HL 17 Poster Ib

Zeit: Freitag 16:30–19:00 Raum: Poster TU F

HL 17.1 Fr 16:30 Poster TU F

Untersuchung von strukturierten II-VI-Halbleiter-Nanopartikeln in unterschiedlicher Umgebung — •R. Lewinski[1], S. Dembski[1], A. Hoffmann[1], A. Gabriel[1], C. Graf[1], R Neder[2], M. Grimm[1], B. Langer[1] und E. Rühl[1] — [1]Institut f. Physikalische Chemie, Universität Würzburg, Am Hubland, 97074 Würzburg — [2]Institut f. Mineralogie und Kristallstrukturlehre, Universität Würzburg

Die elektronischen und strukturellen Eigenschaften von schichtweise aufgebauten II-VI-Halbleiter-Nanopartikeln wurden untersucht. Die Nanopartikel lassen sich mit einer neuartigen Methode chemisch modifizieren, so dass sie in größeren Partikeln einbettbar sind bzw. auf der Oberfläche von Metallkolloiden deponierbar werden. Dadurch sind die strukturellen Eigenschaften der Partikel in unterschiedlicher lokaler Umgebung untersuchbar. Die Kristallstruktur der Partikel wurde mit hochauflösender Elektronenmikroskopie und Röntgendiffraktometrie charakterisiert. Experimente zur Variation der Partikelumgebung wurden in einer Partikelfalle durchgeführt, die eine berührungsfreie Speicherung von Einzelpartikeln zulässt. Die Untersuchung der lokalen elektronischen Struktur erfolgte durch elementspezifische Anregung mit weicher Röntgenstrahlung.

HL 17.2 Fr 16:30 Poster TU F

Untersuchung makroskopischer Lumineszenzausbreitung in ZnO — •Manuel Decker, Heiko Priller, Robert Hauschild, Heinz Kalt und Claus Klingshirn — Institut für Angewandte Physik, Universität Karlsruhe (TH)

Bei der Untersuchung mehrerer ZnO Volumenproben beobachten wir bei T=100K neben der bandkantennahen UV-Photolumineszenz (PL) und dem grünen Emissionsband, verursacht von Sauerstoffleerstellen, zusätzlich noch eine orangene PL-Bande, deren ungewöhnliches zeitliches Verhalten genauer untersucht wird. Diese PL unterscheidet sich von der Lumineszenz in den anderen Spektralbereichen dadurch, dass diese sich langsam vom Anregungsspot über mehrere Millimeter zum Rand der Volumenprobe hin ausbreitet. Nach Abschalten der Laseranregung klingt diese PL im gesamten Kristall gleichmäßig ab. Das Transportphänomen kann durch ein 2d-Diffusionsmodell gut beschrieben werden. Durch Simulation der zeitlichen Dynamik und Vergleich mit den Messdaten wurden Mobilität und Zerfallszeit zu $\mu = 46cm^2/Vs$ respektive $\tau = 0.1s$ bestimmt. Als Interpretation werden ein thermisch aktivierter Hopping Prozess oder ein Elektron- bzw. Lochtransport in Störstellenbändern diskutiert.

HL 17.3 Fr 16:30 Poster TU F

Quadrupole Interaction in Some Spinel Type Ternary Semiconductors — •Veaceslav Samokhvalov[1], Jens Kortus[2], Frank Schneider[3], and Sepp Unterricker[3] — [1]AMD Dresden — [2]MPI für Festkörperforschung Stuttgart — [3]Institut für Angewandte Physik, TU Bergakademie Freiberg, D-09596 Freiberg

An extended group of ternary semiconductors AB_2C_4 (e.g. $CdCr_2Se_4$, $CdIn_2S_4$, $ZnAl_2S_4$) crystallize in the lattice of normal spinel. At the B- and C-sites large electric field gradients (efg) exist. Such efg can be calculated by modern ab-initio methods like the WIEN97 code. A comparison between experiment and theory can judge the quality of calculated charge density distributions. With the PAC-method efg with impurity probes can be determined also. By the calculation of such systems beside accurate anion parameters u the relaxation of the neighbours has to be taken into account. This requires a unit cell of 56 atoms at least.

HL 17.4 Fr 16:30 Poster TU F

Hall effect measurements on ZnO thin films — •Matthias Brandt, Holger von Wenckstern, Susanne Heitsch, Gabriele Benndorf, Holger Hochmuth, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnestrasse 5, 04103 Leipzig

We have investigated the free carrier concentration and the Hall mobility of ZnO thin films in a wide temperature range. The thin films are grown by pulsed laser deposition on a-plane sapphire substrates. We have investigated four different kinds of samples: nominally undoped ZnO, nominally undoped ZnO grown on a MgO buffer layer, Al or Ga doped samples, and Al or Ga doped samples deposited in a MgO buffer layer. The dominating scattering mechanisms and the dominating donor levels are determined and discussed. Further we investigated the optical properties of the thin films using photoluminescence measurements. The obtained results are compared to temperature dependent Hall data of state of the art single crystals.

HL 17.5 Fr 16:30 Poster TU F

Influence of the incorporation of group V elements on the electrical properties of ZnO thin films — •Holger von Wenckstern, Susanne Heitsch, Gabriele Benndorf, Daniel Spemann, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstrasse 5, 04103 Leipzig

We have grown ZnO thin films by pulsed laser deposition on sapphire substrates. The samples were doped with N or with P in order to investigate the change in electrical conductivity compared to nominally undoped samples. For that we have used ZnO targets containing different amounts of e.g. P_2O_5 or e.g. Zn_3N_2. The electrical properties are related to the content of the group V acceptors. A number of samples is also investigated by photoluminescence measurements and new features in the recombination spectrum are correlated with the incorporation of N or P. The changes of the electrical properties after annealing the thin films at temperatures higher than 700°C are also reported.

HL 17.6 Fr 16:30 Poster TU F

Brechungsindex von kubischem $Mg_xZn_{1-x}O$ — •Anke Carstens[1], Rüdiger Schmidt-Grund[1], Bernd Rheinländer[1], Mathias Schubert[1], Holger Hochmuth[1], Michael Lorenz[1], Craig M. Herzinger[2] und Marius Grundmann[1] — [1]Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig — [2]J. A. Woollam Co., Inc. 645 M Street, Suite 102, Lincoln, Nebraska, 68508, USA

$Mg_xZn_{1-x}O$ ist attraktiv für Anwendungen als aktives Material in optoelektronischen Bauelementen, in Bragg-Reflektoren und als Material für optische Bauteile im UV-Bereich. Spektroskopische Ellipsometrie wurde im Spektralbereich von 0,75 eV bis 9,5 eV auf $Mg_xZn_{1-x}O$-Dünnfilme angewendet, die mittels PLD (pulsed laser deposition) auf c-orientierten Al_2O_3 Substraten abgeschiedenen worden waren.

Der Brechungsindex wurde an Proben mit verschiedener Mg-Konzentration ($0.67 \leq x \leq 1$) im Spektralbereich zwischen 0,75 eV und 0,9EG(x) mit einer Genauigkeit von typisch ±0,02 bestimmt. Einflüsse der Oberflächenrauhigkeit wurden mittels verallgemeinerter Ellipsometrie (Mueller-Matrix-Analyse) untersucht und in die Brechungsindex-Analyse einbezogen.

HL 17.7 Fr 16:30 Poster TU F

FIR-MIR Fourier transform spectroscopy of $Zn_{1-x}Mn_xSe$ epilayers grown by molecular-beam epitaxy — •K. C. Agarwal, B. Daniel, C. Klingshirn, and M. Hetterich — Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76131 Karlsruhe, Germany

$Zn_{1-x}Mn_xSe$ is one of the most widely studied diluted magnetic semiconductors (DMS). Recently, DMS like $Zn_{1-x}Mn_xSe$ have been demonstrated to be useful as spin aligners, important ingredients for possible spin-based opto-electronic devices. In this contribution, we present the results of our investigations of n-doped and undoped ZnMnSe epilayers grown by molecular beam epitaxy (MBE) on GaAs(001) substrate. From plasma edge reflection studies of n-doped $Zn_{1-x}Mn_xSe$ epilayers ($0 \leq x \leq 0.13$), the carrier density dependent electron effective mass and transport properties are determined for different Mn contents. In addition, FIR investigations of undoped $Zn_{1-x}Mn_xSe$ epilayers were used to study the temperature dependence of phonons and the high frequency dielectric constant in this material for various Mn contents ($0 \leq x \leq 0.78$).

HL 17.8 Fr 16:30 Poster TU F

Wachstum und Charakterisierung zweidimensionaler ZnO:Al Nanoblätter und Nanowände durch Al2O3-unterstützte Carbothermale Verdampfung — •A. Rahm[1], G.W. Yang[2], M. Lorenz[1], Th. Nobis[1], J. Lenzner[1], G. Wagner[3] und M. Grundmann[1] — [1]Universität Leipzig, Institut für Experimentelle Physik II, D-04103 Leipzig, Deutschland — [2]State Key Laboratory of Optoelectronic Materials and Technologies, School of Physics and Engineering, Zhongshan University, Guangzhou 510275, P. R. China — [3]Universität Leipzig, Institut für Mineralogie, Kristallographie und Materialwissenschaft, D-04103 Leipzig, Deutschland

Mit Hilfe eines Al2O3 unterstützten carbothermalen Verdampfungsprozesses wurden freistehende zweidimensionale ZnO Nanoblätter und honigwabenähnlich verbundene Nanowände zusammen mit Nanodrähten auf goldbedeckten a-Saphir bzw. GaN/Si(111) Substraten gewachsen. Röntgendiffraktionsmessungen haben ergeben, dass die ZnO(0001) und die ZnO(10-11) Orientierung bei den Nanoblättern vorherrschend sind. Transmissionselektronenmikroskopie (TEM), Elektronenverlustspektroskopie (EDX), sowie Rasterelektronenmikroskopie (SEM) wurden zur weiteren strukturellen Charakterisierung verwendet und wir beweisen damit, dass ein Vapor-Liquid-Solid (VLS) Wachstum stattfindet. Temperaturabhängige Kathodolumineszenzmessungen zeigen Donator-Akzeptor-Paar-Übergänge, sowie gebundene Excitonen mit einer Halbwertsbreite von 2.1 meV bei 10K.

HL 17.9 Fr 16:30 Poster TU F

Eignung von ZnO-Nanosäulen als Laseremitter — •Holger Lange[1], Robert Hauschild[1], Joachim Zeller[1,2], Rainer Kling[3], Andreas Waag[4], Claus Klingshirn[1] und Heinz Kalt[1,2] — [1]Universität Karlsruhe (TH) — [2]Center for Functional Nanostructures, Karlsruhe — [3]Universität Ulm — [4]TU-Braunschweig

ZnO-Nanosäulen zeigen selbst bei Raumtemperatur Laseremission und stehen nicht nur deshalb im Mittelpunkt reger Forschungsbemühungen. In diesem Beitrag werden mit Hilfe von numerischen Simulationen (Finite-Elemente-Methode, approximative 3D-Geometrie) die Resonatoreigenschaften von ZnO-Nanosäulen berechnet. Der Einfluss von Geometrieparametern und Substrateigenschaften auf den Q-Faktor wird untersucht.
Im experimentellen Teil werden mit Hilfe spektroskopischer Methoden Alterungseffekte analysiert. Für Nanosäulen und Nanokristallite werden die Lumineszensspektren von frisch präparierten und gealterten Proben mit unter verschiedenen Parametern getemperten Proben verglichen.

HL 17.10 Fr 16:30 Poster TU F

Room-temperature cathodoluminescence of n-type ZnO thin films grown by PLD in N_2, N_2O, and O_2 background gas. — •M. Lorenz[1], H. Hochmuth[1], T. Nobis[1], J. Lenzner[1], G. Zimmermann[1], M. Diaconu[1], H. Schmidt[1], H. von Wenckstern[1], A. Schön[2], D. Schenk[2], and M. Grundmann[1] — [1]Universität Leipzig, Fakultät für Physik und Geowissenschaften, 04103 Leipzig, Germany — [2]El-Mul Technologies Ltd., Soreq, Yavne 81104, Israel

Epitaxial ZnO thin films were grown by pulsed laser deposition (PLD) in N_2, or N_2O, or O_2 background gas on MgO buffered a-plane sapphire substrates. The excitonic room temperature cathodoluminescence (CL) intensity, the carrier concentration and the Hall mobility show well defined maxima for films grown at PLD gas pressures of ca. 1 mbar N_2, N_2O, and O_2. However, despite the comparable high CL intensities of the ZnO films grown in the three different background gases, their surface roughness varied considerably. Films with rough surface show a broadening and splitting of the room temperature CL peak into maxima at 3.21 and 3.26 eV which could be due to either grain morphology or spatial variation of the electronic defect structure. Large-area PLD ZnO thin films were used to demonstrate scintillator device applications. Work supported partially (HS, MD) by the BMBF, FKZ 03N8708.

HL 17.11 Fr 16:30 Poster TU F

Transport of spin-polarized excitons in $Zn_{1-x}Mn_xSe$-based II-VI heterostructures — •B. Daniel, W. Löffler, D. Tröndle, C. Klingshirn, H. Kalt, and M. Hetterich — Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76131 Karlsruhe, Germany

In order to study the transport of spin-polarized excitons through II-VI heterostructures in a magnetic field, polarization-resolved photoluminescence (PL) was measured on a series of different semiconductor heterostructures grown on GaAs by molecular beam epitaxy. To align the exciton spin, either ZnMnSe layers or short-period superlattices (ZnSe/MnSe or CdSe/ZnMnSe) were used. By measuring the PL shift of the latter as a function of the applied magnetic field, the effective g factor could be determined for the different structures. The circular emission detected proved that exciton spin polarization indeed took place. The heterostructures investigated consisted of a buffer layer (ZnSe), a quantum well (CdSe or ZnCdSe), a barrier (ZnSe) and a spin aligner layer (one of the above). In order to clarify the role of different contributions to the polarization degree of the quantum well PL polarization, a series of such structures was grown and investigated, varying in the Mn or Cd content of the spin aligner layer, the thickness of the barrier, and the Zn content in the quantum well. Additional information was deduced from experiments with different excitation wavelength.

HL 17.12 Fr 16:30 Poster TU F

Transport properties of n-doped $Zn_{1-x}Mn_xSe$ semimagnetic heterostructures — •B. Daniel, K. C. Agarwal, J. Lupaca-Schomber, J. Kvietkova, C. Klingshirn, and M. Hetterich — Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76131 Karlsruhe, Germany

$Zn_{1-x}Mn_xSe$ alloys are promising candidates as spin aligners in optoelectronic spin devices. A series of n-doped $Zn_{1-x}Mn_xSe$:Cl samples with various compositions and doping concentrations has been grown by molecular beam epitaxy using elemental sources and $ZnCl_2$. To determine the carrier concentration and mobility as a function of temperature, Hall measurements in the van der Pauw geometry have been carried out on lithographically prepared clover leaf samples. Doping concentrations in the $10^{18}cm^{-3}$ range were observed in $Zn_{1-x}Mn_xSe$. With increasing Mn concentration a decrease in both the dopability and mobility was observed. Recently, we have also started further experiments concerning the investigation of $Zn_{1-x}Mn_xSe$/gold Schottky diodes and the magnetic field dependent tunnelling in $Zn_{1-x}Mn_xSe$/ZnSe structures.

HL 17.13 Fr 16:30 Poster TU F

Anionische Substitution in ZnMgTe — •Stefan Merita und Bruno K. Meyer — I.Physikalisches Institut JLU-Giessen, Heinrich-Buff-Ring 16, D-35392 Gießen

Wir untersuchen die Substituierbarkeit von Tellur durch Sauerstoff und Schwefel an polykristallinen Dünnschichten der Zusammensetzung $ZnTe_{1-x}(O,S)_x$ sowie $Zn_{1-y}Mg_yTe_{1-x}(O,S)_x$ und ihre Auswirkung auf die Bandkantenenergie und Kristallstruktur. Erste Versuche zur Dotierbarkeit des Materials mit Stickstoff werden präsentiert. Die Schichten werden über einen RF-Sputterprozess (Radiofrequenz, 13.56 MHz) hergestellt. Als Ausgangsmaterial dient ein ZnTe-Keramiktarget mit Auflagen von Mg-Folie, welches mit Argon als Prozessgas sowie variabler Zugabe von Sauerstoff bzw. Schwefelwasserstoff als Reaktivgas abgetragen wird. Die Resultate anschließender Temperaturbehandlung in unterschiedlicher Atmosphäre werden untersucht. Zur Analyse der Kristallstruktur wird Röntgenbeugung (XRD) verwendet, Bestimmung der Bandkantenenergie erfolgt mittels optischer Transmissionsmessung. Elektrische Materialeigenschaften (spezifischer Widerstand, Ladungsträgertyp, -dichte und -beweglichkeit) werden durch Hall-Messungen untersucht.

HL 17.14 Fr 16:30 Poster TU F

Guided growth of zinc oxide nano-pillars using self-organizing polymers for patterning the substrate with a catalyst — •Andre Langlois, Anton Reiser, Günther M. Prinz, Andreas Ladenburger, Martin Schirra, Rolf Sauer, and Klaus Thonke — Abteilung Halbleiterphysik, Universität Ulm, D-89069 Ulm

We have produced c-axis oriented zinc oxide nano-pillars via a vapor-liquid-solid process on a-plane sapphire substrates. The self-organizing properties of polymers are used to pattern the substrate surface with a catalyst to control the location of growth seeding. The dependence of the pillar thickness, height, and quality on the temporal growth temperature profile, source material, and oxygen supply during process is investigated. The catalyst pattern is analyzed by atomic force microscopy and high resolution scanning electron microscopy. The optical and crystalline properties of the asgrown nano-pillars are investigated by scanning electron microscopy, high resolution X-ray diffraction, photoluminescence spectroscopy, cathodoluminescence spectroscopy, and Raman spectroscopy.

HL 17.15 Fr 16:30 Poster TU F

Magneto-Photoluminescence and Raman study of zinc oxide nano-pillars — •Günther M. Prinz[1], Anton Reiser[1], Andre Langlois[1], Xinmin Cao[1], Andreas Ladenburger[1], Marek Potemski[2], Wolfgang Limmer[1], Rolf Sauer[1], and Klaus Thonke[1] — [1]Abt. Halbleiterphysik, Universität Ulm, D-89069 Ulm — [2]Grenoble High Magnetic Field Laboratory, 25 Av. de Martys, BP166

For optical characterization of zinc oxide nano-pillars grown on a-plane sapphire we used low-temperature Magneto-Photoluminescence(PL) and Raman spectroscopy. The g-Factors for electrons and holes were calculated based on Magneto-PL data. We observe similar donors and splittings as in ZnO bulk material. From splitting patterns recorded in Faraday and Voigt configuration we estimate the alignment degree of the pillars perpendicular to the a-plane of the substrate. Using Raman measurements we were able to calculate the strain parallel to the c-axis of the nano-pillars [1]. These results are consistent with high resolution x-ray diffraction data measured for comparison.

[1] Th. Gruber et al, J. Appl. Phys. 96(1) 289 (2004)

HL 17.16 Fr 16:30 Poster TU F

Optical phonons and infrared dielectric functions of hexagonal and cubic MgZnO thin films — •C. Bundesmann, M. Schubert, A. Rahm, D. Spemann, H. Hochmuth, E. M. Kaidashev, M. Lorenz und M. Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, D-04103 Leipzig, Germany

Infrared spectroscopic ellipsometry (IRSE) and Raman scattering is applied to study the phonon modes and infrared dielectric functions of $Mg_xZn_{1-x}O$ thin films, which are grown by pulsed laser deposition on c-plane and r-plane sapphire. X-ray diffraction reveals a hexagonal structure for the $Mg_xZn_{1-x}O$ thin films with $x \leq 0.53$, whereas a cubic structure is found for the $Mg_xZn_{1-x}O$ thin films with $x \geq 0.67$. The cubic $Mg_xZn_{1-x}O$ thin films show a one mode behavior, where the TO and LO phonon modes shift linearly with x.[3] The hexagonal c-plane oriented $Mg_xZn_{1-x}O$ thin films on c-plane sapphire show two modes each for polarizations $E\perp c$ and $E||c$.[1,2] The phonon mode behavior with x can be described by the modified random element isodisplacement model.[4] Furthermore, generalized IRSE is applied to a-plane MgZnO thin films on r-plane sapphire, which allows to access the full set of infrared dielectric tensor parameters.[5] For the a-plane MgZnO thin films three phonon modes each for polarizations $E\perp c$ and $E||c$ are detected.

[1] C. Bundesmann et. al, Appl. Phys. Lett. 81, 2376-2378 (2002).
[2] R. Schmidt et. al, Proc. 26th ICPS, Edinburgh, UK (2002).
[3] C. Bundesmann et. al, Appl. Phys. Lett. 85, 905-907 (2004).
[4] J. Chen and W. Z. Shen, Appl. Phys. Lett. 83, 2154 (2003).
[5] C. Bundesmann et. al, Thin Solid Films 455-456C, 161-166 (2004).

HL 17.17 Fr 16:30 Poster TU F

Phonon and free-charge-carrier properties in — •Tino Hofmann[1], Bruno Daniel[2], Kapil Chandra Agarwal[2], Michael Hetterich[2] und Mathias Schubert[1] — [1]Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, 04103 Leipzig — [2]Institut für Angewandte Physik, Universität Karlsruhe, Wofgang-Gaede-Straße 1, 76131 Karlsruhe

$Zn_{1-x}Mn_xSe$ is a potential spin aligner in spintronic devices. We determine the free-charge-carrier effective mass m of doped n-type $Zn_{1-x}Mn_xSe$:Cl grown by molecular beam epitaxy using magnetooptic generalized ellipsometry at far-infrared wavelengths ($100-650\ cm^{-1}$) and external magnetic fields $B = \pm 3$ T. A clear decrease of $m(Zn_{1-x}Mn_xSe, x > 0)$ compared with m(ZnSe) is observed. We furthermore report on the composition dependent MnSe- and ZnSe-like phonon mode frequencies for the composition range from $x = 0$ to 0.2.

HL 17.18 Fr 16:30 Poster TU F

Evidence for an electrically conducting layer at the native zinc oxide surface — •Oliver Schmidt[1], Arnd Geis[1], Peter Kiesel[1], Noble Johnson[1], Andreas Waag[2], and Gottfried Döhler[3] — [1]Palo Alto Research Center, 3333 Coyote Hill Rd., Palo Alto, CA 94304, USA — [2]University of Braunschweig, Institute for Semiconductor Technology, Hans-Sommer Str. 66, 38106 Braunschweig — [3]University of Erlangen, Institute for Technical Physics I, Erwin Rommel-Str. 1, 91058 Erlangen

Measurements of the electrical properties of high-resistivity zinc oxide (ZnO) are strongly influenced by the sample ambient. Temperature-dependent Hall-effect measurements were performed on Li- and Cu-doped bulk crystals in both air and vacuum. Repeating the measurements under a given test ambient produced stable results. Changing the ambient systematically changed the measured results. We explain this behavior in terms of a surface conducting channel that exists in vacuum but is destroyed upon exposure to air. We propose that the surface conducting layer is eliminated in air due to changes of the surface condition (i.e., molecular adsorption from the gas phase and/or surface reconstruction mechanisms).

HL 17.19 Fr 16:30 Poster TU F

Analysis of a conducting channel at the ZnO surface using MOS structures — •Arnd Geis[1], Oliver Schmidt[1], Peter Kiesel[1], Noble Johnson[1], Andreas Waag[2], Andrey Bakin[2], and Gottfried Döhler[3] — [1]Palo Alto Research Center, 3333 Coyote Hill Rd., Palo Alto, CA 94304, USA — [2]University of Braunschweig, Institute for Semiconductor Technology, Hans-Sommer Str. 66, 38106 Braunschweig — [3]University of Erlangen, Institute for Technical Physics I, Erwin Rommel-Str. 1, 91058 Erlangen

The electrical properties of high-resistivity zinc oxide (ZnO) are strongly influenced by the sample ambient. Bulk samples that have been high resistive in ambient air can be reversibly transferred into a high conducting state under vacuum.

As an explanation we proposed a conducting electron channel at the ZnO surface. Under vacuum this channel appears upon annealing. Exposure to ambient air destroys the channel. The channel is evident only for samples showing a high bulk resistivity, and it seems to be the "natural"state of the ZnO surface.

We have investigated a variety of surface passivation layers and coatings in order to preserve or avoid the surface conducting channel under either environment. Appropriate coatings that preserve the surface conducting channel have been used for fabrication of MOS structures. We investigated the nature of the conducting channel by modulating the free carrier concentration at the surface. Our findings are important with regard to MOSFET devices based on ZnO.

HL 17.20 Fr 16:30 Poster TU F

Direct writing of two-dimensional electron gases by focused ion beam implantation doping of inverted GaAs/AlxGa1-xAs-heterostructures — •Christof Riedesel, Dirk Reuter, and Andreas D. Wieck — Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstr. 150, D-44780 Bochum

We use molecular beam epitaxy (MBE) overgrowth of focused ion beam (FIB) implanted AlxGa1-xAs to fabricate laterally patterned two-dimensional electron gases (2DEGs) [1,2]. In this contribution we present directly written 2DEGs with sub-micron resolution. By choosing a line as implantation pattern and thus receiving a narrow lateral doping profile with an approximate width of the FIB-diameter, narrow electronic channels can be fabricated. Due to the additional lateral confinement of the 2D electrons in such a narrow channel the magnetotransport shows characteristic features which can be used to evaluate the electronic width of the channel. So far a minimal electronic channel width of 360 nm has been achieved. Financial support of the German Federal Ministry of Education and Research via grant No. 01BM908/6 is gratefully acknowledged.

[1] D. Reuter, C. Riedesel, P. Schafmeister, C. Meier, and A.D. Wieck, Appl. Phys. Lett. 82 (2003) 481.

[2] C. Riedesel, D. Reuter, and A.D. Wieck, Physica E 21, 592-596 (2004).

HL 17.21 Fr 16:30 Poster TU F

Anharmonic potentials for quantum dot atoms. — •Joseph Ambrose Pagaran and Stephan Fritzsche — Universität Kassel, Institut für Physik, D–34132 Kassel, Germany

Most model potentials that describe how electrons are confined in quantum dot atoms are based on harmonic potentials [1]. However, these model potentials are too simple and often lead to incorrect electronic structure of the system. As alternative model potentials, we propose a one-parameter family of anharmonic potentials following the work of Luban et al. [2] but generalized to three-dimensions. This family of potentials is obtained using the so-called intertwining method [3]. Because this family of potentials has a single parameter, which can be later fitted to the observed energy levels of the system, it may be more appropriate to describe the electron motion in realistic dots. In practice, realistic model potentials are usually derived using numerical methods.

[1] S. Reimann and M. Manninen, Rev. Mod. Phys. 74 (2002) 1283.
[2] M. Luban et.al., Appl. Phys. Lett. 54 (1989) 1997.
[3] J.O. Rosas-Ortiz, J. Phys. A: Math. Gen 31 (1998) L507.

HL 17.22 Fr 16:30 Poster TU F

Magneto transport measurements on overgrown cleaved edge heterostructures in hallbar-geometry — •Markus Lermer, Elisabeth Reinwald, Werner Wegscheider, and Dieter Weiss — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg

We present new methods to pattern and characterise overgrown cleaved edge (CE) heterostructures. By means of a novel sandwich technique a typically $6\mu m$ wide hallbar can be created on the edge of the less than $100\mu m$ wide cleavage-plane. The two-dimensional electron system (2DES) on the CE-plane is contacted by low resistive ohmic fingercontacts. This 4-point geometry allows for the first time direct measurement of the Hall- and longitudinal resistivity components of the 2DES on the cleavage plane. Due to the underlying superlattice the system is density modulated in a direction parallel to the current flow, and shows pronounced magneto resistance oscillations, which can be assigned to the various Fermicontours of a 1D- modulated system. The wet chemical transfer of linepatterns, e-beam written in self assembled monolayers, creates an additional modulation perpendicular to the current flow, so that a 2D-modulated electron system with small unit cell can be realised.

HL 17.23 Fr 16:30 Poster TU F

Defect analysis at the a-Si:H/c-Si heterojunction — •Abdelazize Laades, Lars Korte, Karsten v. Maydell, Christian Schubert, Klaus Kliefoth, Manfred Schmidt, and Walther Fuhs — Hahn-Meitner-Institut Berlin, Silizium-Photovoltaik, Kekuléstr. 5, D-12489 Berlin

Ultrathin undoped hydrogenated amorphous silicon (a-Si:H) layers (thickness ≈ 10 nm) were deposited by plasma-enhanced chemical vapor deposition on p-doped crystalline silicon wafers. The density of states at the a-Si:H/c-Si(p) interface was investigated by field-dependent surface photovoltage (FD-SPV) and photoluminescence (PL) techniques. Photoelectron yield spectroscopy (PEYS) has been applied to determine the density of states $N(E)$ within the ultrathin a-Si:H films.

By means of FD-SPV, the energetic distribution of the interface trap density $D_{\mathrm{it}}(E)$ could be determined. However, at room temperature the measurement is strongly influenced by recharging effects in a-Si:H. This effect can be reduced by cooling the sample down to 100 K.

$D_{\mathrm{it}}(E)$ consists of a continuum with a characteristic curvature extending towards the band edges. The minimum of $D_{\mathrm{it}}(E)$ is as low as 2×10^{11} eV^{-1}cm^{-2} at mid-gap. This demonstrates the excellent passivation of the silicon surface by a-Si:H. Applying PEYS, the Fermi energy and the gap state distribution (density of dangling bonds at mid-gap and Urbach energy of the tail states) in the a-Si:H film were measured. We will discuss the complex relationship between the values of $N(E)$ and $D_{\mathrm{it}}(E)$ measured with both methods.

HL 17.24 Fr 16:30 Poster TU F

Diamagnetic Shift of localized excitons in GaAs/AlGaAs Quantum Wells — •M. Erdmann[1], M. Wenderoth[1], R.G. Ulbrich[1], S. Malzer[2], and G. Döhler[2] — [1]IV. Physikalisches Institut der Universität Göttingen,Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Institut für technische Physik, Universität Erlangen-Nürnberg, Erwin-Rommel-Straße 1, 91058 Erlangen

We have performed Magneto-Micro-Photoluminescence (μPL) experiments on GaAs/AlGaAs quantum wells. Emission spectra with spectral resolution of 70 μeV were obtained using a scanning μPL microscope with lateral resolution of 500 nm. A magnetic field of up to 12 T was applied perpendicular to the quantum wells. The disorder potential of the quantum well interfaces leads to a localization of excitons [1]. We find that with increasing emission energy the diamagnetic shift of individual localized states increases by approximately a factor of 2. We discuss our results with regard to recent calculations of Grochol and Grosse [2].

[1] A. Zrenner et al., Phys. Rev. Lett. 72 (1994) 3382
[2] M. Grochol, F. Grosse, Proc. ICPS, Flagstaff 2004

HL 17.25 Fr 16:30 Poster TU F

Global view on the electronic properties of two-electron anisotropic quantum dots — •Panagiotis Drouvelis[1], Peter Schmelcher[1,2], and Fotis Diakonos[3] — [1]Theoretische Chemie, Universität Heidelberg, Im Neuenheimer Feld 229, D-69120 Heidelberg, Germany — [2]Physikalisches Institut, Philosophenweg 12, Universität Heidelberg, D-69120 Heidelberg, Germany — [3]Department of Physics, University of Athens, GR-15771 Athens, Greece

A detailed investigation of the effects of the interaction and anisotropy on the electronic structure and dynamical properties of two-electron quantum dots is being performed. For a circular quantum dot the system is integrable and the pure symmetry spectrum shows level clustering. The introduction of anisotropy serves as a rapid path to chaos for the classical dot with severe impact on the spectrum, thereby showing widening and interaction of the clusters. For particular anisotropic configurations the spectra show level clustering and one specific case turns out to be integrable. The parity symmetries of the corresponding integral of motion lead to singlet-triplet degeneracies. The developed numerical method also allows for a statistical analysis of the energy levels, which show deviations from the standard predictions. For predominantly chaotic phase spaces the results converge to the Wigner surmise. For very strong anisotropies, i.e., for the wire-like limit, the dynamical properties comprise the complete regime from softly interacting to kicked oscillators while the quantum counterpart exhibits intriguing patterns in the spectral sequence of level spacings.

HL 17.26 Fr 16:30 Poster TU F

All-electron GW code based on FP-(L)APW+lo — •Xinzheng Li, Ricardo Gomez-Abal, and Matthias Scheffler — Fritz-Haber-Institut der Max-Planck-Geselschaft, Faradayweg 4-6, Berlin

In the last years, the GW approximation (GWA) with input from density functional theory (DFT) has allowed for realistic and accurate treatment of the excited state properties of several systems, providing quasiparticle energies, lifetimes and dielectric functions. In most of the existing codes, pseudopotential DFT calculations are used as input and the self energy is computed for the valence states only, which corresponds to the assumption that the core-core and core-valence contributions to the self-energy can be well approximated by DFT. While this assumption is valid in many cases, there are still some others in which these two contributions show discrepancy with the DFT calculations and need to be computed within the GWA. The development of an all-electron GWA calculation is then necessary to include a larger range of materials.

We present a description of an all-electron GW code based on the FP-(L)APW+lo method. The optimized basis used for the matrix representation of nonlocal operators allows the inclusion of core and semicore states on the same footing with a reasonable computational cost. Preliminary results for Silicon are shown.

HL 17.27 Fr 16:30 Poster TU F

Investigation of Schottky diodes in high magnetic fields — •Matthias Schmidt, Holger von Wenckstern, Rainer Pickenhain, Michael Ziese, Pablo Esquinazi, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnestrasse 5, 04103 Leipzig

We report on investigations of Schottky diodes in magnetic fields ranging from 0 to 9 T. The contacts are realized on n-GaAs by thermal evaporation of Ni or Au. The diodes are characterized by current-voltage, capacitance-voltage, and admittance measurements. These measurements are done for temperatures between 10 K and 300 K in dependence on the applied magnetic field. The scope of this contribution is to determine the influence of the ferromagnetic Schottky contact realized with Ni on the interface properties compared to the diamagnetic contact realized with Au.

HL 17.28 Fr 16:30 Poster TU F

Modeling the electrical properties of interfaces obtained via UHV wafer bonding — •Alin Mihai Fecioru, Stephan Senz, and Ulrich Michael Gösele — Max-Planck-Institut für Mikrostrukturphysik, 06120 Halle

Si-Si and Si-GaAs interfaces were obtained by ultrahigh vacuum (UHV) wafer bonding. The electrical properties were characterized by temperature dependent current-voltage (I-V) measurements and deep level transient spectroscopy (DLTS). We compared various models for such interfaces with experimental results. First, the anti-serial Schottky barrier is used to model the band bending at the interfaces, and the proposed mechanism is the thermionic emission over the barrier, which is valid only when the mean free path of the carriers is large compared to the width of the depletion layer. A second approach is based on the drift-diffusion model, which yields analytical results only when the full-depletion approximation is assumed. Since the agreement between the experimental data and the calculated values are generally poor, we suggest an approach where an incomplete trap filling model is implemented into the Poisson equation together with an impact ionization contribution

for high electrical fields.

HL 17.29 Fr 16:30 Poster TU F

Dotierelementabhängigkeit der Rauigkeit von elektronischen Grenzflächen in GaAs — •Sebastian Landrock, Nikos Jäger, Knut Urban und Philipp Ebert — IFF-IMF Forschungszentrum Jülich 52425 Jülich

Es wurden die Schichtdicke sowie die Rauigkeit und Korrelationslänge der elektronischen Grenzflächen von MBE gewachsenen GaAs-p-n-Schichtsystemen mittels Querschnitts-Rastertunnelmikroskopie untersucht. Für die p-dotierten Bereiche wurden zwei verschiedene Dotierelemente verwendet. Dabei zeigte sich, dass bei den mit Be dotierten Proben die Rauigkeit kleiner ist als bei einer C-dotierten Probe. Insbesondere ließ sich nur eine Komponente der Rauigkeit finden, welche durch die Abschirmung der geladenen Dotieratome hervorgerufen wird. Die zuvor gefundene Rauigkeitskomponente aufgrund einer Clusterung der C-Dotieratome liegt nicht in den Be dotierten Proben vor. Darüberhinaus sind die Be-dotierten Schichten -nicht jedoch die C-dotierten Schichten- deutlich verbreitert, was auf eine Diffusion der Be-Atome schließen lässt. Wir zeigen, dass die durch Diffusion bewirkte Aufreihung der Dotieratome an den Grenzflächen für die geringere Rauigkeit der p-n-Grenzflächen verantwortlich ist.

HL 17.30 Fr 16:30 Poster TU F

Scanning Tunneling Microscopy of Substitutional Phosphorus Atoms on different Lattice Sites in the Si(111)-(2×1) Surface — •J. K. Garleff[1], M. Wenderoth[1], R. G. Ulbrich[1], C. Sürgers[2], and H. v. Löhneysen[2] — [1]IV. Physikalisches Institut, Universität Göttingen, D-37077 Göttingen — [2]Physikalisches Institut and DFG Center for Functional Nanostrcutures (CFN), Universität Karlsruhe, D-76128 Karlsruhe

Substitutional phosphorus (P) atoms ($N_D \approx 6 \times 10^{18} cm^{-3}$) at the Si(111)-(2×1) surface were investigated by scanning tunneling microscopy (STM). The samples were prepared by *in situ* cleavage under ultra-high vacuum (UHV) conditions. The measurements were performed at low temperature (8 K) in a custom build STM. The P atoms were identified by their well-known characteristic voltage-dependent contrast [1]. At −0.5 V, the STM image exhibits an additional anisotropic protrusion that extends up to 10 nm along the individual π-bonded chains affected by the P atom. Four site-specific contrast patterns induced by the presence of P are observed in agreement with the four non-equivalent lattice sites for substitutional P atoms at the Si(111)-(2×1) surface [2]. The individual features are attributed to the local electronic properties of P atoms at the different lattice sites.

[1] T. Trappmann, C. Sürgers, and H. v. Löhneysen, Europhys. Lett. **38**, 177 (1997)
[2] K. C. Pandey, Phys. Rev. Lett. **47**, 1913 (1981)

HL 17.31 Fr 16:30 Poster TU F

Conductivity and preparation of nanowires — •F. Kost[1], T. Kolb[1], A. Pucci[1], M. Jalochowski[2], V. Hnatyuk[2,3] und G. Fahsold[1] — [1]Kirchhoff-Institut für Physik, Ruprecht-Karls-Universität, 69120 Heidelberg, Germany — [2]Institute of Physics, Maria Curie-Sklodowska University, 20031 Lublin, Poland — [3]European College of Polish and Ukrainian Universities, 20029 Lublin, Poland

The investigation of metal nanowires is feasible with infrared-spectrometric experiments, which allow analysing these wires in a non-contact mode. Since the wires can be treated as antennas, they show resonances in the mid infrared range. Hence, by measuring the infrared- transmission spectra of nanowires, one can determine various characteristics of the wire. In this regard, size-effects in their conductivity are of special interest. On the basis of model calculations, the measured transmission spectra give information on the dynamic conductivity of the nanowires [1]. In collaboration with the Group of M. Jalochowski (Lublin), we prepare metal nanostructures by evaporating lead on regularly stepped silicon surfaces. Thereby, solid-like nanowires of Pb align parallel to the step edges of the silicon due to self-organization processes. The diameter of such produced single crystalline wires ranges from about 1nm up to few ten nanometers [2].

[1]G. Fahsold and A. Pucci, Adv. in Solid State Physics, Vol. 43, ed. by B. Kramer (Springer, 2003) 833.
[2]M. Jalochowski, M. Strozak, R. Zdyb, Applied Surface Science 211 (2003) 209-215.

Supported by DFG (SPP 1165).

HL 17.32 Fr 16:30 Poster TU F

Classical Analysis of Trajectories in an Open Quantum Dot — •Roland Brunner[1], R. Meisels[1], F. Kuchar[1], M. Elhassan[2], J. Bird[3], and K. Ishibashi[4] — [1]Department of Physics, University of Leoben, Austria — [2]Department of Electrical Engineering, Arizona State University, USA — [3]Department of Electrical Engineering,University at Buffalo The State University of New York — [4]Semiconductor Laboratory, RIKEN, Saitama, Japan

Transport in sub-micron semiconductor structures is an important topic of low-dimensional electron physics. Among other possibilities small structures can be realized in the form of electron billiards, e.g. quantum dots, when the electron mean free path is larger than the region to which the electrons are confined. Then and for low currents, the transport can be described classically by the ballistic motion of single electrons. In this work, we address the question of stable trajectories in open quantum dots and their contribution to prominent structure in the low-field magnetoresistance. We present a classical model which allows to vary the confinement potential, deviations from circular symmetry, the entrance angle of the electrons (focussing), and the number of dots in series. We show in which regions of entrance angles backscattering peaks in the low-field magnetoresistance occur. We find that a smooth (parabolic) confinement potential describes the experimental magnetoresistance traces significantly better than a hard wall potential. For the backscattering regions we calculate the trajectories in a single open quantum dot and observe that all of them are regular and not chaotic.

HL 17.33 Fr 16:30 Poster TU F

Time-resolved THz-spectroscopy of Graphite — •Florian Schapper, Tobias Kampfrath, Luca Perfetti, Christian Frischkorn, and Martin Wolf — Fachbereich Physik der Freien Universität Berlin, Arnimallee 14, 14195 Berlin

We excite graphite with short laser pulses centered at 775 nm and subsequently probe its in-plane optical properties with mid-infrared pulses in a frequency range of about 8 to 28 THz. The field-resolved sampling of the probe pulses allows for the determination of the transient dielectric function of the sample. It contains a Drude-like response and a contribution induced by the blocking of direct optical transition. We are able to extract the temporal evolution of the electronic temperature, plasma frequency, and Drude current relaxation rate. Our results give evidence for the generation of hot optical phonons, which contribute strongly to a striking increase of the Drude relaxation rate by more than 100% during the first picosecond after excitation.

We present first results on shaping mid-infrared pulses by shaping the visible generation pulses.

HL 17.34 Fr 16:30 Poster TU F

Elektrische Transportmessungen in MeV dotierten Diamant-Substraten — •V.A. Tchernychev, T. Vogel und J. Meijer — Zentrale Einrichtung für Ionenstrahlen und Radionuklide, Ruhr-Universität Bochum

Um die Leitfähigkeit von IIa-Diamantsubstraten zu untersuchen, wurde Bor unter verschiedenen Implantationstemperaturen und Konzentrationen mit 2 MeV implantiert. Nach einem Ausheil- und Ätzprozess wurden an den Proben Hall Effekt- Messungen in einem Temperaturbereich von T=20-500°C zur Bestimmung der Ladungsträgerkonzentration und der Beweglichkeit durchgeführt. Die Proben mit Dotierungsgrößen von $10^{15}/cm^2$ zeigten insgesamt einen starken Abfall der Beweglichkeit bei niedrigen Temperaturen, obwohl das Leitfähigkeitsverhalten nur eine geringfügige Änderung zeigte. Als Ursache ist allgemein akzeptiert, dass der freie Ladungsträgerstrom in diesem Temperaturbereich durch Hopping ersetzt wird. Dieser parasitäre Strom zeigt offensichtlich keinen oder nur einen geringen Halleffekt. In der Literatur wird dieses Verhalten aber bislang kontrovers diskutiert; unklar scheint ebenfalls zu sein, ob und in welcher Form Hopping-Leitfähigkeit eine magnetische Induktion erzeugt. Dieser Beitrag soll das gefundene Transportverhalten verschiedener Diamantproben diskutieren und die Ergebnisse mit bekannten Modellvorstellungen vergleichen.

HL 17.35 Fr 16:30 Poster TU F

Optical and electronic properties of nitrogen-doped ultrananocrystalline diamond thin films — •Philipp Achatz, Jose-Antonio Garrido, and Martin Stutzmann — Walter Schottky Institut, Technische Universität München, Am Coulombwall, 85748 Garching, Germany

Ultrananocrystalline diamond thin films have recently attracted re-

newed interest, mainly due to the appearance of a very high n-type conductivity induced by the addition of nitrogen during growth. It has been shown that ultrananocrystalline diamond films can be deposited over large areas with a surface roughness down to 10nm, n-type conductivity up to 200 Ω-1cm-1 , and with electrochemical and mechanical properties very similar to the case of single crystalline diamond films. In this paper, we present our work on the characterization of the electronic, optical and structural properties of N-doped ultrananocrystalline diamond films grown on Si, quartz and diamond substrates. The mechanism of the high conductivity and the change of the electronic structure resulting from the incorporation of nitrogen will be discussed based on Hall effect, temperature dependent conductivity, and photocurrent measurements. Raman and X-ray diffraction experiments have been carried out to asses the structural properties of the ultrananocrystalline diamond films.

HL 17.36 Fr 16:30 Poster TU F

Einfluss der räumlichen Dispersion auf die Lumineszenz von Halbleitern — •Frithjof Meinke und Klaus Henneberger — Universität Rostock, FB Physik, 18051 Rostock

Wir untersuchen den Einfluss der räumlichen Dispersion auf die Lumineszenz eines Halbleiterplättchens in der Nähe der 1s-Energie des Exzitons. Wir folgen einem Modell, das trotz makroskopischer Beschreibung zusätzliche Randbedingungen vermeidet [1] und auf relativ einfache Weise erlaubt, die Lumineszenztheorie ohne Berücksichtigung der räumlichen Dispersion [2] um den Effekt der räumlichen Dispersion zu erweitern. Die retardierte Photon-Greensfunktion für diesen Fall lässt sich übersichtlich als Matrix schreiben und dient der Berechnung der Lumineszenz. Die Polarisationsfunktion des Halbleiters wird im interessierenden Frequenzbereich durch das Oszillatormodell genähert und ihr Übergang zum Vakuum geschieht durch die dielektrische Approximation. Der Unterschied der neuen Lumineszenzspektren gegenüber denen ohne räumliche Dispersion liegt etwa in der Größenordnung des Unterschieds bei Reflexionsspektren. Bedeutsam wird die Mitnahme der räumlichen Dispersion bei der Berechnung der Lumineszenz eines exzitonischen Bose-Einstein-Kondensats.

[1] PRL **80** 2889 (1998)
[2] PRL **76** 1820 (1996)

HL 17.37 Fr 16:30 Poster TU F

Photoluminescence properties of ZnO nanowires at low temperatures — •Lars Wischmeier[1], Tobias Voss[1], Ilja Rückmann[1], Sandra Börner[2], and Wolfgang Schade[2] — [1]Institut für Festkörperphysik, Universität Bremen, P.O. Box 330440, D-28334 Bremen — [2]Institut für Physik und Physikalische Technologien, Technische Universität Clausthal, Leibnizstrasse 4, D-38678 Clausthal-Zellerfeld

Zincoxide nanowires are promising building blocks for miniaturized optoelectronic devices operating in the blue to UV spectral region. Here, the optical properties of such wires with diameters < 200 nm were investigated at low temperatures. The nanowires were grown by a chemical vapor transport and condensation technique on a sapphire substrate.

The photoluminescence (PL) of the nanowire ensemble was measured as a function of temperature (4 - 100 K) and excitation density (up to 7.0 MW/cm^2). From the excitation density dependent measurement the P band resulting from the exciton-exciton collision shows a super-linear increase with slope values of ≈ 1 at low densities (< 0.7 MW/cm^2) and > 2 at higher densities. For a further emission peak originating from the radiative recombination of donor-bound excitons a linear increase was obtained. The temperature dependence of the shift of the emission energy was in good agreement with the empirical Varshni formula.

In addition results of first micro-PL studies of few to single ZnO nanowires with a spatial resolution on a sub-micrometer scale are presented.

HL 17.38 Fr 16:30 Poster TU F

Konzentrische a-Si/SiO$_x$ Bragg-Reflektoren — •Rüdiger Schmidt-Grund[1], Tobias Gühne[2], Bernd Rheinländer[1], Volker Gottschalch[2], Helmut Herrnberger[2], Thomas Nobis[1] und Marius Grundmann[1] — [1]Universität Leipzig, Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig — [2]Universität Leipzig, Fakultät für Chemie und Mineralogie, Linnéstr. 3, 04103 Leipzig

Laterales Bragg-Confinement von Mikroresonator-Lichtemittern erhöht das Verhältnis der Zahl der axial resonanten Moden zur Zahl der spontan emittierten lateralen Moden. Hoch reflektierende Si/SiO$_x$-Bragg-Reflektoren eignen sich gut zur Verbesserung des optischen Confinements in mikro-strukturierten Resonatoren. Auf Mikro-Glasstäbe mit Durchmessern von 5 bis 5000 μm wurden sowohl a-Si- und SiO$_x$-Einzelschichten als auch a-Si/SiO$_x$-Bragg-Reflektoren für den Wellenlängenbereich von 500 nm bis 1000 nm mit kleiner Paarzahl N (typisch N = 4,5) mittels PECVD (plasma-enhanced chemical vapor deposition) konzentrisch abgeschieden. Die Schichtdicken und das Reflexionsvermögen wurden mittels räumlich aufgelöster spektroskopischer Ellipsometrie und Mikro-Reflexion untersucht. Das aus der ellipsometrischen Analyse berechnete Reflexionsvermögen wurde mit demjenigen verglichen, welches mittels Mikro-Reflexion bestimmt wurde. Es wurde ein Zusammenhang zwischen Mikro-Glasstab-Durchmesser und Abscheiderate der Materialien gefunden. Für die Bragg-Reflektoren auf Mikro-Glasstäben wurden maximale Reflexionsvermögen über 96% erreicht. Für alle azimutalen Richtungen wurde eine Bragg-Bande im gleichen Wellenlängenbereich erzielt.

HL 17.39 Fr 16:30 Poster TU F

Laser-induced absorption changes in Cu$_2$O — •Tibor Fleck, Michael Jörger, and Claus Klingshirn — Institut fürAngewandte Physik, Universität Karlsruhe (TH), D-76128Karlsruhe

It is already known that a high density of 1s-excitons in the yellow series of Cu$_2$O leads to a density-dependent absorption change, i.e. increasing bleaching of np states with increasing density. To gather more information about e.g. the lifetime of the para-excitons we monitor the differential absorption spectra (DAS) for different excitation conditions ($\hbar\omega_{exc}$, P$_{exc}$) and delay times after pulsed ns-excitation with excimer- or dye-laser of our naturally grown Cu$_2$O samples.
Different $\hbar\omega_{exc}$ between the phonon-assisted 1s-absorption and excitation high above the band gap including resonant excitation of the np-states with P$_{exc}$ up to the destruction threshold of the samples were chosen. The delay time between pump and probe ranges from time resolved ns-regime to time-integrated μs→ms-regime (the latter with a time resolution of $\approx 4\mu$s). Some of the problems arising with DAS of small absorption changes and their interpretation are discussed.
We compare these results with true 3d numerical simulations of the diffusion equation including the excitonic lifetime as well as surface recombination and exciton creation efficiency.

HL 17.40 Fr 16:30 Poster TU F

Exzitonische Effekte in optischen Spektren von Volumenkristallen: Implementierung der Bethe-Salpeter-Gleichung für PAW Pseudopotentiale — •Patrick Hahn, Wolf-Gero Schmidt, Kaori Seino, Jürgen Furthmüller und Friedhelm Bechstedt — Computational Materials Science Group, FSU Jena, Max-Wien-Platz 1, 07743 Jena

Die optischen Spektren von Gruppe-IV Halbleitern (Si, Diamant, SiC), III-V-Halbleitern (InN,AlN,InP,GaP,GaAs) sowie von hexagonalem Eis werden parameterfrei berechnet und systematisch bez. des Einflusses von Vielteilcheneffekten untersucht, um physikalische Trends zu identifizieren. Die Berechnung der Spektren erfolgt in drei Schritten, beginnend mit der Dichtefunktionaltheorie in LDA- oder GGA-Näherung. Die Lösung der Kohn-Sham-Gleichung für den Grundzustand erfolgt mit einem Ebenen-Wellen-Code (VASP) unter Nutzung von „projector augmented wave “ (PAW) Pseudopotentialen. Darauf aufbauend beziehen wir Quasiteilchenkorrekturen im Rahmen der GWA und den Einfluß der Elektron-Loch-Wechselwirkung durch die Lösung der Bethe-Salpeter-Gleichung mit in die Rechnung ein. Dies führt zu einer hervorragenden Übereinstimmung mit dem Experiment. Physikalische und chemische Trends des Umfangs der Elektron-Loch-Wechselwirkung werden im Detail diskutiert.

HL 17.41 Fr 16:30 Poster TU F

Characterization of vertical-cavity surface-emitting laser structures by modulation spectroscopy — •C. Karcher, B. Metzger, P.J. Klar, and W. Heimbrodt — Department of Physics and Material Sciences Center, Philipps-University of Marburg, Germany

In recent years, various modulation spectroscopic methods have been successfully applied for characterizing vertical-cavity surface-emitting laser (VCSEL) structures. In particular, photomodulated reflectance (PR) and contactless electroreflectance spectra yield useful information about the coupling between the quantum wells in active region of the device and the cavity. Corresponding line shape models for describing the resonance behavior between quantum well exciton and cavity have been developed. An aspect which has not been addressed is the dynamics of the modulation process in VCSEL structures and its dependence on the resonance between cavity and exciton. These effects can be studied in the frequency domaine by monitoring the quadrature PR signal

as a function of modulation frequency. We studied these effects in an InGaAs/GaAs/AlAs VCSEL structure as a function of cavity detuning using modulation frequencies in the range of 1 HZ to about 100 KHz and using various modulation laser wavelengths.

HL 17.42 Fr 16:30 Poster TU F

Anomalous temperature-dependence of free-charge-carrier concentration in modulation-doped $Al_xGa_{1-x}As$/GaAs quantum well superlattices studied by far-infrared magnetooptic Mueller-matrix ellipsometry — •Tino Hofmann[1], Claas von Middendorff[1], Gunnar Leibiger[2] und Mathias Schubert[1] — [1]Fakultät für Physik und Geowissenschaften, Institut für Experimentelle Physik II, Universität Leipzig, Linnéstraße 5, 04103 Leipzig — [2]Fakultät für Chemie und Mineralogie, Halbleiterchemie, Universität Leipzig, Linnéstraße 3, 04103 Leipzig

A study of the temperature-dependent free-charge-carrier properties in modulation-doped $Al_xGa_{1-x}As$:Si/GaAs (L, $x = 0.45$) superlattices is presented. Two different samples with quantum well lengths $L = 18$ nm and $L = 4$ nm are investigated using magnetooptic generalized ellipsometry at far-infrared wavelengths ($100 - 650 cm^{-1}$) at external magnetic fields $B = \pm 3$ T and temperatures ranging from $T = 10$ to 293 K. The model analysis allows independent determination of the free-charge-carrier parameters density N, mobility μ and effective mass m within the wells dispensing with the need for electrical contacts. Beside a weak anisotropic mobility behavior, a strong increase of the quantum-well free-charge-carrier density with decreasing temperature is observed for $L = 4$ nm in contrast to the sample with $L = 18$ nm where the free-charge-carrier density decreases as expected. A simple rate model successfully describes this behavior as a steady state of three condensation processes.

HL 17.43 Fr 16:30 Poster TU F

Fabrication of high-Q microdisks with embedded InAs quantum dots — •F. Wilde, T. Kipp, Ch. Heyn und D. Heitmann — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg

Optical microdisks resonators have recently gained interest since their whispering gallery modes (WGMs) combine high Q-factors with small mode volumes [1] and thus giving the opportunity to study light confinement and light-matter interaction in various aspects. Especially a microdisk containing only one quantum dot which matches a WGM frequency and is spatially located in the antinode of the WGM would be of great interest [2].

We have fabricated large arrays of GaAs microdisks with embedded InAs quantum dots (QDs) using laser-interference lithography and a two-step etching process [3]. Our aim is to fabricate microdisks with decreasing densities of QDs so that eventually there is only one QD per microdisk. We report about the optimization of the preparation process in particular the etching which causes sidewall roughness and predominantly limits the Q-factor of a WGM. The samples are characterized by microphotoluminescence.

[1] B. Gayral *et al.*, Appl. Phys. Lett. **75**, 1908 (1999)
[2] P. Michler *et al.*, Appl. Phys. Lett. **77**, 184 (2000)
[3] K. Petter *et al.*, Appl. Phys. Lett. **81**, 592 (2002)

HL 17.44 Fr 16:30 Poster TU F

Size dependent excitation energies of valence band plasmons in Si and SnO_x nanoparticles — •H Nienhaus, V Kravets, A Lorke, H Wiggers, M Kennedy, and F E Kruis — Sonderforschungsbereich 445, Universität Duisburg-Essen, 47048 Duisburg

Si and SnO_x nanoparticles with diameters in the range between 3 and 30 nm were produced in the gas phase and deposited on Au and Pd thin films. Structure and chemical composition were characterized by electron microscopy and Auger electron spectroscopy, respectively. By use of low electron energy-loss spectroscopy, electronic excitations of energies between 5 and 25 eV in the particles have been investigated. The energies of the valence band plasmons in both, Si and SnO_x, particles exhibit a strong size-dependence. Shifts of a few eV are observed when the diameter of the particle is reduced. The variation of the energy is found to be inversely proportional to the particle diameter. There are no significant changes of the excitation energy when varying the oxygen content of the tin oxide particles. In addition, energy losses due to interband transitions and core level ionization do not change with particle size.

HL 17.45 Fr 16:30 Poster TU F

SILICON LIGHT EMITTING DIODES PREPARED BY ION IMPLANTATION OF PHOSPHOROUS AND BORON — •Yevgen Yeromenko[1], Tzanimir Arguirov[1,2], Martin Kittler[2], and Winfried Seifert[2] — [1]BTU Lehrstuhl Experimentalphysik II — [2]IHP/BTU Joint Lab

The further progress in microelectronic technology requires, among others one more efficient and noise free way of transferring signals between the parts within a chip. A solution for substituting the currently used conductor interconnects is looked up in the optics: the use of optical interconnects. One aspect in the way to establish a viable optical communication in a chip is the development of efficient light emitter on silicon basis, compatible with currently used CMOS technology.

Here we report on light emitters, prepared by ion implantation. Boron or phosphorous are implanted in moderately doped n or p type silicon wafers and the wafers are subsequently annealed. In this way p-n junctions are formed. We study the influence of sample preparation conditions (implantation dose and energy, annealing type) over the room temperature silicon band edge luminescence from the diodes.

We observed efficient room temperature electroluminescence by forward biasing the diodes at typical for the microelectronics operating voltages - below 2V. The luminescence shows anomalous temperature behavior - its intensity becomes stronger with increasing the temperature.

HL 17.46 Fr 16:30 Poster TU F

Luminescence of Ge/Si heterostructures with miniband realized by Sb doping — •Vadim Talalaev, George Cirlin, Alexander Tonkikh, Nikolay Zakharov, and Peter Werner — Max-Planck-Institut, Weinberg 2, 06120 Halle (Saale)

The structure and emission properties of Ge/Si quantum dot superlattices (QDSLs) grown by molecular beam epitaxy are studied. In our particular system, an unusual large conduction band offset is formed by Sb doping of the Si spacer layers. Thereby, this heterostructure has a quantum well (QW) system for the electrons. The Arrhenius analysis of photoluminescence spectrum and a strict dependence of the activation energy versus spacer thickness indicate the existence of the electron state in this QWs. Related to this energy level, we measure the electroluminescence with a external efficiency 4E-4 at 1.55 um up to room temperature. We demonstate that such high luminescence efficiency is related to the formation of a conduction miniband due to tunneling of electrons between adjacent QWs and to the transition to quasi-direct excitons in Ge/Si QDSL. Miniband width (15-35 mev) and conduction band offset (110 mev) are calculated assuming different effective masse of electron state density for the Si QWs and Ge barriers as well. The details and limitations of the miniband concept are discussed.

HL 17.47 Fr 16:30 Poster TU F

Deposition von Si- und Ho-Ionen in $GaAs/Al_xGa_{1-x}As$ Heterostrukturen mittels fokussierter Ionenimplantation — •Sinan Ünlübayir, Dirk Reuter, Alexander Melnikov und Andreas D. Wieck — Lehrstuhl für angewandte Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum

Durch Anlegen einer Gegenspannung an den Probentisch einer Anlage zur fokussierten Ionenimplantation (FIB) ist es möglich, eine Vielzahl von Ionensorten auf Energien von typ. 50 eV abzubremsen. Aufgrund der geringen Ionenenergie werden für den Depositionsprosses nur geringe Kristallschäden erwartet, da die Eindringtiefen theoretisch nur von der Größenordnung einer Monolage sind. Eine III/V-Molekularstrahlepitaxie (MBE)-Anlage ist direkt mit der FIB-Anlage verbunden. Dies erlaubt es, den MBE-Prosses zu unterbrechen und durch diese Ionendeposition lokale Fremdatome einzubringen. Als Anwendungsbeispiel diskutieren wir die Deposition von Ho in das zweidimensionale Elektronensystem in einer $GaAs/Al_xGa_{1-x}As$-Heterostruktur, Ho dotierten InAs Quantenpunkten sowie mittels Si-Deposition dotierten $GaAs/Al_xGa_{1-x}As$-Heterostrukturen. Mittels Magnetotransportmessungen und Photolumineszenz wurde der Einfluß der eingebrachten Atome auf die elektrischen und optischen Eigenschaften untersucht.

HL 17.48 Fr 16:30 Poster TU F

Elektrische Charakterisierung von (Ga,Mn)As — •SAFAK GÖK[1], Hartmut Zabel[2] und Andreas Wieck[1] — [1]Angewandte Festkörperphysik, Ruhr-Universität Bochum — [2]Experimentalphysik/Festkörperphysik, Ruhr-Universität Bochum

An ferromagnetische (Ga,Mn)As-Proben, die mit der Molekular-

strahlepitaxie (MBE)-Technik hergestellt wurden, wurden Magnetotransportmessungen durchgeführt. Wir zeigen das Verhalten des Magnetowiderstandes und des Hallwiderstandes in Abhängigkeit von Temperatur. Unterhalb der Curie-Temperatur (76K) zeigen die Proben einen sehr starken negativen Magnetowiderstand. Bei höheren Temperaturen wird der Magnetowiderstand kleiner und wir beobachten auch ein Bereich mit positivem Magnetowiderstand für B=0T. Unserer Ziel ist ähnliche magnetische Halbleiter ortsaufgelöst herzustellen. Wir benutzen fokusierte Ionenstrahlen, um in das GaAs-Gitter magnetische Ionen einzubauen. Die ersten Ergebnisse bezüglich der Morphologie und Zusammensetzung der implantierten Bereiche werden vorgestellt.

HL 17.49 Fr 16:30 Poster TU F

MOVPE growth of $B_xGa_{1-x}P$ alloys on (001) GaP substrates — •Volker Gottschalch[1], Gunnar Leibiger[1], Jens Bauer[1], and Gabi Benndorf[2] — [1]Universität Leipzig, Institut für Anorganische Chemie, Linnéstraße 3, 04103 Leipzig — [2]Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig

Only a few data are available on the boron incorporation in $A^{III}B^{V}$ compounds. Epitaxial growth of $B_xGa_{1-x}As$ and $B_xGa_{1-x-y}In_yAs$ alloys on GaAs have been studied. We have studied the boron incorporation in GaP because of their optoelectronic properties and the potential application to optoelectronic devices. We report on the metal-organic vapourphase epitaxy growth of $B_xGa_{1-x}P$ alloys on (001) GaP substrates using the precursors triethylboron, trimethylgallium and phosphine. The mole fraction of Boron in the epitaxial layer was varied from x = 0 to 0.03. The growth behaviour of single layers and strained quantum well structures was studied. The influence of the growth conditions on layer deposition, boron incorporation, interface quality, and optical properties of bulk-like and quantum well structures is discussed and compared with the Nitrogen incorporation in GaP.

HL 17.50 Fr 16:30 Poster TU F

(InGa)As Laserbauelemente (1,2 μm) mit vergütetem Resonator — •Tobias Gühne[1], Volker Gottschalch[1], Gunnar Leibiger[1], Helmut Herrnberger[2], Jaro Kovač[3], Jaro Kovač jr.[4], Rüdiger Schmidt-Grund[5] und Bernd Rheinländer[5] — [1]Universität Leipzig, Institut für Anorganische Chemie, Linnéstraße 3, 04103 Leipzig — [2]Leibniz-Institut für Oberflächenmodifizierung e.V., Permoserstr. 15, 04303 Leipzig — [3]Slowakische Technische Universität, Fakultät für Mikroelektronik, Ilkovicova 3, SK 81219 Bratislava — [4]International Laser Center, Ilkovicova 3, SK 81219 Bratislava — [5]Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig

Die Darstellung und der Einfluss von a-Silizium- und Siliziumoxid-Schichten als Spiegel- und Antireflektionsschichten für Laserdioden (1,2 μm) wurde untersucht. Alle Laserstrukturen wurden mittels MOVPE auf (001)-GaAs gezüchtet. Das aktive Gebiet besteht aus einer Doppelquantengrabenstrukur von $Ga_{0,63}In_{0,37}As$, eingebettet in GaAs. Als Mantelschichten dienen zwei $Al_{0,35}Ga_{0,65}As$ Schichten. Mittels PECVD wurden die Laserriegel auf den Spaltflächen vergütet. Auf einer Resonatorfläche wurde ein 5,5-facher Braggspiegel aus Silizium und Siliziumoxid abgeschieden. Durch diese Vergütung wird nahezu die gesamte Lichtintensität über die Frontfläche emittiert, welche ihrerseits mit einer SiO_x-Schicht versehen in ihrer Reflektivität gemindert wurde. Die Auswirkungen auf den differentiellen Quantenwirkungsgrad, die Schwellstromdichte und die Strahlgüte wurden untersucht.

HL 17.51 Fr 16:30 Poster TU F

MOVPE-Darstellung freistehender $A^{III}B^{V}$-Nanodrähte — •Jens Bauer[1], Volker Gottschalch[1], Helmut Herrnberger[2] und Gerald Wagner[2] — [1]Universität Leipzig, Institut für Anorganische Chemie, Linnéstraße 3, 04103 Leipzig — [2]Leibniz-Institut für Oberflächenmodifizierung e.V., Permoserstr. 15, 04303 Leipzig

Halbleitende Nanostrukturen bilden die Grundlage für neuartige optoelektronische Bauelemente. Dabei nehmen freistehende Nanodrähte eine Hauptrolle ein, da Heterostrukturen integriert werden können und die Morphologie der Nanodrähte eine einfache Kontaktierung erlaubt. Im Bereich einiger Nanometer lassen sich Quanteneffekte ausnutzen. Im Beitrag werden die Arbeiten zur Darstellung freistehender $A^{III}B^{V}$-Nanodrähte mittels Metallorganischer Gasphasenepitaxie (MOVPE) in einem „bottom-up"-Prozess vorgestellt. Die Grundzüge des Nanodrahtwachstums beruhen auf dem für Elementhalbleiter bekannten „vapor-liquid-solid" (VLS)-Wachstumsprozess, der für $A^{III}B^{V}$-Halbleiter und die MOVPE einiger Modifikationen bedarf. Es werden Untersuchungen zur Substratpräparation mit Goldpartikeln vorgestellt und der Einfluss von Wachstumsparametern (Temperatur, Partialdrücke, Wachstumszeit) auf die Realstruktur diskutiert. Schließlich wird auf erste Ergebnisse zur physikalischen Charakterisierung der Nanodrähte eingangen.

HL 17.52 Fr 16:30 Poster TU F

Magneto-optical spectroscopy and thermal annealing effects in GaInNAs / GaAs quantum well structures and bulk GaAsN — •A. Grau, P. Feinäugle, W. Löffler, H. Kalt, and M. Hetterich — Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe, D - 76131 Karlsruhe, Germany

As a promising material system for the realization of near infrared optoelectronic devices GaInNAs / GaAs gained more and more importance, but still many material parameters are not well known.

In earlier investigations we used photoreflectance (PR) and photoluminescence excitation (PLE) spectroscopy in order to get more information about the band alignment and conduction band dispersion in GaInNAs-based quantum well structures as a function of compositions and well width. In this contribution we present the results of extended studies using magneto-photoluminescence (MPL) and magneto-absorption of GaInNAs / GaAs multiple quantum well structures. From the theoretical modelling of our MPL measurements we are able to obtain values for the reduced effective exciton mass and the electron effective mass. As expected a strong increase in the electron effective mass due to the presence of nitrogen is found, in good agreement with theory and our earlier PLE and PR results.

Additionally, we studied the effect of thermal annealing on the photoluminescence (PL) of GaAsN bulk samples in terms of intensity, line width and energy shift of the PL peak.

HL 17.53 Fr 16:30 Poster TU F

Studies of the local vibrational N-mode in III-N-V dilute nitrides by Raman spectroscopy — •M. Güngerich, P.J. Klar, W. Heimbrodt, B. Kunert, K. Volz, and W. Stolz — Department of Physics and Material Sciences Center, Philipps-University of Marburg, Germany

The local environment of the nitrogen atom is of crucial importance for the global electronic structure changes of the III-V host, i.e. the strength of the local perturbation at the N-site due to the differences in size and electronegativity between the N atom and the anion it replaces determines the magnitude of the band structure changes. The phonons of the dilute nitrides exhibit a two-mode behaviour. A local N-mode is observed in addition to the host-like modes. The local N-mode is a useful probe of the local N-environment. We study the frequency of the N-related mode in various III-N-V alloys, i.e. GaNAs, GaNSb, GaNP, at ambient pressure and at hydrostatic pressures up to 20 GPa yielding information about the Ga-N bond strength in a wide range of lattice constants.

HL 17.54 Fr 16:30 Poster TU F

Investigation and modelling of the temperature-dependent electronic states in GaNAs and GaInNAs/GaAs quantum well structures — •M. Hetterich[1], A. Grau[1], T. Passow[1], A.Yu. Egorov[2], and H. Riechert[2] — [1]Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76131 Karlsruhe, Germany — [2]Infineon Technologies AG, Corporate Research Photonics, D-81730 München, Germany

Recently, GaInNAs/GaAs has evolved to one of the most promising material systems for the realization of optoelectronic devices operating in the near infrared spectral range. However, many aspects of its electronic structure are still under debate.

In our contribution we investigate the temperature-dependent conduction band structure of GaNAs and GaInNAs/GaAs MQWs with high In concentration using photoreflectance (PR) spectroscopy. The band structure is described using the well-known band anti-crossing (BAC) model. For the BAC wavefunction in general GaInNAs heterostructures we have derived special boundary conditions which are applied to calculate the bound states in the quantum well samples. From the modelling of our experimental data we obtain information about the BAC Hamiltonian parameters. Both the energy of the nitrogen level E_N and the coupling parameter C_{NM} in the Hamiltonian are found to decrease with increasing temperature. The anti-crossing interaction between E_N and the conduction band leads to a significantly reduced temperature dependence of the band-gap compared to nitrogen-free material.

HL 17.55 Fr 16:30 Poster TU F

Magneto-gyrotroper photogalvanischer Effekt in Halbleiter-Quantentrögen — •Wolfgang Weber[1], V.V. Bel'kov[2], S.D. Ganichev[1], E.L. Ivchenko[2], S.A. Tarasenko[2], S.N. Danilov[1], Petra Schneider[1], S. Giglberger[1], M. Olteanu[1], P. Tranitz[1], W. Wegscheider[1], D. Weiss[1] und W. Prettl[1] — [1]Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg — [2]A. F. Ioffe Physico-Technical Institute, 194021 St. Petersburg, Rußland

Der Magneto-gyrotrope photogalvanische Effekt wurde in (001)- und (110)-orientierten Zinkblendestruktur basierten Quantentrögen unter optischer Anregung im Terahertz Frequenzbereich sowohl experimentell, als auch theoretisch untersucht. Die verwendeten Anregungsfrequenzen verursachen Intrasubband-Übergänge im Elektronenband. Ein parallel zur Probenebene ausgerichtetes Magnetfeld erzeugt Photoströme sowohl bei polarisierter als auch bei unoplarisierter Anregung. Im allgemeinen überlagern sich der spingalvanische Effekt, der durch zirkular polarisiertes Licht verursacht wird, und der magneto-gyrotrope Effekt, der durch unpolarisierte Anregung verursacht wird. Wir zeigen, daß die beiden Effekte im Falle zweier spezieller Geometrien separabel sind.

HL 17.56 Fr 16:30 Poster TU F

Ultrahigh vacuum direct bonding of III-V semiconductors at room temperature after cleaning with hydrogen ion — •Nasser Razek[1], Axel Schindler[1], Volker Gottschalch[2], and Bernd Rauschbach[1] — [1]Leibniz-Institut für Oberflächenmodifizierung e. V., Permoserstr. 15, D-04318 Leipzig, Germany — [2]Unversität Leipzig, linnestr.3 04103 Leizig, Germany

Direct wafer bonding of GaAs were carried out in an ultrahigh vacuum. The wafer surfaces GaAs were cleaned by bombardment of low energy a mass separated hydrogen of ions 300 eV with current density ~ 4.5 $\mu A/cm^2$ at temperature 150 °C. After cleaning at room temperature, the wafers were connected face to face. At contact, the interface formed spontaneously over the whole wafer area without any application of mechanical pressure. Then, the bonded wafers were annealed in UHV or at low temperature <200 °C to improve the bonding at the interface over the large wafer areas. The samples interface has been investigated by infrared transmission pictures and cross-sectional transmission electron microscopy. The electrical characteristic of the bond interface has been investigated by current-voltage (I-V) measurement.

HL 17.57 Fr 16:30 Poster TU F

Optical orientation of electron spins in GaAs quantum wells — •Stefan Pfalz[1], Roland Winkler[1], Tobias Nowitzki[1], Dirk Reuter[2], Andreas Wieck[2], Daniel Hägele[1], and Michael Oestreich[1] — [1]Universität Hannover, Institut für Festkörperphysik, Abteilung Nanostrukturen, Appelstraße 2, 30167 Hannover, Germany — [2]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstraße 150, 44780 Bochum, Germany

We present a detailed experimental and theoretical analysis of the optical orientation of electron spins in GaAs/AlAs quantum wells. Using time and polarization resolved photoluminescence excitation spectroscopy, the initial degree of electron spin polarization is measured as a function of excitation energy for a sequence of quantum wells with well widths between 63 Å and 198 Å. The experimental results are compared with an accurate theory of excitonic absorption taking fully into account electron-hole Coulomb correlations and heavy-hole light-hole coupling. We find in wide quantum wells that the measured initial degree of polarization of the luminescence follows closely the spin polarization of the optically excited electrons calculated as a function of energy. This implies that the orientation of the electron spins is essentially preserved when the electrons relax from the optically excited high-energy states to quasi-thermal equilibrium of their momenta. Due to initial spin relaxation, the measured polarization in narrow quantum wells is reduced by a constant factor that does not depend on the excitation energy.

HL 17.58 Fr 16:30 Poster TU F

Spin dependent bleaching of the optical absorption in GaAs-QWs — Stefan Pfalz, Roland Winkler, Daniel Hägele, •Michael Römer, and Michael Oestreich — Universität Hannover, Institut für Festkörperphysik, Abteilung Nanostrukturen, Appelstraße 2, 30167 Hannover

The initial degree of spin polarization for optically excited electron-hole pairs in GaAs quantum wells is studied using time and polarization resolved photoluminescence spectroscopy. We observe a dramatic decrease of initial spin polarization with increasing excitation power. We argue that this decrease can be attributed to a spin dependent phase space filling. Optically created electrons and holes can partially block the creation of additional carriers, an effect known as bleaching of the optical resonance. This effect is spin dependent and effective as long as electrons and holes have not undergone a scattering event. A rate equation model yields good agreement with our experimental findings.

HL 17.59 Fr 16:30 Poster TU F

Parasitäre Moden in GaN Doppelheterostruktur Laserdioden — •Holger Fischer[1], Ulrich T. Schwarz[1], Thomas Schödl[1], Markus Pindl[1], Georg Feicht[1], Michael Furitsch[2], Andreas Leber[2], Andreas Miler[2], Alfred Lell[2] und Volker Härle[2] — [1]Institut für Angewandte und Experimentelle Physik, Universitätsstr. 31, 93053 Regensburg, Germany — [2]OSRAM Opto Semiconductors GmbH, Wernerwerkstr. 2, 93049 Regensburg, Germany

Wir untersuchen die Auswirkungen parasitärer Moden auf das Verstärkungsspektrum und auf das Fernfeld von (Al,In)GaN Laserdioden. Als Substratmaterial wird für diese Laserdioden entweder SiC oder GaN verwendet, das Substrat hat also gleichen oder höheren effektiven Brechungsindex als der Wellenleiter. Die Lasermode kann sich dadurch abhängig von der Wellenlänge ins Substrat ausbreiten. Im Verstärkungsspektrum beobachten wir deshalb Oszillationen der Verstärkung im Transparenzbereich der Diode. Auch die Auswirkungen auf das Fernfeld der Laserdioden haben wir durch Messungen untersucht. Wir können desweiteren durch Messungen des Nahfelds die parasitären Moden direkt nachweisen. Rechnungen nach der 1-dimensionalen Transfermatrixmethode zeigen gute Übereinstimmung zwischen Theorie und Experimenten. Ein besseres Verständnis der Entstehung und Auswirkungen der parasitären Moden soll dazu beitragen, die Laserstrukturen zu verbessern und die Ausbildung parasitärer Moden zu unterdrücken.

HL 17.60 Fr 16:30 Poster TU F

Molekular-Strahl-Epitaxie von Mn dotierten GaN Schichten — •Martin Kocan, Martin Roever, Dong-Du Mai, Marco Bertelli, Tore Niermann, Jörg Malindretos, Jan Zenneck, Michael Seibt und Angela Rizzi — IV. physikalischer Institut, Georg-August-Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen

Theoretische Arbeiten sagen für den magnetisch verdünnten Halbleiter GaN:Mn ferromagnetische Eigenschaften mit einer Curie Temperatur von über 300 K vorher. Das macht dieses Materialsystem interessant für 'Spin-Elektronik' Anwendungen. Die verfügbaren experimentellen Daten bestätigen zum Teil die Existenz einer ferromagnetischen Ordnung oberhalb von Raumtemperatur, sind bisher jedoch nicht konsistent genug, um die Frage nach den zugrunde liegenden Mechanismen zu beantworten. In diesem Beitrag wird die Untersuchung von GaN:Mn Strukturen vorgestellt. Die GaN:Mn Schichten wurden mittels einer MBE (Molekular-Strahl-Epitaxie) Anlage mit einer Uni-Bulb(TM) Plasma-Quelle hergestellt. Das Wachstum erfolgte auf einem p-Si(111) Substrat. Die GaN:Mn Schichten wurden bei unterschiedlichen Wachstumsbedingungen aufgewachsen. Unterschiedliche Mn Konzentration wurde in den Schichten gemessen. Die Oberflächenmorphologie wurde mit einem optischen Mikroskop und einem AFM (Atomic Force Microscopy) analysiert. Mit XRD (X-ray Diffraction) und TEM (Transmission Electron Microscope) konnte man die strukturellen Eigenschaften auf Ausscheidungen-Bildung untersuchen. Die magnetischen Eigenschaften zeigen sowohl paramagnetisches als auch ferromagnetisches Verhalten.

HL 17.61 Fr 16:30 Poster TU F

Scanning Tunneling Spectroscopy of Carbon and Zinc Acceptors in GaAs — •S. Loth[1], M. Wenderoth[1], T. C. G. Reusch[1], L. Winking[1], R. G. Ulbrich[1], S. Malzer[2], and G. Döhler[2] — [1]IV. Physikalisches Institut, Universität Göttingen, D-37077 Göttingen — [2]Institut für Technische Physik, Universität Erlangen-Nürnberg, D-91058 Erlangen

Carbon and zinc dopants embedded near in-situ cleaved {110} surfaces of GaAs were studied with low temperature UHV scanning tunneling spectroscopy (STS) at 8K. Both dopants are shallow substitutional acceptors, carbon on an As site and zinc on a Ga site. Laterally resolved STS measurements show conductivity at voltages well below 1V, localized at the dopant atoms. In the voltage interval from 0V to 1V the conductance above undisturbed surface regions vanishes. We employ a quantum-mechanical transport simulation to describe the tunnel current along a path perpendicular to the sample surface from the metallic tip to the bulk of the semiconductor. The comparison of the simulated spectra

with the measured ones allows us to identify the transport mechanisms which contribute to the specific shape of the I(V) characteristics.

HL 17.62 Fr 16:30 Poster TU F

Optical and magnetic properties of rare earth implanted AlN — •G. Öhl[1], U. Vetter[1,2], M. Uhrmacher[1], C. Ronning[1], and H. Hofsäss[1] — [1]Georg-August-Universität, II. Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Philipps-Universität, AG Oberflächenphysik, Renthof 5, 35032 Marburg

Rare earths (RE) in AlN already have been studied extensively. Nevertheless, as shown in recent studies e.g. on the system AlN:Gd [1,2], where single systems with moderate Lanthanide doses implanted were investigated - RE in AlN show very promising features, e.g. for the use as electroluminescent emitters.

In this study we investigated single (at high doses) and double systems of RE in AlN thin films grown on SiC. The RE were implanted at different energies and fluences giving a square implantation profile. RBS analysis was performed to monitor the annealing behaviour of the implantation profile, while possible clustering of the metal ions was monitored by XRD measurements. Optical properties were investigated by means of temperature dependent time-resolved cathodoluminescence studies, life-time and energy-transfer studies were performed on selected radiative intra-4f electron transitions of the implanted lanthanide ions. In addition, magnetic properties of the RE implanted AlN will be discussed.

(1) U. Vetter et al., Appl. Phys. Lett. 83, 11 (2003) (2) J.B. Gruber, U. Vetter et al., Phys. Rev. B 69 (2004)

HL 17.63 Fr 16:30 Poster TU F

Structural and magnetic properties of Co-implanted ZnO films — •Numan Akdogan[1], Alexei Nefedov[1], Hartmut Zabel[1], and Hans-Werner Becker[2] — [1]Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany — [2]Ionenstrahlenphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany

The recently discovered class of ZnO-based dilute magnetic semiconductors (DMSs), which can be formed by doping $3d$ transition metal atoms in ZnO, offers an interesting combination of electrical, optical, and magnetic properties. Of special interest is the possibility to join aspects of semiconductor and magnetic effects to develop new device concepts. Furthermore, the band gap in ZnO is large enough (3.3 eV) to allow operation of such devices at room temperature. Moreover, according to suggestion of Dietl [1], the ZnO-based DMSs can order ferromagnetically at room temperature. In this contribution we report on structural and magnetic properties of Co-implanted ZnO films. ZnO films were epitaxially grown sapphire substrates via rf-sputtering. Subsequentially the films were doped with Co-ions via ion implantation. The structural characterization was carried out using synchrotron radiation at the HASYLAB and the DELTA (Dortmund). The magnetic properties were investigated using x-ray resonant magnetic scattering (XRMS) at BESSY as well as MOKE and SQUID magnetometry. This work is supported by BMBF through the project 03ZAE8BO. N.A. acknowledges a fellowship through the International MPI Research School "SurMat".

1. T. Dietl et al, Science **287**, 1019 (2000).

HL 17.64 Fr 16:30 Poster TU F

Structural, optical and electrical properties of p-type transparent conducting $CuAlO_2$ thin films prepared by RF reactive sputtering — •Bin Yang, Bruno K. Meyer, Angelika Polity, Thorsten Krämer, and Baker Farangis — I. Physikalisches Institut, Justus-Liebig-Universität, Heinrich-Buff-Ring 16, 35392 Giessen, Germany

In recent years, p-type transparent conducting oxide compounds based on the delafossite structure have attracted much attention because of their potential in preparing novel transparent p-n junction for device applications. In this work, transparent conducting $CuAlO_2$ thin films have been deposited by RF reactive sputtering technique on glass and quartz substrates using CuAl alloy target in a mole ratio of 1:1. A study of structural, optical, and electrical properties was performed on the films, varying deposition parameters such as the substrate temperature and the oxygen partial pressure. The crystalline phase in the films was identified to be the delafossite structure by x-ray diffraction. The optical properties, such as the wavelength dependence of the transmittance and the band gap, were determined. The average transmittance is 55% in the wavelength range of 400-1100 nm and the band gap E_g ∼3.45 eV. Hall effect measurements confirmed the p-type nature of the semiconductors. The temperature dependence of the electrical conductivity of the $CuAlO_2$ thin films was measured.

HL 17.65 Fr 16:30 Poster TU F

Elektrische und optische Charakterisierung elektrochemisch abgeschiedener Zinkoxid/Farbstoff-Absorbermaterialien — •Jens Reemts, Jürgen Parisi und Achim Kittel — Abteilung Energie- und Halbleiterforschung, Institut für Physik, Universität Oldenburg, 26111 Oldenburg

Elektrochemische Farbstoff-Solarzellen verwenden zur Absorption von Licht und zum Transport der Ladungsträger kein klassisches Halbleitermaterial, sondern organische Farbstoffe, die an ein anorganisches Trägermaterial angelagert werden. Zinkoxid ist aufgrund seiner hohen Porosität und damit verbundenen großen Oberfläche neben TiO_2 ein vielversprechendes Material für solche Solarzellen. Ein großer Vorteil der Zinkoxidelektroden ist, dass die Farbstoff-Sensibilisatormoleküle direkt während der elektrochemischen Herstellung in das Trägermaterial eingebaut werden. Wir charakterisieren den Einfluss unterschiedlicher Farbstoffmaterialien und -konzentrationen auf die Oberflächenmorphologie mittels optischer und Rastersonden-Mikroskopie. Die elektrischen Eigenschaften dieser als Elektrode verwendeten Kompositschichten werden mit Hilfe von Strom/Spannungs-Messungen unter Beleuchtung und in Dunkelheit untersucht. Die spektrale Antwort der transversalen und lateralen Filmleitfähigkeiten wird unter Beleuchtung mit verschieden farbigen LEDs charakterisiert. Wir beobachten neben thermisch aktivierten Zuständen sehr lange Relaxationszeiten auf Änderungen der Beleuchtungsintensität mit unterschiedlichen Wellenlängen bei Messungen ohne Elektrolyten.

HL 17.66 Fr 16:30 Poster TU F

Two Photons photoemission from metastable continuum states of fullerens and nanoclusters — •Oleg Kidun[1], Jamal Berakdar[1], and Natasha Fominykh[2] — [1]MPI für Mikrostrukturphysik, Halle, Germany — [2]Institute of Physics, St. Petersburg State University, St. Petersburg, Russia

Using the variable phase approach [1-3]we developed a method for the investigation of the quasistationary states of fullerenes and nanoclusters. In particualr we explore the possibility of the two-photons photoemission from these states. The energy and the time behavior of two-photon photoionization probability is studied in details and illustrated by numerical results.

[1] F. Calogero, Variable Phase Approach in Potential Scattering, AP, NY (1967)

[2] V. Babikov, Method of the Phase Functions in Quantum Mechanics, Nauka, Moscow (1969)

[3] O. Kidun, N. Fominykh, J. Berakdar, J. Phys. A 35, 9413 (2001)

HL 17.67 Fr 16:30 Poster TU F

In-plane gate transistors realized by writing with focused-ion-beam implantation — •Mihai Draghici, Dorina Diaconescu, Dirk Reuter, and Andreas D. Wieck — Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum

The focused-ion-beam (FIB) technique was used in past to directly write in-plane gate transistors [1]. Insulating regions are written by FIB implantation on $GaAs/Al_xGa_{1-x}As$ - heterostructure samples in order to define a narrow conducting channel and to electrically separate the gate electrode from the channel.

We present a new method where the conducting channel is defined by doping with FIB implantation (positive writing mode). Using a p-type $GaAs/Al_xGa_{1-x}As$ - heterostructure as base material, n-type conducting regions are realized by overcompensation doping with Si ions. This technique involves an additionally technological step, thermal annealing in order to activate the dopants but offers the possibility to integrate n- and p-conducting channels on the same wafer (similar to CMOS technique).

We discuss the dependence of electrical properties of the n- and p-type transistors on the channel dimensions and implantation doses.

[1] A. D. Wieck and K. Ploog, Appl. Phys. Lett. 56, 928 (1990).

HL 17.68 Fr 16:30 Poster TU F

Evaluation of active semiconductor structures by combined scanning thermo-elastic microscopy and finite element simulations — •Ralf Meckenstock[1], Dirk Dietzel[1], Sutharat Chotikaprakhan [1], Jean L.N. Fotsing[1], Josef Pelzl[1], and Simone Cassette[2] — [1]Exp. Phys. 3, Solid State Spectroscopy, Ruhr-University Bochum, D-44780 Bochum, Germany — [2]Thales Research and Technology France, F-91404 Orsay Cedex, France

The main objections of experimental and theoretical efforts of a common research work are the localization of the heat sources and the determination of the temperature peak rises in the hot region of nano-tailored semiconductor devices. Here we report on combined investigations of hot areas in a high power high electron mobility transistor (HEMT) using a scanning thermo-elastic microscope (SthEM) and finite element (FE) simulations of the problem. The sample was a AlGaN/GaN-HEMT grown on sapphire substrate, with a gold coating for improved thermal management.The thermo-elastic image reveals a hot line adjacent to the gate region as it is predicted by the finite element simulation. A rescaling of the estimated temperature amplitude obtained by the thermo-elastic measurements leads for conditions of the FE-simulations to a maximum temperature of about 200 °C in reasonable agreement with the simulation. Work performed in the frame of the EC-project MICROTHERM.

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Relationship between Mn 3d electron hybridization and magnetic order in (GaMn)As dilute ferromagnetic semiconductors — •F. Kronast[1], R. Osyannikov[1], A. Vollmer[1], H.A. Dürr[1], W. Eberhardt[1], P. Imperia[2], D. Schmitz[2], G. Schott[3], K. Brunner[3], M. Sawicki[4], and L. Molenkamp[3] — [1]Bessy GmbH , Albert-Einstein-Str.15, 10439 Berlin — [2]Hahn-Meitner-Institut, Albert-Einstein-Str.15, 10439 Berlin — [3]Universität Würzburg, am Hubland, D-97074 Würzburg — [4]Institute of Physics, Polish Academy of Sciences, Warszawa, Poland

The hybridization of Mn $3d$ and Ga/As valence orbitals in $(Ga_{1-x}Mn_x)As$ films with x between 0.007 and 0.062 was studied using x-ray absorption techniques. The signature of Mn acceptor states responsible for long-range ferromagnetic order can be identified with x-ray magnetic circular dichroism at all Mn concentrations. An additional magnetically dead Mn species with a reduced number of $3d$ electrons is observed for 0.062 Mn. We provide evidence that this is due to Mn-Mn nearest neighbor pairs which bind valence holes and ultimately limit the size of the magnetic ordering temperature.