots contain well separated Mn ions. Neither Mn-Mn coupling nor oxidation to higher Mn-oxidation states were observed.

HL 46.54 Thu 15:00 Poster A

In-situ RHEED Characterization of ZnO and $Mg_xZn_{1-x}O$ thin films — •Christian Wille, Alexander Hirsch, Robert Pilz, Frank Ludwig, and Meinhard Schilling — Institut für Elektrische Messtechnik und Grundlagen der Elektrotechnik, TU Braunschweig, Hans-Sommer-Straße 66, D-38106 Braunschweig, Germany

Due to its wide and direct band gap ZnO is interesting to be used as semiconductor in oxide superlattices. A possibility to overcome the lattice mismatch between perovskite oxides and hexagonal ZnO is to use cubic $Mg_xZn_{1-x}O$ instead of hexagonal one.

Using Pulsed Laser Deposition (PLD) ZnO and $Mg_xZn_{1-x}O$ thin films were grown on $Al_2O_3(0001)$ and $SrTiO_3(100)$ substrates respectively. The epitaxial growth of the films is investigated by in-situ reflection high energy electron diffraction (RHEED) supplemented by x-ray diffraction (XRD) and atomic force microscopy (AFM).

Standard ceramics synthesis is used to prepare the targets. To obtain atomically flat sapphire surfaces an annealing treatment is applied. The surface of the $SrTiO_3$ substrates is atomically flat and TiO_2 terminated after chemical and subsequent annealing treatment. The dependence of the PLD parameters on the growth conditions is analyzed. To obtain maximum information the experiments are planned by means of statistical design of experiments (DOE).

HL 46.55 Thu 15:00 Poster A

Growth of smooth ZnO layers by a modified CVD process — •Anton Reiser[1], Andreas Ladenburger[1], Günther M. Prinz[1], Martin Schirra[1], Uwe Röder[1], Martin Feneberg[1], Johannes Biskupek[2], Ute Kaiser[2], Klaus Thonke[1], and Rolf Sauer[1] — [1]Institut für Halbleiterphysik, Universität Ulm, D-89069 Ulm — [2]Zentrale Einrichtung Elektronenmikroskopie, Materialwissenschaftliche Elektronenmikroskopie, Universität Ulm, D-89069 Ulm

We grow ZnO layers by a modified CVD process on different substrate materials with growth rates of several micrometers per hour. This process is performed in a simple quartz liner tube at temperatures between 700 and 850 °C at normal pressure, using ZnO powder as source material. The growth can be controlled by the presence of seeding metal particles, allowing the definition of lateral structures. Growth also proceeds without catalyst particles, when a nucleation layer is deposited. The best results for heteroepitaxy are obtained on GaN films grown by MOVPE on c-plane sapphire substrates. In XRD measurements, $\Theta/2\Theta$ scans exhibit smaller halfwidth of the diffraction peaks for the ZnO single crystal layers than for the GaN templates. TEM images show that the interfaces between ZnO and GaN are atomically flat. For GaN substrates, the optical quality of the ZnO layers is excellent in terms of photoluminescence intensity and halfwidth of the dominant donor bound exciton lines.

HL 46.56 Thu 15:00 Poster A

MOVPE growth study of ZnO wires and layers — •K. Mergenthaler[1], V. Gottschalch[1], H. Paetzelt[1], G. Wagner[2], J. Bauer[1], and G. Benndorf[3] — [1]Institut für Anorganische Chemie, Universität Leipzig, Johannisallee 29, D-04103 Leipzig — [2]Institut für Mineralogie, Kristallographie und Materialwissenschaften, Universität Leipzig, Linnéstr. 3, D-04103 Leipzig — [3]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstr. 3, D-04103 Leipzig

It is necessary for many applications to obtain high-quality single crystal ZnO layers. But the tendency to form nanostructures might be useful for future nanosized devices. In this study we used an atmospheric pressure MOVPE system with two independent gas inlets to avoid parasitic reactions. We varied the temperature from 500 to 800 °C and the VI/II ratio from 1200 to 72000 to find the ideal growth parameters for layers and needle-like growth. Precursors were DEZn and N_2O with N_2 as the carrier gas. We used different substrates (e.g. c-, r-plane sapphire) and analysed both anisotropic growth of ZnO micro- and nano-needles and VLS growth with gold as catalyst. The crystalline quality and the optical properties were analysed by SEM, cathodoluminescence, photoluminescence and x-ray diffraction measurements. The influence of the growth conditions on structural quality, morphology and optical properties is discussed.

HL 46.57 Thu 15:00 Poster A

Optical and structural properties of NiO and NiMnO thin films grown on ZnO and sapphire substrates — •Lars Hartmann[1], Qingyu Xu[1], Heidemarie Schmidt[1], Holger Hochmuth[1], Michael Lorenz[1], Marius Grundmann[1], Pablo Esquinazi[1], Mario Saenger[2], Tino Hofmann[2], Mathias Schubert[2], and Sy-Hwang Liou[3] — [1]Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Linnéstrasse 5, D-04103 Leipzig, Germany — [2]Department of Electrical Engineering, University of Nebraska-Lincoln 209N WSEC P.O.

Box 880511 Lincoln, NE 68588-0511, USA — [3]Department of Physics and Astronomy, Nebraska Center for Materials and Nanoscience

Antiferromagnetic NiO is one of the key materials to realize spin valves in diluted magnetic semiconductors. In our current work we present the possibility of epitaxially growing NiO thin films on ZnO and sapphire substrates with different orientations. The magnetic properties of the films have been probed by SQUID measurements and the optical properties have been investigated by spectral ellipsometry from the near IR to the near UV range. The crystal structure and the film orientation was investigated by X-ray diffraction. Combined AFM and MFM measurements are showing a smooth surface structure and provide the possibility to investigate the magnetic properties of the sample surface. Especially the epitaxial growth of NiO on magnetic ZnO is an important step towards the realization of ZnO based spin valves.

HL 46.58 Thu 15:00 Poster A

Magnetic properties of ZnMnO — •Jan Stehr[1], Christoph Knies[1], Detlev Hoffman[1], Wei Xu[2], Yingxue Zhou[2], and Xinyi Zhang[2] — [1]I. Physikalisches Institut, Justus-Liebig-Universität, Heinrich-Buff-Ring 16, D- 35392 Giessen — [2]Department of Physics, Fudan University, 220 Handan Road, Shanghai 200433, China

A set of ZnMnO samples grown by MBE on Si with Mn concentrations from 3 % to 30% has been investigated by extended x-ray absorption fine structure (EXAFS) measurements, electron paramagnetic resonance (EPR) and magnetisation measurements. The magnetisation shows a ferromagnetic like hysteresis in samples with Mn concentrations below 10 %. An estimate of the ratio of the net magnetisation to the concentration of saturated magnetisation Mn2+ spins gives only 2 % of the total Mn content. The EPR shows dominating signals originating from concentration broadened, and exchange narrowed Mn2+ ions. The formation of secondary Mn phases is evident from EXAFS for samples with Mn concentrations higher than 20 %.

HL 46.59 Thu 15:00 Poster A

Influence of buffer layers on the structural properties of ZnO grown by plasma assisted molecular beam epitaxy — •Bernhard Laumer, Thomas Wassner, Stefan Maier, Martin Stutzmann, and Martin Eickhoff — Walter Schottky Institut, Technische Universität München, Am Coulombwall 3, 85748 Garching, Germany

We have investigated the influence of ZnO and MgO buffer layers on the structural properties of ZnO-films heteroepitaxially grown on (0001)- and (11-20)-sapphire substrates by plasma assisted molecular beam epitaxy. The use of a thin buffer layer facilitates the nucleation process on the sapphire substrate and thus allows the growth of ZnO-films at higher substrate temperatures, leading to a higher surface mobility of the adatoms. A systematic high resolution X-ray diffraction study of symmetric and asymmetric reflexes was carried out to analyze the impact of the buffer growth conditions on the structural properties such as the edge- and screw dislocation densities in the deposited ZnO-films. In addition, the effect of offcut-substrates and buffer layer annealing on the structural quality of the ZnO epilayers has been investigated. The influence of the structural properties on the electrical and optical characteristics (luminescence, conductivity, carrier mobility) of the ZnO layers will also be discussed.

HL 46.60 Thu 15:00 Poster A

Thermische Behandlung kommerzieller ZnO-Substrate zur Restrukturierung der Oberfläche als Vorstufe für die ZnO-Homoepitaxie — •Sören Heinze, Andre Krtschil, Jürgen Bläsing, Armin Dadgar und Alois Krost — Otto-von-Guericke-Universität Magdeburg, Institut für Experimentelle Physik

Wir stellen die Ergebnisse einer systematischen thermischen Behandlung kommerziell verfügbarer ZnO-Substrate und deren Charakterisierung mittels Rasterkraftmikroskopie (AFM) und Röntgenbeugung vor. Die Studie hat das Ziel, die ZnO-Substrate so zu präparieren, dass sie für eine nachfolgende metallorganische ZnO-Gasphasenepitaxie auf diesen modifizierten Substraten geeignet sind. Die Substrate wurden in einer Rapid-Thermal-Annealing-Anlage unter konstantem O_2-Fluss mit verschiedenen Temperaturregimes thermisch behandelt. Der Zinkpartialdruck wurde dabei mittels eines Zinkreservoirs in Form von ZnO-Pulver kontrolliert. In Abhängigkeit von der Maximaltemperatur beobachten wir mittels AFM ab 900°C die allmähliche Ausbildung von ZnO-Doppelstufen. Homogen ausgerichtete ZnO-Doppelstufen mit nur geringer Defektdichte sind bei 15-minütigem Ausheilen bei 1100°C zu verzeichnen. Eine Verringerung der Menge des eingewogenen ZnO-Pulvers führt zu einer verstärkten Ausbildung von dreidimensionalen ZnO-Nanosäulen. In Röntgenbeugungsuntersuchungen wurde festgestellt, dass die ungetemperten Substrate stark gekrümmt sind. Diese Krümmung geht durch das Ausheizen zurück. Innerhalb der strukturellen Eigenschaften konnten keine Veränderungen festgestellt werden, was auf eine ausschließliche Modifikation der Oberfläche hinweist.

HL 46.61 Thu 15:00 Poster A

Chlorine in epitaxially grown ZnO — •Felizitas Eylert, Swen Graubner, Stefan Lautenschläger, Christian Neumann, Joachim Sann, Niklas Volbers, and Bruno Meyer — 1. Physikalisches Institut, Justus-Liebig-Universität Gießen

The group-III elements Al, Ga and In introduce shallow donor states into ZnO and are widely used for obtained high free carrier concentrations up to the metallic limit. Much less is known from the group-VII elements, F, Cl and Br. There exists experimental evidence that at least Cl is indeed a shallow donor and produces high n-type conduction when in the CVD growth zinc chloride is used as a precursor. However, solid precursors are difficult to control in the CVD growth. It was therefore, our interest to use gaseous components. We, therefore, grew ZnO layers on GaN templates and ZnO substrates with CH3Cl as precursor for chlorine. We will report on the structural, optical and electrical properties of those films.

HL 46.62 Thu 15:00 Poster A

Structural and electrical investigation of fluorine doped ZnSe — •Marina Panfilova, Alexander Pawlis, Christof Arens, Detlef Schikora, and Klaus Lischka — Universität Paderborn, Department Physik, Warburger Str. 100, 33095 Paderborn

Fluorine doped ZnSe is a promising material for the realization of practical quantum information technology due to the potential of excitons bound to individual fluorine donors with a pure nuclear spin of 1/2. Exploitation of this in a single-photon source requires knowledge of the properties of the fluorine donor in ZnSe. Capacitance-Voltage and Hall-Effect have been measured to estimate the fluorine donor concentration and the carrier background concentration in ZnSe layers. Several ZnSe:F samples were grown by molecular beam epitaxy using various fluxes of fluorine. The fluorine donor concentration is found to increase with increasing fluorine source temperature. The carrier background concentration was established in the order of 10^{15} cm^{-3}. For the isolation of individual F-atoms different etching techniques were used to fabricate micro-discs and mesa structures with diameter between 10 and 1 μm. Surface and edge morphologies were investigated by atomic force microscopy and scanning electron microscopy. The optical properties of few and individual F-atoms inside mesa and micro-disc structures were measured. Deterministic photon emission from individual F-Donor bound excitons was observed.

HL 46.63 Thu 15:00 Poster A

Polaron and phonon properties in WO_3 thin films — •Mario Saenger[1], Thomas Höing[2], Tino Hofmann[1], and Mathias Schubert[1] — [1]Center for Materials and Nanoscience, Department of Electrical Engineering, University of Nebraska-Lincoln, NE 68588-0511, U.S.A. — [2]FLABEG GmbH. und Co. KG, Glasserstr. 1, D-93437, Furth i. Wald, Germany

We report on the evolution of the optical phonon and polaron mode properties in amorphous tungsten oxide thin films by spectroscopic ellipsometry over the infrared to ultraviolet spectral range upon electrochemical proton and electron intercalation. We obtain a quantitative description for the coloration induced optical constants spectra changes by model dielectric function analysis of the intercalated thin films. Upon increased intercalated charge densities we observe the strong polarity reduction of the tungsten-oxygen bending mode, the formation of a distinct vibration band located above the tungsten oxide phonon modes, a strong increase of polarity together with the red shift of the polaron mode, whereas proton- and moisture-related lattice vibration modes remain unaltered. Our experimental results indicate no actual hydrogen incorporation upon intercalation. From the phonon mode changes we suggest that oxygen extraction related defect generation upon intercalation causes the polaron formation, also indicative for tungsten oxidation-state reduction from W^{6+} to W^{5+}. The red shift of the polaron mode can be explained by increase in polaron-polaron interaction, while its amplitude dependance on the intercalated charge density is concordant with the exponential intercalation model

HL 46.64 Thu 15:00 Poster A

Correlation between structural, optical and electrical prop-

erties and the suitability of phase change alloys — •Michael Woda, Christoph Steimer, Daniel Wamwangi, and Matthias Wuttig — I. Insitute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany

Phase change random access memory (PCRAM) is a very promising candidate to replace Flash memories employed in the non-volatile storage sector. In the active region of this emerging memory, a phase change material is found. This class of materials is already used in rewritable optical data storage. In both application areas the reversible switching between the amorphous and the crystalline state by short current or laser pulses, respectively is used to store data.

A key question that has not yet been answered regards the optimum choice of materials for phase change recording. We present a material selection strategy which classifies carefully chosen alloys, being representative for a larger selection of phase change materials, regarding their suitability for non-volatile storage applications.

XRD and XRR measurements reveal structural properties of the as-deposited, amorphous and the crystalline state, the corresponding local bond arrangements and the change of film density. Ellipsometry measurements determine the optical contrast of the samples while the temperature dependent resistivity is measured by four point probe experiments. Finally the electrical switching behaviour is tested in nanometer size test cells to validate the full functionality of the chosen materials.

HL 46.65 Thu 15:00 Poster A

Resonant photoluminescence up-conversion in a multi quantum well structure mediated by surface acoustic waves — •Stefan Völk[1], Jens Ebbecke[1], Achim Wixforth[1], Dirk Reuter[2], and Andreas Wieck[2] — [1]Institut für Physik der Universität Augsburg, Experimentalphysik I, 86135 Augsburg, Germany — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany

We have investigated the excitation emission spectrum of a multi quantum well (MQW) structure under the influence of a surface acoustic wave (SAW). Electron-hole pairs can be excited by laser light in semiconductor structures which form excitons at low temperatures.

The recombination of electron-hole pairs leads to emission of photoluminescence (PL) light. This emission energy is in general equal or smaller than the energy of the optical excitation source. In quantum well (QW) structures the emission energy is defined by the lowest quantized energy levels.

PL up-conversion means that the energy of emitted photons is higher than the excitation energy. Such a process can be observed in MQW structures with QWs of different widths by applying a SAW. We explain this effect through a dynamic conduction and valence band modulation leading to a resonant charge carrrier population of QWs.

HL 46.66 Thu 15:00 Poster A

Crystallization in mass-asymmetric electron-hole bilayers — •Patrick Ludwig[1,2], Alexej Filinov[1,3], Yurii Lozovik[3], Heinrich Stolz[2], and Michael Bonitz[1] — [1]CAU zu Kiel, ITAP, Leibnizstrasse 15, D-24098 Kiel — [2]Universität Rostock, Institut für Physik, Universitätsplatz 3, D-18051 Rostock — [3]Institute of Spectroscopy RAS, Moscow region, Troitsk, 142190, Russia

We focus on the effect of the mass ratio on crystal formation in quantum electron-hole bilayers. Varying the mass ratio M of holes and electrons between 1 and 100 for a fixed layer separation at low temperature and high density, one can tune the hole behavior from delocalized (quantum) to localized (quasi-classical) while the electrons remain delocalized all the time.

As was recently observed for bulk semiconductors [1], holes undergo a phase transition to a crystalline state if the mass ratio exceeds a critical value of $M_{cr} \approx 80$. Here, we extend this analysis to bilayers where M_{cr} can be drastically reduced by properly choosing d and the in-layer particle density. The complicated overlap of correlation and quantum effects of both, electrons and holes, is fully taken care of by performing first-principle path integral Monte Carlo simulations. We present results for two types of e-h bilayers: a mesoscopic system of $N = 36$ particles in a parabolic trap and for a macroscopic system of the same density.

[1] M. Bonitz, V.S. Filinov, V.E. Fortov. P.R. Levashov, and H. Fehske, Phys. Rev. Lett. **95**, 235006 (2005)

HL 46.67 Thu 15:00 Poster A

Effect of doping on the band structure in Spin-LED devices — •N. Höpcke, W. Löffler, C. Sailer, J. Lupaca-Schomber, S. Li, T. Passow, C. Klingshirn, M. Hetterich, and H. Kalt — Institut für Angewandte Physik and DFG Center for Functional Nanostructures (CFN), Universität Karlsruhe (TH), 76128 Karlsruhe, Germany

We develop p-i-n diode structures to initialize and detect the electron spin for investigations on spin dynamics. The spins are aligned in the diluted magnetic semiconductor ZnMnSe. In an InGaAs/GaAs quantum-dot layer the recombination of electrons and holes takes place and the polarization of the emitted light is a direct proof of the electron spin state. Here, we investigate the effect of the doping concentration in the ZnMnSe layer on the bandstructure and thereby on the spin polarization. Decreasing the doping concentration leads to higher polarization at low fields and avoids charging of the quantum dots.

HL 46.68 Thu 15:00 Poster A

Ferroelectric properties of $BaTiO_3$ - ZnO heterojunctions — •Matthias Brandt[1], Holger von Wenckstern[1], Holger Hochmuth[1], Michael Lorenz[1], Marius Grundmann[1], Jürgen Schubert[2], Venkata Voora[3], and Mathias Schubert[3] — [1]Universität Leipzig, Institut für Experimentelle Physik II, Leipzig, Germany — [2]IBN 1-IT and cni, Forschungszentrum Jülich GmbH, Jülich, Germany — [3]Department of Electrical Engineering, University of Nebraska-Lincoln, Lincoln, U.S.A.

Bariumtitanate (BTO), as many materials in the perowskite structure, exhibits a spontaneous polarization which is switchable by an external electric field if the crystal exists in its ferroelectric phase (below the curie temperature of $\approx 120°$C). ZnO, a wurtzite crystal, shows a spontaneous polarization parallel to its crystallographic c axis, regardless of the outer field. Within this work, BTO films have been grown by pulsed laser deposition (PLD) on various substrates (Si, Pt, STO with SRO buffer, STO:Nb). Formation of heterojunctions between these materials leads to the occurrence of unique coupling effects. These cause polarization hysteresis, which we observed in electrical and electro-optical measurements. Structural, optical and electrical properties of these heterojunctions will be compared to results obtained from bare BTO layers. Further a model of the polarization exchange coupling was developed, and will applied to analyze the experimental data.

HL 46.69 Thu 15:00 Poster A

Magnetic bipolar heterojunction based on Ga(Mn)As — •Heigl Stefan, Ursula Wurstbauer, Dieter Schuh, and Werner Wegscheider — Universität Regensburg, Institut für Experimentelle und Angewandte Physik, D-93040 Regensburg

We report on the results of transport measurements on magnetic bipolar GaMnAs heterostructures grown by molecular beam epitaxy. Devices based on spin-polarized bipolar transport employing GaMnAs layers were already proposed by Fabian et al. [1]. We have fabricated GaAs based pn-heterojunctions using silicon for n-type doping, carbon for non magnetic p-type doping and manganese for magnetic pmag - type doping. In a first growth step we deposited a 1 μm thick highly doped n- or p- type GaAs layer on semi insulating (001) GaAs. After ex-situ cleaving the substrate, we have overgrown the (110) cleavage plane with a complementary doped (p-, p_{mag}- or n-type) thin GaAs layer. These devices show the typical I-V characteristic known for pn-junctions. If Mn is used as a dopant, additional features for this magnetic pn-junction appear in the I-V curves when a magnetic field is applied. We acknowledge the support of this work by the DFG via SFB 689 Spinphänomene in reduzierten Dimensionen. [1] I. Zutic, J. Fabian, and S. Das Sarma, Rev. Mod. Phys. 76, 323 (2004)

HL 46.70 Thu 15:00 Poster A

Optical Modes in Pyramidal Microcavities — •Frank M. Weber[1], Matthias Karl[1], Jaime Lupaca-Schomber[1], Wolfgang Löffler[1], Shunfeng Li[1], Thorsten Passow[1], Jacques Hawecker[2], Dagmar Gerthsen[2], Heinz Kalt[1], and Michael Hetterich[1] — [1]Universität Karlsruhe (TH) and Center for Functional Nanostructures (CFN), 76128 Karlsruhe, Germany — [2]Laboratorium für Elektronenmikroskopie and CFN, Universität Karlsruhe (TH), 76128 Karlsruhe, Germany

We investigate the application of pyramidal GaAs structures on GaAs/AlAs distributed Bragg reflectors as optical resonators. The structures are fabricated using electron beam lithography and a wet chemical etching technique. In contrast to self-assembled growth this allows us to engineer the exact geometry of the microcavities. InGaAs quantum dots (QDs) inside the cavity couple to the resonator and the luminescence spectrum of the QD ensemble around 950 nm

shows clear peaks. These correspond to optical modes in the pyramid which is confirmed by temperature-dependent measurements. We further investigate and simulate the dependence of the modal density on pyramid size. Complex structures such as pyramids with interconnects which could serve as coupled resonators were also manufactured.

HL 46.71 Thu 15:00 Poster A

Coupled micro-cavities based on GaAs pillars — •Matthias Karl[1], Wolfgang Löffler[1], Shunfeng Li[1], Thorsten Passow[1], Erich Müller[2], Fabián Pérez-Willard[2], Dagmar Gerthsen[2], Heinz Kalt[1], and Michael Hetterich[1] — [1]Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe (TH), 76128 Karlsruhe, Germany — [2]Laboratorium für Elektronenmikroskopie and CFN, Universität Karlsruhe (TH), 76128 Karlsruhe, Germany

Pillar-type micro-cavities are studied in our contribution. The pillars are milled with a focused ion beam out of a layer structure with top and bottom AlAs/GaAs distributed Bragg reflectors grown by molecular-beam epitaxy. In(Ga)As quantum dots emitting at around 950 nm are embedded in the middle of the GaAs-based λ-cavity. Optical modes in these pillars are detected by a micro-photoluminescence set-up.

Treating the pillar as a short step-index fiber we are able to model the experimental results with a finite-element method. This allows us to predict the resonances for different pillar diameters as well as for coupled pillar structures. Asymmetric coupled resonators designed by our calculations are investigated experimentally achieving optical modes either localized in one of the pillars or delocalized over the whole structure.

HL 46.72 Thu 15:00 Poster A

Stability of Mesoporous Ultra-low Refractive Index Substrates — •Denan Konjhodzic[1], Matthias Herrmann[2], and Frank Marlow[1] — [1]Max-Planck-Institut für Kohlenforschung, Kaiser-Wilhelm-Platz 1, D-45470 Mülheim an der Ruhr, marlow@mpi-muelheim.mpg.de, www.mpi-muelheim.mpg.de/marlow.html — [2]Technische Universität Chemnitz, Straße der Nationen 62, D-09107 Chemnitz

Mesoporous silica films synthesized by dip-coating in an evaporation-induced self-assembly process have been used for the first time as low-n substrates for 2D photonic crystals [1]. They have wide applications in the field of photonic crystals and optical waveguides. The optimized low refractive index films (n = 1.18) have been synthesized at low humidity conditions, whereas at higher humidity other interestingly structured films are found [2].

In this contribution we investigate the stability of the films in respect to thermal and mechanical stress, as well as the stability upon high humidity treatment and ageing. The structure stability was shown by small angle X-ray scattering and refractive index measurements. The mechanical properties (e.g. Young modulus) were determined from the nanoindentation. Stability of the refractive index was investigated with the angle-dependent interferometry and was found to be high under ambient humidity and temperature conditions.

[1] M. Schmidt et al., Appl. Phys. Lett. 85 (2004) 16
[2] D. Konjhodzic et al., Appl. Phys. A 81 (2005) 425

HL 46.73 Thu 15:00 Poster A

Modified Radiation Dynamics in Nanostructured Materials — •Jens Niegemann, Martin Pototschnig, Lasha Tkeshelashvili, and Kurt Busch — Institut für Theoretische Festkörperphysik, Universität Karlsruhe

Since photonic crystals have been proposed in 1987, the modification of spontaneous emission has been considered as a feature of fundamental interest. Here, we use a high-accuracy time-domain simulation of the coupled Maxwell-Bloch-equations, to investigate the influence of photonic crystals and/or metallic nano-structures on the decay of initially excited two-level atoms. In particular, we investigate the effects of finite sample sizes as well as the influence of non-radiative transitions and dephasing.

All simulations are performed by a non-linear extension of a matrix-exponential integrator based on Krylov-subspace techniques [1]. This method provides highly accurate and stable results while still allowing us to treat lossy, optically anisotropic and dispersive materials as well as CFS-PML boundary conditions. Thus, it is very well suited to study a large variety of experimentally relevant systems.

[1] J. Niegemann, L. Tkeshelashvili, and K. Busch, "Higher-order time-domain simulations of Maxwell's equations using Krylov-subspace methods", J. Comput. Theor. Nanosci. (in press)

HL 46.74 Thu 15:00 Poster A

Simulation of Metallic Nanostructures using Krylov-subspace methods — •Michael König, Jens Niegemann, Lasha Tkeshelashvili, and Kurt Busch — Institut für Theoretische Festkörperphysik, 76128 Karlsruhe, Germany

The Krylov-subspace method provides a stable, highly accurate scheme for the numerical solution of Maxwell's equations. We present an extension of the basic algorithm [1] to include perfectly matched layers and Drude-Lorentz dispersion relations, which are implemented through auxiliary differential equations. This approach allows an accurate and efficient simulation of metallic nanostructures in open, three-dimensional systems. Specifically, we compare numerical calculations for certain metallic model systems with experimental results. In particular, the accuracy and efficiency of our approach allows to investigate local field enhancement effects in metallic nanostructures.

[1] J. Niegemann, L. Tkeshelashvili, and K. Busch, Higher-order time-domain simulations of Maxwell's equations using Krylov-subspace methods, J. Comput. Theor. Nanosci. (in press)

HL 46.75 Thu 15:00 Poster A

Optimized design of plasmonic MSM photodetector — •Jurana Hetterich[1], Georg Bastian[2], Nikolai A. Gippius[3], Sergei G. Tikhodeev[3], Gero von Plessen[4], and Uli Lemmer[1] — [1]Lichttechnisches Institut, Universität Karlsruhe, Kaiserstr. 12, 76131 Karlsruhe, Germany — [2]Fachbereich Technik, Fachhochschule Trier, Schneidershof, 54293 Trier, Germany — [3]A. M. Prokhorov General Physics Institute RAS, Vavilova 38, Moscow 119991, Russia — [4]Institute of Physics (IA), RWTH Aachen University, 52056 Aachen, Germany

We present an optimized design for a plasmonic metal-semiconductor-metal (MSM) photodetector with interdigitated electrodes with subwavelength dimensions and a single GaInNAs quantum well as an absorbing layer. Our calculations show that the coupling between localized plasmons and waveguiding modes leads to a strong enhancement of the electromagnetic field near the metallic electrodes, which results in an increased absorption in the quantum well. This allows both high quantum efficiency and fast electrical response of the MSM photodetector. As the localized plasmons in 1D metallic gratings can be excited only by light polarized perpendicular to the slits (TM polarization) the photodetector is expected to be polarization sensitive. With a grating periodicity of 820 nm and electrode finger width of 460 nm a 16-fold increase in the absorption of TM-polarized light in the quantum well is achieved in comparison to a case without electrodes. First experimental results will be shown and compared with the simulation.

HL 46.76 Thu 15:00 Poster A

Electrodeposited ZnO / tetrasulfophthalocyanatonickel (TSPcNi) films: An inorganic / organic hybrid system with infinitely variable composition — Cathrin Boeckler, Armin Feldhoff, and •Torsten Oekermann — Institute of Physical Chemistry and Electrochemistry, Leibniz Universität Hannover, Callinstrasse 3-3A, 30167 Hannover, Germany

Electrodeposition is a low-cost and convenient method for the preparation of inorganic / organic hybrid materials for optoelectronic applications such as dye sensitized solar cells, in which high efficiencies were achieved with electrodeposited nanostructured ZnO / dye films [1]. ZnO / dye hybrid systems investigated so far were based on a ZnO framework, which became instable at higher dye concentrations. We now found that electrodeposited ZnO / TSPcNi hybrid films represent a system which can be infinitely varied in its content. With increasing dye concentration in the deposition bath, a transition from films based on crystalline ZnO, which appear green due to TSPcNi momomers, over blue films with dye dimers or aggregates to deep blue films based on an amorphous dye framework is observed. All films are highly transparent. The electrical and photoelectrical properties are dominated by the respective framework of each film. Consequently, films with a balanced composition show the lowest conductivity, while their photoconductivity is the highest, indicating that both phases take part in the transport of photogenerated electrons.

[1] T. Yoshida, M. Iwaya, H. Ando, T. Oekermann, K. Nonomura, D. Schlettwein, D. Wöhrle, H. Minoura, Chem. Commun. 2004, 400.

HL 46.77 Thu 15:00 Poster A

Scanning capacitance microscopy measurements on Si epilayers — •C. Henkel[1], H. Schmidt[1], C. Sturm[1], M. Grundmann[1], A. Krtschil[2], A. Krost[2], P. Pelzing[3], and A. Möller[3] — [1]Universität

Leipzig, Fakultät für Physik und Geowissenschaften, EXPII, Germany — [2]Otto-von-Guericke-Unversität Magdeburg, Institut für Experimentelle Physik, Germany — [3]SGS Institut Fresenius GmbH, 01109 Dresden, Germany

We address the issue of extracting active dopant profile information from scanning capacitance microscopy (SCM) measurements because the direct imaging of dopant distribution and electrically active defects on the nanometer scale is one of the important issues facing semiconductor industry today. The samples are cross sections of differently doped Si epilayers on Si substrates with a native oxide layer as the insulating surface layer in the local metal-oxide semiconductor (MOS) structure. The SCM measurements have been performed at different biases ranging from -3 V to +3 V using a Dimension 3100 from Veeco Instruments. Before probing SCM at systematically increased bias voltages starting from -3V, the conducting tip has been shortly biased by 3V/0V in order to reach equilibrium conditions.We used a realistic one-dimensional MOS model taking into account high frequency effects, contact resistance and a surface layer capacitance to simulate dC/dV-V characteristics measured on the Si epilayers. Finally, by converting the measured SCM data into doping profiles, we demonstrate the capability of the SCM technique for extracting the free charge carrier concentration.

HL 46.78 Thu 15:00 Poster A

Untersuchung von Halbleiter-Nanopartikeln in levitierten flüssigen Mikrotropfen im weichen Röntgenbereich — •René Lewinski[1,2], Sofia Dembski[2], Burkhard Langer[1], Christina Graf[1,2] und Eckart Rühl[1,2] — [1]Institut für Chemie und Biochemie, FU Berlin, Takustr. 3, 14195 Berlin — [2]Institut für Physikalische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg

Halbleiternanopartikel (HNP) haben einzigartige, größenabhängige optische und elektronische Eigenschaften. Die Untersuchung der elektronischen und geometrischen Struktur mittels weicher Röntgenstrahlung erfolgte bisher nur an getrockneten Proben auf Oberflächen, was den Nachteil der unkontrollierten Aufladung der HNP hat. Zudem werden HNP meist in Flüssigkeiten angewendet, wo sich die elektronische Struktur von der auf Oberflächen unterscheidet. Wir haben deshalb HNP in einem Flüssigkeitstropfen dispergiert und in einer elektrodynamischen Falle levitiert. So können HNP mit weicher Röntgenstrahlung untersucht und der Ladungszustand des Tropfens definiert eingestellt werden. Solche Experimente erfordern jedoch Hochvakuumbedingungen, weshalb zur Dispersion der HNP ein hochsiedendes, flüssiges Siloxan-Copolymer verwendet wurde. Die Detektion der Röntgenabsorptionsfeinstruktur im kantennahen Bereich (NEXAFS) erfolgte durch Messung der röntgenangeregten optischen Fluoreszenz, da in der Falle eine Detektion von Ladungsträgern nicht möglich ist. Zunächst wurde das Dispersionsmittel durch Messungen an der Si 2p Kante charakterisiert. Die HNP wurden an der S 2p und Se 3p Kante vermessen.

HL 46.79 Thu 15:00 Poster A

Temperature variations during low-temperature growth of GaMnAs — •Kamil Olejnik, Vit Novak, Miroslav Cukr, and Jiri Oswald — Institute of Physics AS CR, Cukrovarnicka 10, 162 53 Prague, Czech Republic

Substrate temperature is known to be a critical parameter in the low-temperature MBE growth of ferromagnetic GaMnAs layers. We report on significant temperature changes of the GaAs substrate determined by band-gap spectroscopy technique during the growth of the GaMnAs film. Typically, an increase of 20 - 40 degrees is observed within the first 20 nm of the growing layer, depending mainly on the Mn doping level; at the same time no increase of the thermocouple temperature is detected. The effect is attributed to the free carrier and Mn-acceptor related absorption, both increasing along with the increasing Mn content. A mathematical model is formulated based on the heat balance between the thermal sources, radiative cooling and the heat capacity of the substrate. Within the proposed overheating mechanism the onset of the surface roughening during the growth can be ascribed to reaching a certain critical substrate temperature. (Grant Nr.202/04/1519)