HL 9 Poster I

Time: Monday 15:15–17:45 Room: P3

HL 9.1 Mon 15:15 P3

Systematische Untersuchung zum Strahlprofil von fokussierten Ionenstrahlen — •andre uhlemann, Alexander Melnikov, Rolf Wernhardt, and Andreas Wieck — Angewandte Festkörperphysik Ruhr-Universität Bochum, Universitätstr.150,44801 Bochum

Systematische Untersuchung zum Strahlprofil von fokussierten Ionenstrahlen Andre Uhlemann, Alexander Melnikov, Rolf Wernhardt und A.D.Wieck Lehrstuhl für angewandte Festkörperphysik, Ruhr-Universität Bochum,Universitätsstr.150, Bochum 44780 Techniken zur Anwendung fokussierter Ionenstrahlen (FIB) finden an vielen Stellen Einzug in die Nanotechnologie. Die Verbesserung der Funktionalität vieler Anwendungen macht eine systematische Untersuchung von Strahlprofilen und deren unerwünschte Seitendosis erforderlich. Mit Hilfe von Ionenstrahllithographie und durch das Sputtern dünner Goldfilme wird das Strahlprofil eines Zwei-Linsen- FIB Systems untersucht .Im Vordergrund dieser Untersuchung steht die Einflussnahme von Abbildungsparametern wie z.B Blenden, Strahlstrom, Stigmatoren und Strahlengang auf das Strahlprofil. Es wird darüber hinaus die Frage diskutiert , unter welchen Konditionen eine Strahlaufweitung aufgrund des statistischen Coulomb-Effekts vorliegt, und in wie weit eine Holtsmarkverteilung das Strahlprofil besser als eine einfache Gaussverteilung beschreiben kann.

HL 9.2 Mon 15:15 P3

MOVPE of InN on nitridated sapphire and GaN templates — •M. Drago[1], C. Werner[1], P. Vogt[1], G. Manolis[2], M. Pristovsek[1], U. W. Pohl[1], M. Kneissl[1], and W. Richter[3] — [1]Techn. Univ. Berlin, Institut für Festkörperphysik, Hardenbergstraße 36, 10623 Berlin, Germany — [2]Nat. Techn. University of Athens, Dept. of Physics, GR-15780 Athens, Greece — [3]Univ. di Roma Torvergata, Dipart. di Fisica, Via della ricerca scientifica 1, I-00133 Rome, Italy

Optimum crystalline quality and defect analysis are still critical issues for InN research. For MOVPE growth on sapphire, substrate nitridation is the key step in order to obtain single crystal InN layers. Here we report studies on sapphire nitridation with ammonia by in-situ spectroscopic ellipsometry (SE). At 1050°C, 100 mbar and an ammonia flow of 1 L/min the sapphire surface reacts completely within 45 s, forming an AlN layer about 0.8 nm thick. The influence of sapphire nitridation on the quality of InN layers was assessed ex-situ investigating a set of InN layers grown on sapphire after different nitridation duration. For a 45 s nitridation InN displayed the best morphology, electronic properties and narrowest (00.2) X-Ray reflections. For a duration of 180 s sapphire nitridation (˜1.0 nm AlN calculated by SE), the InN (10.2) reflections became narrower. Longer nitridation times led to deterioration of the quality of the InN layers. These results are compared to the growth of InN on GaN templates. SXPS measurements on the InN layers demonstrate no contamination by carbon, but show some traces of oxygen, which influence electronic and optical properties of InN.

HL 9.3 Mon 15:15 P3

Spin noise spectroscopy in GaAs — •M. Roemer, M. Oestreich, R.J. Haug, and D. Haegele — Institut für Festkörperphysik, Universität

We observe the thermal noise of electron spins in bulk GaAs by Faraday-rotation noise spectroscopy. This new experimental technique allows for nearly perturbation free measurements of the spin dynamics in semiconductors. Faraday-rotation is measured in the spectral region below the band gap, which avoids common problems like carrier heating and electron spin relaxation by spin interaction with optically created holes. We measure exemplarily the electron spin relaxation time and the electron Landé g–factor in n–doped GaAs at low temperatures and discuss the noise power in dependence on the probe wavelength. The measured noise power is compared to a theory based on Poisson distribution probability which yields good agreement.

HL 9.4 Mon 15:15 P3

Electrical Characterization of AlInN / GaN heterostructures grown by MOVPE — •C. Baer, H. Witte, A. Krtschil, C. Hums, J. Blaesing, A. Dadgar, and A. Krost — Otto-von-Guericke-University Magdeburg, Postfach 4120, 39016 Magdeburg

AlInN/GaN-junctions are of special interest due to its possible application as p-type FETs for In concentrations above 32%. However, there is only rare information on the electrical properties of AlInN and AlInN/GaN heterostructures up to now. We have investigated AlInN/GaN grown on different buffer layer structures on sapphire or Si substrates by metal organic vapour phase epitaxy.

At first we investigated the influence of the different junctions on the electrical measurements. For instance, in Hall-effect and CV-measurements the properties of the GaN buffer layer were found to be dominant. In samples with thick and thin AlInN layers we found both n-type and p-type conductivity regions by Halleffect and CV-measurements as well as by scanning capacitance microscopy (SCM). The origin for the different conductivity types will be discussed in terms of the layer structure and various defects. Furthermore, the AlInN/GaN structures were characterized by photo-conductivity spectroscopy, optical and thermal admittance spectroscopy and by deep level transient spectroscopy with respect to the defects.

HL 9.5 Mon 15:15 P3

Optical Investigation of AlN Layers and AlN Single Crystals — •Günther M. Prinz[1], Martin Feneberg[1], Christoph Kirchner[2], Sarad B. Thapa[2], Matthias Bickermann[3], Boris Epelbaum[3], Ferdinand Scholz[2], Klaus Thonke[1], and Rolf Sauer[1] — [1]Abt. Halbleiterphysik, Universität Ulm, D-89069 Ulm — [2]Abt. Optoelektronik, Universität Ulm, D-89069 Ulm — [3]Institut für Werkstoffwissenschaften 6, Universität Erlangen, D-91058 Erlangen

Aluminum nitride (AlN) has an ultra-wide direct bandgap of approximately 6.2eV at LHe temperature. This fact and the full miscibility with gallium nitride make AlN a very promising material for optoelectronic applications.

We investigate both AlN layers grown by MOCVD on sapphire and AlN single crystals using cathodoluminescence and photoluminescence spectroscopy. In both cases the light is dispersed by a monochromator with a focal length of 1m (yielding a spectral resolution better than 1meV) and detected by a LN2-cooled CCD-camera.

The measurements are carried out from LHe to room temperature. For both sample types, we observe strong near band-edge emission at around 6eV. The spectral shift of the near band-edge luminescence as a function of temperature is fitted using different models.

HL 9.6 Mon 15:15 P3

Spatial fluctuations of the local potential in Silicon doped GaAs — •K. Teichmann[1], S. Loth[1], M. Wenderoth[1], R. G. Ulbrich[1], and U. Kretzer[2] — [1]Universität Göttingen, IV. Physikalisches Institut, Germany — [2]Freiberger Compound Materials GmbH, Freiberg, Germany

We investigated highly Silicon doped GaAs (10^{+19} cm^{-3}). Silicon is typically incorporated as a shallow donor, and is known to show strong autocompensation at high doping concentrations [1]. In our measurement we used UHV scanning tunneling microscopy at 8K. We prepared our sample as {110} cleavage plane. In particular we investigated distribution of dopants. In addition constant current topographies reveal a large amount of dopant induced defects. Both are not statistically distributed and show significant clustering on a length scale of several nanometers. By scanning the same region of the sample with different voltages (multibias spectroscopy) and by performing dI/dz spectroscopy we studied the correlation between the local dopant distribution and the electrostatic potential ($\phi_{el.stat.}(x,y)$) as well as the local apparent barrier height.

[1] C. Domke et al., Phys. Rev. B **54**, 10288 (1996).

HL 9.7 Mon 15:15 P3

To handicraft material systems with magnetic and semiconducting properties — •Safak Gök, Alexander Melnikov, Jun Ling Yang, and Andreas D. Wieck — Ruhr-Universität Bochum, Universitätstr. 150, D-44780 Bochum

We have tried to fabricate a material system, which owns semiconducting and magnetic properties at the same time. Therefore we have utilized the advantages of our combined molecular beam epitaxy - focused ion beam (MBE-FIB) -System, to deposite Mn atoms into GaAs in a soft landing mode. This technique offers the possibility to integrate the magnetic atoms into the semiconductor lattice with very low crystal defects. Magneto - transport measurements show an anomalous Hall effect which reveals clearly that our MBE-FIB-System makes possible an important

progress the research towards convenient material for spintronics.

HL 9.8 Mon 15:15 P3

Magnetotransport of $Ga_{1-x}Mn_xAs$ on (001) and (311)A GaAs — •Ursula Wurstbauer, Matthias Reinwald, Matthias Döppe, Dieter Schuh, Dieter Weiss, and Werner Wegscheider — Universität Regensburg, 93040 Regensburg, Germany

We have studied $Ga_{1-x}Mn_xAs$ grown by low-temperature molecular beam epitaxy (LT-MBE) on GaAs (001) and (311)A substrates. In-plane and out-of-plane magnetotransport measurements clearly reveal an anomalous Hall effect (AHE) and a giant planar Hall effect (GPHE). Rotating the samples in the field, the magnetic anisotropy relative to the crystal orientation can be deduced. The (001) samples show for in-plane measurements a cubic anisotropy with the hard axis aligned along the [1-10] and [110] directions and an easy axis along [100] and [0-10]. Additional an uniaxial anisotropy with the hard axis along the [001] direction and the easy axis parallel to the surface was observed by out-of-plane measurements.
Unlike these, the (311)A samples exhibit for both in-plane and out-of-plane measurements a complex superposition of the AHE and the GPHE. In addition, we compared post growth annealing with an in-situ annealing method using an As capping layer. In both cases we found an increase of T_c.

HL 9.9 Mon 15:15 P3

Temperature Dependence of the Electron g Factor in GaAs — •Stefanie Döhrmann[1], Roland Winkler[1,2], Daniel Hägele[1], and Michael Oestreich[1] — [1]Universität Hannover, Institut für Festkörperphysik, Abteilung Nanostrukturen, Appelstr. 2, 30167 Hannover — [2]Northern Illinois University, Department of Physics, De Kalb, IL 60115, USA

We present detailed high precision measurements of the electron Landé factor g^* in weakly n-doped GaAs. Using time- and polarization resolved spin quantum beat spectroscopy in an external magnetic field, we determine g^* in a temperature range from 2 K to 300 K. At low temperatures, we find a strong interaction between the electron and nuclear spin system. The resulting dynamic nuclear polarization (DNP) acts as an additional magnetic field which drastically affects the measured g^*. The value of the bare g^* can be determined accurately by monitoring the time dependent DNP. We systematically investigate the dependence of g^* on excitation polarization, excitation energy, excitation density, external magnetic field and temperature. The measured temperature dependence of g^* shows the opposite trend compared to $\mathbf{k} \cdot \mathbf{p}$ calculations.

HL 9.10 Mon 15:15 P3

Self-built molecular beam epitaxy system for III - V semiconductors — •K. Trounov, I. Kamphausen, D. Reuter, and A. D. Wieck — Lehrstuhl fuer Angewandte Festkoerperphysik, Ruhr-Universitaet Bochum, Universitaetsstr. 150, D-44780 Bochum

We are setting up an MBE system for the growth of III-V semiconductor heterostructures. The system is completely in-house designed and fabricated. It consists of three chambers: a load lock, a buffer chamber, and the main chamber. We will discuss design considerations as e.g. the shutter mechanism and the materials choice for the individual components. The present status of the system will also be discussed.

HL 9.11 Mon 15:15 P3

Influence of the structural transition from $Ga_{1-x}Mn_xAs$ alloys to granular GaAs:Mn/MnAs hybrids probed by magneto-transport — •M. Elm[1], J. Teubert[1], P.J. Klar[1], W. Heimbrodt[1], M. Reinwald[2], and W. Wegscheider[2] — [1]Dept. Physics and WZMW, Philipps-University of Marburg, Germany — [2]Institute of Applied and Experimental Physics II, University of Regensburg, Germany

The magneto-resistance properties of $Ga_{0.98}Mn_{0.02}As$ alloys on (311)A substrate grown by molecular beam epitaxy and corresponding GaAs:Mn/MnAs hybrid samples obtained by controlled thermal annealing at different temperatures were studied. Thermal annealing leads to the formation of MnAs clusters. The size of the clusters increases with increasing annealing temperature whereas the cluster density decreases accordingly. The magneto-resistance measurements were performed on Hall-bars with a length of 650 μm and a width of 200 μm in fields up to 10 T and in the temperature range from 2 to 280 K. Clear differences are observed in the transport behaviour of the alloy sample and the hybrid samples. The results are compared with measurements of GaMnAs/MnAs hybrid structures grown by MOVPE on (100) substrates.

HL 9.12 Mon 15:15 P3

Why does the level-repulsion model fail in the vicinity of the GaN_xP_{1-x} indirect gap? — •M. Güngerich[1], P.J. Klar[1], W. Heimbrodt[1], G. Weiser[1], J.F. Geisz[2], C. Harris[3], A. Lindsay[3], and E.P. O Reilly[3] — [1]Dept. of Physics and Material Sciences Center, Philipps-University, Renthof 5, D-35032 Marburg, Germany — [2]National Renewable Energy Laboratory, 1617 Cole Boulevard, Golden, Colorado 80401, USA — [3]Tyndall National Institute, Lee Maltings, Prospect Row, Cork, Ireland

The character of the fundamental band gap of P-rich GaN_xP_{1-x} has been under controversial discussion during the last few years. By electromodulated absorption studies of MOVPE-grown GaN_xP_{1-x} with $0.0 \leq x \leq 0.029$, we prove that a simple parametrization of the electronic structure in the energy range of the N localized levels according to a two-level repulsion-model fails in this material. The Γ character of electronic transitions in the range of the N levels is shown to be spread over several sharp transitions rather than concentrated in a single E_- transition. Pressure-dependent photoluminescence indicates a purely impurity-like character of these transitions. For ordered structures containing well separated N atoms the applicability of the level-repulsion model is confirmed by tight-binding calculations. As soon as, due to statistical spatial N-distribution, N pairs and clusters are formed the model breaks down and needs to be replaced by the Linear Combination of Isolated Nitrogen States (LCINS) approach. Photocurrent measurements confirm the widely observed blue shift of the GaP-like E_+ band gap.

HL 9.13 Mon 15:15 P3

Low-temperature scanning tunneling microscopy on semiconductor samples grown by molecular beam epitaxy — •Selina Olthof, Oguzhan Gürlü, Giovanni Costantini, Armando Rastelli, Oliver G. Schmidt, M. Alexander Schneider, and Klaus Kern — Max-Planck-Institut für Festkörperforschung, Heisenbergstr.1, D-70569, Stuttgart

The Scanning Tunneling Microscope (STM) is a powerful tool to analyze surfaces with atomic resolution as well as to perform local spectroscopy. Especially for the latter investigation, an instrument working at liquid helium temperatures gives superior access to the electronic structure of e.g. heterostructures and quantum dots. To be able to investigate semiconductor samples that are grown by Molecular Beam Epitaxy (MBE) in a home build low temperature UHV-STM, a battery operated vacuum system was build that allows sample transfer between separate chambers. As sample sizes in the STM are smaller than the 2" wafer standard used in semiconductor MBE, an adapter was designed that interferes as little as possible with the MBE growth procedure. First results of topographic and spectroscopic studies performed at 6 Kelvin on MBE-grown III-V heterostructures will be presented.

HL 9.14 Mon 15:15 P3

Carrier relaxation dynamics in annealed and hydrogenated (GaIn)(NAs)/GaAs quantum wells — •Torben Grunwald[1], Kristian Hantke[1], Jörg D. Heber[1], Sangam Chatterjee[1], Peter J. Klar[1], Kerstin Volz[1], Wolfgang Stolz[1], Antonio Polimeni[2], Mario Capizzi[2], and Wolfgang Rühle[1] — [1]Faculty of Physics and Material Sciences Center, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany — [2]CNISM-Dipartimento di Fisica, Universitá di Roma, Piazzale A. Moro 2, I-00182 Roma, Italy

We measured time-resolved photoluminescence on as-grown, annealed, as well as annealed and hydrogenated $(Ga_{0.7}In_{0.3})(N_{0.006}As_{0.994})$/GaAs quantum well structures. The post-growth treatment changes not only the photoluminescence decay time but also the intensity of photoluminescence directly after excitation. This initial luminescence intensity is determined by a competition between relaxation of electrons into nitrogen related potential fluctuations in the conduction band and their capture by deep traps. In contrast, the decay of the photoluminescence is mainly determined by the competition between radiative and nonradiative recombination, which are both influenced by localization. Annealing decreases localization effects and nonradiative recombination. Hydrogenation also reduces localization effects but increases nonradiative recombination.

HL 9.15 Mon 15:15 P3

(InGa)As Oberflächenemitter mit horizontaler Kavität (HCSEL) — •Volker Gottschalch[1], Helmut Herrnberger[2], Tobias Gühne[1], Jaroslav Kovac jr.[3], Gunnar Leibiger[1], Jaroslav Kovac[3], Rüdiger Schmidt-Grund[1], Joachim Zajadacz[2], Jens Dienelt[2], and Axel Schindler[2] — [1]Universität Leipzig, Fakultäten für Chemie und Physik, Linnéstrasse 3, D-04103 Leipzig — [2]Leibniz-Institut für Oberflächenmodifizierung e.V., Permoser Str. 15, D-04318 Leipzig — [3]Slowakische Technische Universität, Fakultät für Mikroelektronik, Ilkovicova 3, SK-81219 Bratislava

Oberflächenemittierende Laserdioden mit horizontaler Kavität sind infolge ihrer hohen Lichtleistungen im Vergleich zu VCSEL-Strukturen von speziellem Applikationsinteresse. $In_{0.37}Ga_{0.63}As$-Doppel-QW-Laserstrukturen mit Emissionswellenlängen bis zu 1180 nm wurden mit der MOVPE im Standardsystem bei Abscheidungstemperaturen von 550℃ gezüchtet. Die Schwellstromdichten der Oxidstreifenlaser lagen bei 250 Acm^{-2}. Mittels der PECVD wurden die Laserriegel auf den Spaltflächen mit dielektrischen Spiegeln aus SiO_x/Si-Schichtfolgen vergütet. Die Auswirkungen auf den differentiellen Quantenwirkungsgrad, die Schwellstromdichte und die Strahlgüte wurden untersucht. Mikrospiegel von 45° wurden durch reaktives Ionenstrahlätzen (Cl_2 CAIBE) erzeugt und nach der Charakterisierung der Einzeldioden ebenfalls zur Auskopplung des Laserstrahls durch das GaAs-Substrat mit einem Bragg-Spiegel versehen. Die elektrooptischen Kennlinien der Dioden werden diskutiert.

HL 9.16 Mon 15:15 P3

MOVPE-Wachstum von GaN Nadeln — •Matthias Shirnow[1], Volker Gottschalch[1], Gerald Wagner[2], Jens Bauer[1], Hendrik Paetzelt[1], and Jörg Lenzner[3] — [1]Institut für Anorganische Chemie, Universität Leipzig, Johannesallee 29, D-04103 Leipzig — [2]Institut für Kristallographie und Mineralogie, Universität Leipzig, Linnéstrasse 3, D-04103 Leipzig — [3]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstrasse 3, D-04103 Leipzig

Das MOVPE-Wachstum von GaN-Nadeln wurde für die Quellenkombination Trimethylgallium und Dimethylhydrazin untersucht. Als Substratmaterial kamen (001), $(111)_{Ga}$, $(\bar{1}11)_{As}$ GaAs-, (111) Si- und (0001), $(01\bar{1}2)$ Al_2O_3-Substrate zum Einsatz. Bei der Niederdruck-MOVPE in einem kommerziellen Reaktor wurde der DMHy-Partialdruck von 0.07 bis 1 mbar und die Wachstumstemperatur von 550 bis 750℃ variiert. Die Charakterisierung erfolgte mittels TEM, HRTEM, SAD, Röntgendiffraktometrie und CL. GaN-Nadeln entstanden im Temperaturgebiet von 550 bis 650℃. In allen Fällen wurde unter den GaN-Nadeln eine GaN-Schicht detektiert. Der anisotrope Wachstumsprozess ("'catalyst-free"'), der zu nadelförmigen Kristallen im nm- bis μm-Bereich führt, steht offensichtlich mit Zinkblende-Wurtzit-Übergangen in dieser Übergangsschicht im Zusammenhang.

HL 9.17 Mon 15:15 P3

$A^{III}B^V$ Nano- und Mikroröhren verschiedener Orientierung und Struktur — •Hendrik Paetzelt[1], Volker Gottschalch[1], Jens Bauer[1], Helmut Herrnberger[2], and Gerald Wagner[3] — [1]Institut für Anorganische Chemie, Universität Leipzig, Johannesallee 29, D-04103 Leipzig — [2]Leibniz-Institut für Oberflächenmodifizierung e.V., Permoser Str. 15, D-04318 Leipzig — [3]Institut für Kristallographie und Mineralogie, Universität Leipzig, Linnéstrasse 3, D-04103 Leipzig

Aus stark verzerrten MOVPE-Heterostrukturen wurden mittels materialselektiver Ätztechnik $A^{III}B^V$ Nano- und Mikroröhren definierter Geometrie und Orientierung erzeugt. Die Schichtfolgen (BGa)As/GaInAs und (BGa)P/(GaIn)P wurden mit Opferschichten aus AlAs und AlGaP kombiniert, um Röhren mit Durchmessern zwischen 140 nm und 2 μm herzustellen. Der Einfluss der Materialparameter: Zusammensetzung, Schichtdicke, Grenzflächengüte, sowie der Substratorientierung bzw. Fehlorientierung auf Durchmesser und Struktur der Röhren, wurden untersucht und mittels linearer Elastizitätstheorie modelliert. TEM Aufnahmen von Querschnittsflächen und AFM Aufnahmen der Oberflächen bzw. der Grenzflächen werden vorgestellt und diskutiert. Die Auswirkungen einer nachträglichen epitaktischen Abscheidung von pseudomorphen GaAs-Schichten auf die gekrümmte Oberfläche der Röhren, und deren Einfluss auf Stabilität und Röhrendurchmesser wurden untersucht, und damit die Möglichkeit der nachträglichen Veränderung der Spannungsverteilung in der Nanoröhre aufgezeigt.

HL 9.18 Mon 15:15 P3

Oberflächenpassivierung von GaAs-Nanodrähten und Ladungsträgerconefinement durch Mantelstrukturen — •Jens Bauer[1], Volker Gottschalch[1], Hendrik Paetzelt[1], Gabriele Benndorf[2], and Gerald Wagner[3] — [1]Institut für Anorganische Chemie, Universität Leipzig, Johannesallee 29, D-04103 Leipzig — [2]Institut für Experimentelle Physik II, Universität Leipzig, Linnéstrasse 3, D-04103 Leipzig — [3]Institut für Kristallographie und Mineralogie, Universität Leipzig, Linnéstrasse 3, D-04103 Leipzig

Eine Kombination von MOVPE (metallorganische Gasphasenepitaxie) und VLS ("'vapor-liquid-solid"')-Wachstumsmechanismus erlaubt die Darstellung von Halbleiternanodrähten. Durch gezielte Variation der Züchtungsbedingungen können sowohl eine säulenförmige als auch eine spitz zulaufende Morphologie erreicht werden. Die geringen lateralen Ausdehnungen führen zu einem hohen Einfluss von Oberflächeneffekten auf die optischen Eigenschaften dieser Nanodrähte. Durch geeignete Passivierungsmethoden reduzieren sich derartige Einflüsse deutlich. Unter Ausnutzung von normalem epitaktischen Schichtwachstum lassen sich Mantelstrukturen auf den Nanodrähten realisieren ("'core-shell"'-Strukturen), welche bei geeigneter Materialwahl ein Ladungsträgerconfinement im Nanodraht ermöglichen. Im Beitrag werden die Passivierung von GaAs-Nanodrähten durch in-situ-Stickstoffbehandlung bzw. ex-situ-SiO_x-Abscheidung und der Aufbau von GaAs/(AlGa)As bzw. GaAs/Ga(AsN) "'core-shell"'-Strukturen vorgestellt und die Einflüsse auf die Photolumineszenzausbeute diskutiert.

HL 9.19 Mon 15:15 P3

Optical orientation of electron spins by in-plane excitation of GaAs quantum wells — •Niels Ubbelohde[1], Stefan Pfalz[1], Roland Winkler[1,2], Daniel Hägele[1], and Michael Oestreich[1] — [1]Universität Hannover, Institut für Festkörperphysik, Appelstr. 2, D-30167 Hannover — [2]Department of Physics, Northern Illinois University, De Kalb, IL 60115, USA

We study the optical orientation of electron spins in GaAs quantum wells using a light beam propagating *parallel* to the plane of the two-dimensional (2D) system. A circularly polarized laser pulse is focussed on the cleaved edge of the quantum wells thus creating spin-polarized electrons in the wells. Application of an in-plane magnetic field perpendicular to the excitation direction leads to spin precession which we observe in the emission along the growth direction of the 2D system. From the polarization- and time-resolved photoluminescence, we obtain the initial degree of electron spin polarization P_0 which is studied as a function of the excitation energy. In comparison with the optical orientation for excitation in growth direction [1], we observe a qualitatively different behaviour of the energy dependence of P_0. While the former geometry yields a high degree of initial spin polarization for excitation of the lowest heavy-hole exciton, we now measure $P_0 = 0$. Furthermore, we find that the sign of P_0 is independent of the excitation energy.

[1] S. Pfalz, R. Winkler, T. Nowitzki, D. Reuter, A. D. Wieck, D. Hägele and M. Oestreich, Phys. Rev. B **71**, 165305 (2005)

HL 9.20 Mon 15:15 P3

Slow, focused ion beam (FIB) meet high-purity layers: combined MBE-low-energy-FIB facility to creat shallow, overgrown doped layers — •Sinan Ünlübayir, Dirk Reuter, Alexander Melnikov, and Andreas D. Wieck — Ruhr-Universität Bochum, Universitätsstraße 150, 44801 Bochum

We have modified a commercial focused ion beam (FIB) to allow usage in a variable energy range between only 10 eV to 30 keV. To slow down the ions, a retarding field between the sample stage and a FIB column is applied. In case of slow ion implantation it is common to speak about deposition, because the depth of penetration is few nanometer, or around one monolayer. The FIB is connected with a ultra high vacuum lock to a III/V molecular beam epitaxy system. This enable us to overgrow the implanted regions after transferring into the MBE chamber. With this technique we have embeded lateral, shallow doped regions into GaAs or AlGaAs. The present work discussed about Si- and Be-doped layers in GaAs, which are produced by ion energy between 10 eV to 1000 eV. Furthermore we doped GaAs/$Al_xGa_{1-x}As$-Heterostructures (so-called HEMTs) with this Si deposition technique. It will be showed that, production of two dimensional electron gases (2DEG) is achieved. The samples have been examined by means of Hall and magneto transport measurements at low temperatures. The smallest lateral size of the doped layer obtained by us was 5 μm. To the best of the authors knowledge, this is the smallest size reported elsewhere.

HL 9.21 Mon 15:15 P3

Magnetotransport of p-type and n-type (B,Ga,In)As — •J. Teubert[1], P. J. Klar[1], W. Heimbrodt[1], and V. Gottschalch[2] — [1]Dept. Physics and WZMW, Philipps-University, Germany — [2]Faculty of Chemistry and Mineralogy, University of Leipzig, Germany

We present magnetoresistance (MR) measurements on p-type and n-type (B,Ga,In)As in fields up to 10 T and at temperatures down to 2 K. The samples were grown by MOVPE with B and In contents of 2,7% and 6%, respectively, and with different carrier concentrations. The MR results will be compared with those of (Ga,In)(N,As). Both, the incorporation of N and B forms highly localized energy levels resonant with the conduction band leading to an interaction of these localized levels with the extended conduction band states. In the case of N, one observes strong level-repulsion effects and thus a strong red-shift of the fundamental band gap. B seems to have much less influence on the conduction band structure compared to N, e.g. no significant reduction of the band gap was observed and only an increase of effective electron mass was found. Despite the difference in band-structure modification due to B and N, it is surprising that the MR results of (B,Ga,In)As show many similarities to those of (Ga,In)(N,As) e.g. strong Anderson localization effects for n-type samples.

HL 9.22 Mon 15:15 P3

Thermopower measurements on n-type (Ga,In)(N,As) — •J. Teubert, P. J. Klar, W. Heimbrodt, K. Volz, W. Stolz, and P. Thomas — Dept. Physics and WZMW, Philipps-University of Marburg, Germany

We present first thermopower measurements on n-type-(Ga,In)(N,As) semiconductor alloys. N in (Ga,In)(N,As) forms a highly localized energy level resonant with the conduction band that strongly perturbs the conduction band structure of the crystal. The interaction between the localized N-related levels and the extended conduction band states leads to a strong dependence of the local band gap on nitrogen concentration. Together with the variation of the local N-environment this results in significant spatial and energetic disorder. For example, these effects manifest themselves in the magnetotransport behaviour of n-type (Ga,In)(N,As), which is dominated by weak Anderson localization effects. Combined thermopower and resistivity measurements can be analysed using models established for amorphous semiconductors. This analysis yields further insight into the nature (i.e. lengthscale, width) of the disorder potential fluctuations.

HL 9.23 Mon 15:15 P3

Pulsed Laser Deposition growth and characterization of laterally arranged uniform ZnO nanowires — •Andreas Rahm[1], Thomas Nobis[1], Michael Lorenz[1], Gregor Zimmermann[1], Marius Grundmann[1], Bodo Fuhrmann[2], and Frank Syrowatka[2] — [1]Universität Leipzig, Fakultät für Physik und Geowissenschaften, Linnéstr. 5, D-04103 Leipzig, Germany — [2]Universität Halle, Zentrum für Materialwissenschaften, Hoher Weg 8, D-06120 Halle, Germany

A regular lateral alignment of Zinc Oxide nanostructures which have very promising optical properties is necessary for practical device applications. We report on the Pulsed Laser Deposition [1] growth of free standing nanowire arrays with uniform hexagonal arrangement. In order to achieve this we prepared an ordered array of catalytic gold particles by nanosphere lithography [2] using monodisperse spherical polystyrol nanoparticles. These templates were investigated by Scanning Electron Microscopy and Atomic Force Microscopy prior to growth. Using XRD we determined the crystallographic relations between the ZnO wires and the a-plane sapphire substrates. Furthermore we present Cathodoluminescence measurements.

[1] M. Lorenz, E.M. Kaidashev, A. Rahm, T. Nobis, J. Lenzner, G. Wagner, D. Spemann, H. Hochmuth, M. Grundmann, Appl. Phys. Lett. 86 (2005), 143113

[2] J.C. Hulteen, R.P. van Duyne, J. Vac. Sci. Technol. A 13(3) (1995), 1553

HL 9.24 Mon 15:15 P3

Cathodoluminescence Study of Zinc Oxide Nanopillars in a Field Emitter-SEM — •Martin Schirra, Anton Reiser, Andreas Ladenburger, Rolf Sauer, and Klaus Thonke — Abt. Halbleiterphysik, Universität Ulm, D-89069 Ulm

Investigation of semiconductor nanostructures in a scanning electron microscope (SEM) requires a field-emitter (FE) type cathode for high spatial resolution. When apart from SEM images also cathodoluminescence (CL) shall be measured, one has to know and control the excited sample volume which limits the spatial CL resolution and, due to electron scattering, is mainly determined by the energy of the primary electron beam. We present a simple model to estimate the size of the excitation volume. Small excitation volumes require low acceleration voltages, which in turn demand short working distances in the FE-SEM. This is problematic, if the CL-signal is coupled out via mirror optics. Therefore we have developed a setup which uses UV transparent glas fiber optics. The system was tested by recording CL spectra of single ZnO nanopillars. A spatial resolution of 80nm at a spectral resolution better than 0.5meV was achieved. Recording extrinsic and intrinsic near bandedge CL features the crystalline quality, strain, defects, shallow dopant species and doping gradients along the pillar axis are assessed and the results are discussed.

HL 9.25 Mon 15:15 P3

Investigation of ZnO layers obtained by RBQE method — •Lia Trapaidze, Tamaz Butkhuzi, Tamar Khulordava, Lia Aptsiauri, Eka Kekelidze, Maia Sharvashidze, and Giorgi Natsvlishvili — Tbilisi State University, Dep. of Physics, 3 Chavchavadze Ave, 0128, Tbilisi, Georgia

Wide band semiconductors are interesting materials for obtaining of the light-emitting diodes in the violet and ultraviolet area, solid-state lasers and other electro optic systems. We elaborated non-equilibrium method Radical Beam Epitaxy (RBE), which gives us a possibility to regulate effectively electro-optical characteristics of the wide band semiconductors. Using RBQE method it is possible to get p-type, n-type and isolate layers of ZnO and p-n junction of the basis of ZnO/ZnO. By means of RBE method ZnO layers were grown on the basis of ZnO. The temperature of treatment was 400 C, duration was 4 hours. We measured I-V characterization, after them we obtained p-n junction. In the ultraviolet part of the PL spectra of ZnO epitaxial layers we observed intense peaks and the visible part were reduced. Observation of acceptor bound exciton in ZnO layers obtained by RBQE are characterized by high purity and perfection structure and significantly reduced number of point defect, what is one of the most important problems. For structural characterization of ZnO, new layers were checked with a Siemens D5000 XRD (X-Ray diffraction) spectrometer.

HL 9.26 Mon 15:15 P3

Confined optical modes in monolithic ZnSe-based pillar microcavities — •H. Lohmeyer[1], K. Sebald[1], C. Kruse[1], J. Gutowski[1], D. Hommel[1], J. Wiersig[2], N. Baer[2], and F. Jahnke[2] — [1]Institute of Solid State Physics, University of Bremen, P.O.Box 330 440, 28359 Bremen, Germany — [2]Institute of Theoretical Physics, University of Bremen, P.O.Box 330 440, 28359 Bremen, Germany

We report on the successful realization and optical characterization of monolithic II-VI pillar microcavities (MCs) which are very promising for future applications such as single photon emitters at elevated temperatures or quantum-dot based vertical-cavity surface-emitting lasers in the blue-green spectral region.

VCSEL structures made of ZnCdSSe/ZnSSe λ-cavities and Bragg mirrors composed of ZnSSe and MgS/ZnCdSe superlattices have been fabricated by molecular-beam epitaxy. Airpost pillar MCs with diameters between 500 nm and 4 μm were fabricated by focused ion-beam etching. The discrete mode spectra of the pillars are studied by photoluminescence measurements.

The measured data show full agreement with calculations of the transmission spectra of the three-dimensional pillars based on a vectorial transfer-matrix method. Achievable Purcell factors well above 10 can be estimated from the measured quality factors and calculated mode volumes. First investigations of the coupling of quantum-dot like emitters to the pillar modes show a strong enhancement in the detected photoluminescence signal of the latter in resonance with modes of the cavity.

This work was supported by the Deutsche Forschungsgemeinschaft.

HL 9.27 Mon 15:15 P3

Growth and characterization of Mn- and Co- doped ZnO nanowires — •Andreas Rahm, Evgeni M. Kaidashev, Heidemarie Schmidt, Mariana Diaconu, Andreas Pöppl, Rolf Böttcher, Christoph Meinecke, Tilman Butz, Michael Lorenz, and Marius Grundmann — Universität Leipzig, Fakultät für Physik und Geowissenschaften, Linnéstr. 5, D-04103 Leipzig, Germany

ZnO based nanostructures have attracted increasing interest in recent years due to their structural diversity. Furthermore, transition metal

doping (e.g. by Co or Mn) of ZnO has been predicted [1] and shown [2] to create a promising ferromagnetic material for spintronics. We report on the high-pressure pulsed laser deposition growth of zinc oxide nanowires [3] containing about 0.2 at-% Co and 0.5 at-% Mn by NiO and Au catalyst. Scanning electron microscopy and X-ray diffraction measurements revealed arrays of parallel-standing nanowires with hexagonal cross section and uniform in-plane epitaxial relations without rotational domains. Elemental analysis was carried out using particle induced X-ray emission and Q-band electron spin resonance. The valence of the incorporated Mn was determined to be 2+. Atomic and magnetic force microscopy measurements indicate that Mn is incorporated preferentially at the nanowire boundaries. [1] T. Dietl , H. Ohno, F. Matsukura, J. Cibert, D. Ferrand, Sciene 287, 1019 (2000) [2] K. Ueda, H. Tabata, T. Kawai, Appl. Phys. Lett. 79, 988 (2001) [3] M. Lorenz, E.M. Kaidashev, A. Rahm, T. Nobis, J. Lenzner, G. Wagner, D. Spemann, H. Hochmuth, M. Grundmann, Appl. Phys. Lett. 86 (2005), 143113

HL 9.28 Mon 15:15 P3

Synthesis and Characterisation of CdSe:Mn-nanoparticles — •Andreas Hofmann[1], Christina Graf[1], Reinhard Neder[2], Georg Schmidt[3], and Eckart Rühl[1] — [1]Institut für Physikalische Chemie, Universität, , Am Hubland, D-97074 — [2]Institut für Mineralogie und Kristallstrukturlehre, Universität Würzburg, Am Hubland, D-97074 — [3]Physikalisches Institut, Universität Würzburg, Am Hubland, D-97074

We present a new preparation method for dilute magnetic II-VI-semiconductor nanoparticles by a high temperature synthesis. On the basis of a Green Chemistry approach we use CdO and different Mn-precursors to build up nearly monodisperse CdSe:Mn-nanocrystals (NC) without a size-selection process. The NC have a manganese content of about 1%, which was measured by ICP. SQUID-measurements also show a paramagnetic coupling, which indicates that there is no interaction between Mn-atoms. The size of the NC (3 to 7 nm) was determined by transmission electron microscopy and photoluminescence-measurements. We use EPR-spectroscopy to determine the location of Mn in the particles. It is shown that Mn is embedded in the CdSe-core. It is crucial for integrating Mn in the core of the NC that it has a zinc-blende lattice [1]. This is accomplished by growing CdSe on zinc-blende ZnSe NC. However, we use a novel synthesis [2] to produce zinc-blende CdSe-cores, where Mn can incorporate easily. Further, we try to coat the particles with a thin ZnS-shell and discuss resulting changes in fluorescence quantum yield.
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[2] M. B. Mohamed et al., J. Phys. Chem. B, **10533**, 109, (2005).

HL 9.29 Mon 15:15 P3

The influence of native and impurity defects on the formation of radiative centres in ZnSe crystals — •Vadim Sirkeli, Galina Ivanova, Dmitrii Nedeoglo, and Natalia Nedeoglo — Moldova State University, Department of Physics, A. Mateevici str. 60, Chisinau, MD-2009 Moldova

Photoluminescence spectra of both as-grown ZnSe crystals and the crystals doped with Au from Zn+Au or Se+Au melt have been investigated. It is established that gold-doping from Zn+Au melt leads to the formation of both simple Au_i donor and Au_{Zn} acceptor defects. Associative radiative centres (Au_{Zn}-Au_i) and (Au_{Zn}-D) are also formed. The edge luminescence of the crystals is attributed to radiative annihilation of Au_i and V_{Se} donor-bound excitons. The luminescence spectra of ZnSe crystals doped with Au from Se+Au melt contain only one narrow line, which is ascribed to radiative annihilation of Au_{Zn} acceptor-bound excitons. It is shown that the process of the formation of Au_i donor or Au_{Zn} acceptor defects and their complexes with native defects can be controlled by changing the composition of annealing medium. The observed variations of radiative properties for gold-doped ZnSe crystals are explained by amphoteric properties of gold impurity and its ability to form the complexes with native defects.

HL 9.30 Mon 15:15 P3

Optical and vibrational properties of p-doped $Zn_{1-x}Mn_xTe$-bulk material — •C. Kehl[1], M. Eyring[1], M. Lentze[1], T. Kiessling[1], Le Van Khoi[2], J. Geurts[1], and W. Ossau[1] — [1]Universität Würzburg, Physikalisches Institut, Experimentelle Physik III, Am Hubland, 97074 Würzburg — [2]Institut of Physics, Polish Academy of Science, AL. Lotnikow 32/46, 02-668 Warsaw

Using magneto-optic photoluminescence, reflectivity and Raman measurements, p-doped $Zn_{1-x}Mn_xTe$-bulk material was investigated in order to study its optical properties at the fundamental band gap and its lattice dynamics. The samples used for this study were grown via Bridgman technique with a Mn concentration from 0 up to 30% and doping levels from p = $1{\cdot}10^{16}$ to $5{\cdot}10^{19}$ cm^{-3}.
The photoluminescence and reflectivity respectively was measured both *without magnetic field* and *with B-fields up to* 4 *Tesla* in Faraday configuration. It was applied for the exact determination of the Mn concentration in several samples, as well as for the investigation of the internal electronic Mn transition, the donor-acceptor-transition and the excitonic excitations. Furthermore the phonon behaviour was investigated via resonant Raman experiments, close to the fundamental gap resonance. The experiments were performed both without B-field and with B-field in Voigt configuration. An obvious dependence of the phonon eigenfrequencies on the Mn concentration of the sample could be demonstrated.

HL 9.31 Mon 15:15 P3

Growth and Doping of ZnO Nanostructures on Different Substrate Materials — •Anton Reiser, Günther M. Prinz, Martin Schirra, Andreas Ladenburger, Martin Feneberg, Rolf Sauer, and Klaus Thonke — Abt. Halbleiterphysik, Universität Ulm, 89069 Ulm

Growth of ZnO nanostructures either by vapor-liquid-solid epitaxy (VLSE) or by modified chemical vapor deposition (CVD) is investigated. Variation of the growth parameters such as temperature of the sample, temperature and composition of the source materials, flow of the transport gas, oxygen supply etc. allows to control preferential growth of specific ZnO nanostructures. Different substrates, as e.g. a-, r-, c-plane sapphire, silicon, and gallium nitride, affect the structure and the optical properties of the resulting nanostructures. We study the doping of such nanostructures, either directly in the growth process, by adding suitable materials to the sources, by using different catalyst materials, or by ion implantation of the as-grown structures. The crystalline quality and the optical properties of the nanostructures as grown and after subsequent process steps are monitored by SEM images and x-ray analysis, by micro-Raman measurements, by photoluminescence, and by field emitter type SEM cathodoluminescence spectroscopy.

HL 9.32 Mon 15:15 P3

Impact of As-doping on the optical properties of ZnO — •Martin Noltemeyer, Frank Bertram, Thomas Hempel, Silke Petzold, Jürgen Christen, Sören Giemsch, Armin Dadgar, and Alois Krost — Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, Germany

We present results from the optical and structural characterization of heteroepitaxial grown ZnO which was doped with arsenic. The samples were grown by metal organic vapor phase epitaxy (MOVPE) on GaN/sapphire templates. For doping experiments the layers were doped with arsenic using different AsH_3-flows ranging from 0.0005-0.5 sccm. An un-doped reference samples is grown for comparison. In the low temperature (T = 4.2K) photoluminescence spectrum the free exciton X, the bound exciton lines I_0/I_1, I_2/I_3, and I_8, as well as the 1st and 2nd LO phonon replica from I_8 can be easily identified. In addition, the TES-I_8 line can be observed. With increasing the AsH_3-flow all excitonic lines broaden and significantly decrease in intensity. In particular I_2/I_3 completely disappears. As a more prominent feature, a distinguished donor acceptor pair recombination band (DAP) shows up with As-doping at 3.23 eV exhibiting up to 6 well resolved LO phonon replicas. Spatially and spectrally resolved cathodoluminescence measurements give a direct correlation of structural and optical properties of these layers.

HL 9.33 Mon 15:15 P3

Doping of ZnS monocrystals by P ions — •Aptsiauri Lia, Kekelidze Eka, Trapaidze Lia, and Butkhuzi Tamaz — Tbilisi State University, Chavchavadze ave.3, 0128, Tbilisi Georgia

. ZnS belongs to a class of materials that can be easily doped only n-type, but to obtain samples with low ohmic is considered to be difficult mainly because of intense compensating processes, which are widely investigated. In the present work in order to obtain hole conductivity in ZnS by phosphorus doping and to identify the centers that are responsible for the increase of hole concentration as well as the centers compensating the conductivity we carried out implantation of ZnS mono-crystals by P ions. Initial mono-crystals were of electric conductivity. After implantation the samples were annealed under preliminary deposited gold layers in nitrogen atmosphere. The lowest resistivity was obtained We carried

out Thermodynamic analysis for ZnS-P. We defined defects and carriers as a function of zinc vacancies concentration. Thermodynamic analysis showed that difficulty of doping is conditioned by the fact that area of hole conductivity is too narrow and at high temperatures it may even disappear.

HL 9.34 Mon 15:15 P3

Energy transfer processes between extended band states and Te-related localized states in $ZnS_{1-x}Te_x$ — •T. Niebling, P.J. Klar, and W. Heimbrodt — Dept. Physics and WZMW, Philipps-Univerisity of Marburg, Germany

Various wurtzite $ZnS_{1-x}Te_x$ bulk samples of low x have been studied by time-resolved photoluminescence (PL). The dependence on concentration, on temperature, and on excitation density as well as the temporal behaviour indicate that the dynamics of the PL is influenced by excitation transfer processes between band states and the isoelectronic impurity levels located above the top of the valence band. These states can be related to Te_n complexes where $n = 1, 2, 3$ is the number of Te impurities forming the complex. For higher Te concentrations or immediately after the excitation pulse, the PL spectrum is dominated by a UV band whose intensity shifts towards a blue band either with increasing concentration or with increasing time delay after the excitation pulse. The observed concentration dependence is a manifestation of the statistics of the different complexes where preferably higher Te clusters occur with increasing x. The time evolution of the PL is caused by excitation transfer processes towards smaller energies. The energy transfer from the isolated centres to the pair states will be discussed in detail.

HL 9.35 Mon 15:15 P3

Hydrogen-related shallow donors in zinc oxide studied by infrared absorption and photoconductivity — •F. Börrnert, E. V. Lavrov, and J. Weber — Technische Universität Dresden, 01062 Dresden, Germany

Zinc oxide samples grown from vapor phase and treated with hydrogen and/or deuterium plasma were studied by means of infrared absorption spectroscopy and photoconductivity. Two electronic transitions were found in infrared absorption at 1430 and 1480 cm^{-1}. These lines belong to the H-I defect which was tentatively associated with bond-centered hydrogen. The energies of these transitions rule out H-I as a candidate for the hydrogen-related shallow donor in zinc oxide. Electronic transitions of three independent hydrogen-related shallow donors were observed in the photoconductivity spectra at 180, 240, and 310 cm^{-1}.

HL 9.36 Mon 15:15 P3

Pseudopotential investigations of electronic and optical properties of wurtzite ZnO and GaN — •Daniel Fritsch, Heidemarie Schmidt, and Marius Grundmann — Universität Leipzig, Fakultät für Physik und Geowissenschaften

We have investigated the electronic properties of two important UV materials by means of the empirical pseudopotential method (EPM) including spin-orbit coupling. The transferable model potential parameters of the ionic model potential used in this work were fitted to experimentally well-known low-temperature transition energies of wurtzite ZnO and GaN to obtain a reliable description of the band dispersion throughout the Brillouin zone.

We determined the transition matrix elements in the electric dipole approximation at special points in the Brillouin zone following the scheme proposed by Chadi and Cohen [1]. A summation of these matrix elements yields the dielectric function and can be related to experimental data obtained by spectroscopic ellipsometry [2].

[1] D. J. Chadi and M. L. Cohen, Phys. Rev. B 8, 5747 (1973).
[2] D. Fritsch et al., Proceedings of NUSOD '05, 69 (2005).

HL 9.37 Mon 15:15 P3

Influence of confinement effects and carrier concentration on spin relaxation rates studied by spin-flip Raman spectroscopy on heavily doped (Zn,Mn)Se and (Cd,Mn)Te — •M. Lentze[1], L. C. Smith[2], D. Wolverson[2], P. Grabs[1], and J. Geurts[1] — [1]Universität Würzburg, Experimentelle Physik III, Am Hubland, 97074 Würzburg — [2]University of Bath, Department of Physics, Bath BA2 7AY, United Kingdom

Spin-flip Raman spectroscopy (SFRS) is a convenient way to study optical properties of diluted magnetic semiconductors (DMS). Especially useful features of the technique are optical material selectivity (important for heterostructures) as well as high sensitivity. We studied II-VI semiconductors like $Zn_{(1-x)}Mn_xSe$ and $Cd_{(1-x)}Mn_xTe$ which are promising components for the new spin based information technology (spintronics).

Our investigations are focused on n-doped heterostructures, containing quantum wells with 2DEG ($(Zn, Mn)Se$ and $(Cd, Mn)Te$) embedded in $(Zn, Be)Se$ and $(Cd, Mg)Te$ respectively. Analysing the Raman signal we obtain the effective Manganese content, the g-values of the electrons and their exchange parameter $N_0\alpha$. A non-ambiguous influence of confinement and electron concentration in the quantum wells on the SFRS linewidth occurs for both material systems.

Besides backward scattering experiments, also spin-flip Raman spectra in forward scattering were taken, after selective substrate etching. By the comparison of half width of the SFRS signals we could determine spin relaxation times T_2 as well as spin diffusion constants D_s. An obvious decrease of T_2 with increasing n-doping level could be demonstrated.

HL 9.38 Mon 15:15 P3

Cathodoluminescence of PLD grown ZnO thin films: A comparison of experiment and simulation — •Robert Johne, Michael Lorenz, Holger Hochmuth, Jörg Lenzner, Holger von Wenckstern, Gabriele Benndorf, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, 04103 Leipzig, Germany

We have investigated ZnO thin films on sapphire, which are intended to serve as scintillators. Cathodoluminescence (CL) spectra were excited on the ZnO side of the thin film samples and the emitted light was detected in two geometries: (a) on the ZnO side (reflection geometry) and (b) on the sapphire substrate side (transmission geometry). The excitonic CL peak in reflection geometry red-shifts with increasing CL excitation energy. This redshift and the peak shift of reflection relative to transmission geometry spectra can be explained by a model of photon propagation including the effect of self-absorption of the near band edge luminescence in the ZnO film. In addition, different surface morphologies, slopes and positions of the intrinsic absorption edge and effects to due detection in a limited solid angle were included in the simulation and compared with experimental results. These influences may explain the occasionally observed double peak structure of experimental CL spectra in reflection geometry.

HL 9.39 Mon 15:15 P3

Ferromagnetism in Zn(Mn,Sn)O and Zn(Mn,P)O films — •M. Diaconu[1], H. Schmidt[1], M. Fecioru-Morariu[2], G. Güntherodt[2], D. Spemann[1], H. Hochmuth[1], M. Lorenz[1], and M. Grundmann[1] — [1]Inst. für Exp. Physik II, Fakultät für Physik, Uni. Leipzig, Linnestrasse 3-5, 04103 Leipzig — [2]II. Physikalisches Institut, RWTH Aachen, Physikzentrum Melaten, Huyskensweg Turm 28B, 52074 Aachen

Ferromagnetic behavior was observed in Zn(Mn,Sn)O films below 250 K and in Zn(Mn,P)O films above 300 K, with a maximum magnetic moment of 0.045 μ_B per Mn ion at room temperature. The films have a Mn content around 5 at% and P content around 0.1 and 0.5 at% or Sn content around 0.05 at% and were grown by pulsed laser deposition on a-plane sapphire. The film composition was determined by Rutherford backscattering and particle induced X-ray emission. The presence of secondary phases was investigated by X-ray diffraction. We also investigated the effect of annealing at 800°C in N_2 atmosphere and we observed that after 2 hours annealing the films became paramagnetic at all temperatures and electrically insulating.

HL 9.40 Mon 15:15 P3

Integral electrical and micro-electrical investigations of ZnO thin films — •H. von Wenckstern, M. Brandt, H. Schmidt, G. Zimmermann, R. Johne, J. Lenzner, H. Hochmuth, M. Lorenz, and M. Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstraße 5, 04103 Leipzig

ZnO thin films grown by pulsed-laser deposition on sapphire substrates are investigated by integral electrical and micro-electrical methods. Temperature dependent Hall measurements yield the dominant scattering mechanisms and the thermal activation energy of dominant donors. The results obtained from this integral method are compared to surface properties investigated on the nanometer scale. For that, atomic force microscopy, scanning capacitance microscopy, scanning surface potential microscopy, and scanning electron microscopy measurements are used. Further, the influence of a degenerate layer at the sapphire/ZnO interface on the determination of transport properties is discussed thoroughly in this contribution.

HL 9.41 Mon 15:15 P3

Electrical characterization of ZnO grown by MOCVD on a multi-layer template — •Stephan Tiefenau, H. Witte, A. Krtschil, A. Dadgar, S. Giemsch, and A. Krost — Otto-von-Guericke Universität Magdeburg, FNW/IEP/AHE, Postfach 4120, 39016 Magdeburg

Currently, ZnO layers are in the focus of interest due to its possible applications in future optoelectronic devices, for instance in highly efficient LED and laser diodes. However, there are still some problems in the growth of high quality ZnO and especially in an effective p-type doping. For the latter topic, electrical measurements are important to understand transport and compensation mechanisms and properties of deep defects. The ZnO layers were grown by metal organic vapor phase epitaxy on a GaN/AlN template either on silicon or sapphire substrates. The heterostructures cause space charge regions which influence the electrical characteristics and have to be considered. We compare Hall effect and C-V measurements and show the different information depths of these methods. Furthermore, the impact of layer defects such as holes and surface roughness is investigated systematically with C-V measurements and scanning surface potential microscopy. On the basic of these investigations, properties of ZnO related deep defects and of interface states are characterized using photoconductivity spectroscopy, thermal and optical admittance spectroscopy and deep level transient spectroscopy.

HL 9.42 Mon 15:15 P3

Photoluminescence studies of VPE-grown ZnO nanorods — •H. Gafsi[1], C. Bekeny[1], T. Voss[1], I. Rückmann[1], J. Gutowski[1], A. Che Mofor[2], A. Bakin[2], and A. Waag[2] — [1]Institute of Solid State Physics, University of Bremen, P.O.Box 330 440, 28359 Bremen, Germany — [2]IHT, TU Braunschweig, P.O Box 3329,38023 Braunschweig

Capable of emitting UV light ZnO is a promising semiconductor for realizing fully integrated optoelectronic nanodevices. It has a wurtzite crystal structure with a large band gap of $3.37\,eV$ $(300\,K)$ and an exciton binding energy of $60\,meV$, which assures excitonic emission processes still being important at room temperature.

Here, we present temperature dependent PL measurements on ZnO nanorods grown by vapor-phase epitaxy (VPE) on two different substrates, $6H\text{-}SiC$ and a-plane Al_2O_3.

The PL reveals well resolved near-band-gap features, in particular excitonic peaks. Also, it shows phonon-assisted excitonic transitions at temperatures up to about $200\,K$. On the high energy side of the free exciton at around $3.42\,eV$ an emission band with several fine structure lines is observed whose origin is discussed. Comparing the PL spectra on different substrates, $a\text{-}Al_2O_3$ provides a narrower donor-bound-exciton emission peak than $6H\text{-}SiC$. Though nominally undoped the rods on $6H\text{-}SiC$ show signatures, which can be attributed to band-to-acceptor transitions. These results demonstrate that by using VPE it is possible to produce nanorods of high quality without using a catalyst.

HL 9.43 Mon 15:15 P3

Composition Dependent Properties of Structured II-VI Semiconductor Nanoparticles — •Sofia Dembski[1], Christina Graf[1], Reinhard Neder[2], and Eckart Rühl[1] — [1]Institut für Physikalische Chemie, Universität Würzburg, Am Hubland, D-97074 Würzburg — [2]Institut für Mineralogie und Kristallstrukturlehre, Universität Würzburg, Am Hubland, D-97074 Würzburg

II-VI-Semiconductor nanoparticles (quantum dots, QD) have unique size-dependent optical and electronic properties. Especially, small nanoparticles have a large surface-to-bulk ratio. Therefore, it is expected that the particle surface dominates their properties so that the local environment near the surface strongly influences their properties. We present a systematic study on optical, electronic, and structural properties of QD in selected environments. CdSe-ZnS core-shell nanoparticles are obtained from the high temperature thermolysis of organometallic precursors in coordinative solvents. These particles are subsequently functionalized either by an exchange of their ligands or by the reversible coating with an amphiphilic polymer. As a result, the particles can be studied in various environments. The crystal structure of the QD is characterized by transmission electron microscopy (TEM) and x-ray diffraction (XRD). The influence of the local environment on the optical properties of the QD is studied by optical absorption and photoluminescence spectroscopy.

HL 9.44 Mon 15:15 P3

Phonon properties in $Zn_{1-x}Mn_xSe$ bulk epilayers and thickness effect on the shape of reststrahlen band — •K. C. Agarwal, B. Daniel, D. Kälblein, C. Klingshirn, and M. Hetterich — Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76131 Karlsruhe, Germany

Recently, diluted magnetic semiconducts (DMS) like $Zn_{1-x}Mn_xSe$ attract a lot of attention due to their potential for the realization of spin devices. In this contribution, we present the results of our temperature dependent far infrared (FIR) investigations performed on MBE grown $Zn_{1-x}Mn_xSe$ epilayers. Our results reveal the phonon properties of this mixed crystal alloy. For the $Zn_{1-x}Mn_xSe$ samples with low Mn contents ($x = 0,8$ %), the anharmonic interactions are small resulting in equal values of the transverse optical (TO)- and longitudinal optical (LO)-broadenings (γ). However, for the samples with larger Mn contents a significant difference between LO and TO broadenings is found. In addition to the known ZnSe-like and MnSe-like phonon resonances, we observe a weak feature below the MnSe-like phonon band. The frequency of this feature shows a temperature and Mn dependent shift. We suggest that this feature observed in our measurements is a "weak-mode", which has its origin in the disorder resulting from the Mn incorporation in the samples. Additionally, the shape of the reststrahlen band is found to change significantly with layer thickness. This effect is studied in some detail for pure ZnSe epilayers by comparing our experimental data with theoretical simulations.

HL 9.45 Mon 15:15 P3

PAC-measurements in GaN on alternative Si(111)-based substrates — •J. Penner[1], R. Vianden[1], A. Dadgar[2], and A. Krost[2] — [1]Helmholtz - Institut für Strahlen- und Kernphysik der Universität Bonn, Nußallee 14-16, 53115 Bonn, Germany — [2]Institut für Experimentelle Physik, Otto-von-Guericke-Universität, PO-Box 4120, 39016 Magdeburg, Germany

Si(111) substrates are an interesting alternative for growing GaN epilayers. However, since lattice parameters and thermal behaviour of Si differ from GaN, high defect densities and hydrostatic expansion is produced during the growth of epilayers. Thin AlN buffer layers can help to build up compressive strain and to reduce the defect density [1]. The AlN layers also passivate the silicon surface and inhibit the so-called melt-back etching. We used the Perturbed-Angular-Correlation (PAC) method to study the electric field gradient at the site of ^{111}In implanted into GaN/AlN/Si(111). Subsequently, an annealing programme was carried out. A similar behaviour as seen in GaN grown on sapphire is found.However, the interaction frequency observed for probes on regular sites and the frequency for probes sitting in an disturbed environment are significantly higher than the corresponding values for GaN/sapphire. We discuss possible reasons for this behaviour.

[1] A. Dadgar et. al.; Appl. Phys. Lett. 82 (2003), 28-30

HL 9.46 Mon 15:15 P3

Formation of Antimony rich double layer structures at InP/GaAsSb Interfaces — •Stefan Weeke[1], Martin Leyer[1], Markus Pristovsek[1], and Wolfgang Richter[2] — [1]Institut für Festkörperphysik, Hardenbergstraße 36, TU Berlin, 10623 Berlin — [2]Dipartimento di Fisica, Roma II (Tor Vergata), Via della Ricerca Scientifica 1, I-00133 Rome, Italy

The GaAsSb/InP material system is promising for InP based DHBTs. However, segregation of antimony into InP is a serious problem, affecting the quality of the interface and hence the device performance. To investigate the segregation behaviour of antimony, we exposed InP surfaces with antimony by TMSb covering the typical InP/GaAsSb growth temperature range in MOVPE.We have observed the unexpected formation of an antimony rich double layer structure with one layer occuring at the interface and the other 50 to 100nm deep in the InP overlayer after subsequent overgrowth with InP. It was observed that the spacing between the layers depends on growth temperature, growth rate and the amount of antimony deposited on the surface.During MOVPE growth of GaAsSb only the antimony rich surface reconstruction is observed by RAS. During overgrowth with InP the antimony slowly vanishes, until at a certain point all remaining Sb is incorporated into a second antimony rich layer. This transition is most easily seen in first derivative of the RAS transients. As an explanation of this unusual segregation behaviour a model of strain induced surface melting is proposed.

HL 9.47 Mon 15:15 P3

Characterization of thin sol-gel-deposited high-k zirconia (ZrO_2) layers — •Peter Iskra[1], Michel Kazempoor[2], Gerhard Lilienkamp[1], and Winfried Daum[1] — [1]Institut für Physik und Physikalische Technologien, TU Clausthal — [2]Institut für Schichten und Grenzflächen (ISG3), Forschungszentrum Jülich GmbH

Thin ZrO_2 films have been deposited on silicon (100) with and without native oxide layers using the sol-gel process. The oxide thickness and surface morphology was determined by ellipsometry and AFM measurements. Auger depth profiles were used to characterize composition and interface reactions. We applied tunneling-AFM to evaluate the local thickness and electrical properties of the oxides. AFM measurements showed a roughness of the oxide layers which is comparable to the roughness of the substrates. By means of the depth profiles we found appropriate parameters for the sol-gel process such as composition of the sol, annealing temperature, and oxygen partial pressures which made the deposition of stoichiometric, carbon-free layers possible. The Auger depth profiles revealed that a thin interface layer of complex composition is formed and how the thickness of this layer depends on the annealing process. First attempts have been made to evaluate film characteristics such as thickness and homogeneity from tunneling-AFM images and tunneling I-V curves.

HL 9.48 Mon 15:15 P3

Spontaneous 2D accumulation of charged Be dopants in GaAs p-n superlattices — •Sebastian Landrock, Knut Urban, and Philipp Ebert — Institut für Festkörperforschung, Forschungszentrum Jülich, 52425 Jülich

In a classical view abrupt dopant profiles in semiconductors tend to be smoothed out by diffusion due to concentration gradients and repulsive screened Coulomb interactions between the charged dopants. We demonstrate, however, using scanning tunneling microscopy and secondary ion mass spectroscopy, that charged Be dopant atoms in GaAs p-n superlattices spontaneously accumulate and form two-dimensional dopant layers. These are stabilized by reduced repulsive screened Coulomb interactions between the charged dopants arising from the two-dimensional quantum mechanical confinement of charge carriers.

HL 9.49 Mon 15:15 P3

Structural study of Cyclopentene on InP(001)(2x4) — •Miron Kropp[1], Regina Passmann[1,2], Patrick Vogt[1], Norbert Esser[2], and Wolfgang Richter[3] — [1]TU Berlin, Institute of Solid State Physics, Hardenbergstr. 36, 10623 Berlin, Germany — [2]ISAS - Institute for Analytical Sciences - Department Berlin, Albert-Einstein-Str. 9, 12489 Berlin, Germany — [3]Università degli Studi di Roma "Tor Vergata", Via della Ricerca Scientifica 1, 00133 Roma, Italy

Organic molecules could be the ideal building blocks for functionalization of semiconductor surfaces. Up to now most of the experimental work has been concerned with Si surfaces. Almost no results exist for the technologically important III-V(001) surfaces such as InP(001) and GaAs(001). Here we report on the modification of the optical anisotropy during absorption of Cyclopentene(C_5H_8) on the InP(001)(2x4) surface as measured by Reflectance Anisotropy Spectroscopy (RAS). Surfaces are also characterized by LEED and Auger Electron Spectroscopy (AES). Upon Cyclopentene deposition, the InP(001)(2x4) LEED pattern disappears until only the (1x1) bulk symmetry remains. Auger spectra show that a carbon peak emerges. The surface related RAS features around 1,8 eV are reduced in intensity depending on the amount of molecules deposited. By annealing the sample at 400°C the whole process can be reversed and the (2x4) can be restored. Comparison to calculations of the InP(001)(2x4) RAS signal hint towards an interactions between Cyclopentene and the Indium dangling bonds. In addition the atomic structure of the C_5H_8/InP(001) surface is studied by SXPS and STM.

HL 9.50 Mon 15:15 P3

Improving the interface between silicon and La_2O_3 high-k dielectric — •Sandra Seidel, Christian Wolff, Andreas Assmuth, Tanja Stimpel-Lindner, Hermann Baumgärtner, and Ignaz Eisele — Institut für Physik, Fakultät für Elektrotechnik, Universität der Bundeswehr München, 85577 München-Neubiberg, Deutschland

The traditional scaling of CMOS devices is reaching the fundamental limits of the standard materials. Therefore, new materials have to be introduced. The most critical point for the shrinking is the introduction of a high dielectric constant (high-k) material as alternative gate material. In general materials having dielectric constant around 10 are suggested for short term and materials having k > 20 for long term solution. Furthermore, the dielectric constant is not the only parameter to be taken into consideration. Other important parameters are band gap, band alignment and interface-state density. In this work, molecular-beam deposited La_2O_3 was studied as a possible high-k candidate. In direct contact with silicon, this binary oxide is unstable and interfacial SiO_2 and silicate layers are formed. Therefore, an engineered interfacial layer was required in order to take advantage of the potential high-k characteristics. This interface can be achieved by growing an ultrathin nitride layer between substrate and high-k material. Electrical characteristics and XPS results will be shown.

HL 9.51 Mon 15:15 P3

Band Bending of Sulfur Passivated GaAs: A Raman Investigation — •Steve Pittner[1], Gianina Nicoleta Gavrila[2], Georgeta Salvan[1], Axel Fechner[1], Marion Friedrich [1], and Dietrich R. T. Zahn[1] — [1]Chemnitz University of Technology, Semiconductor Physics, D-09107 Chemnitz, Germany — [2]BESSY GmbH, Albert-Einstein-Straße 15, D-12489 Berlin, Germany

In this work the influence of a wet chemical treatment using a solution of S_2Cl_2 + CCl_4 (1:3) on GaAs(100) on the depletion layer thickness and band bending was investigated. Various excitation wavelengths were employed for taking Raman spectra under UHV conditions. The depletion layer thickness and band bending was calculated from the ratio of the coupled plasmon- LO phonon (PLP) mode and LO mode in the Raman spectra. The dependence on the information depth of different laser lines will be shown. N - and p-type doped GaAs are compared. The results are discussed in comparison to previous measurements [1,2] and it is illustrated that the improved treatment used leads to reduction of the depletion layer thickness and the band bending by approximately 60% for n-type GaAs. The importance of annealing steps in UHV are pointed out.

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HL 9.52 Mon 15:15 P3

Charge trapping at Si(100)-ZrO_2 interfaces studied by second-harmonic generation — •Bastian Manschwetus, Armin Rumpel, Peter Iskra, Gerhard Lilienkamp, and Winfried Daum — Institut für Physik und Physikalische Technologien, TU Clausthal, Leibnizstrasse 4, D-38678 Clausthal-Zellerfeld

Thin ZrO_2 layers deposited on Si(100) substrates by a sol-gel technique have been studied by second-harmonic generation (SHG) spectroscopy using femtosecond laser pulses. SHG spectra in the two-photon energy range between 3.1 eV and 4.2 eV are dominated by interband transitions at the main bulk critical-points of silicon (E_1 at 3.3 eV and E_2 at 4.4 eV) and by a specific interface transition at 3.6 eV. Fixed-frequency measurements at 730 nm and 700 nm laser wavelength (1.70 eV and 1.77 eV, respectively) show a pronounced time dependence of the SHG signal. This time dependence on the scale of seconds to several minutes describable by two exponentials varies as the intensity of the exciting laser beam is increased. In analogy to previous results of other groups obtained for Si-SiO_2 systems we relate the time dependence of the SHG signal to a quasi-static electric field giving rise to electric-field-induced SHG at the silicon side of the interface. This field is caused by multi-photon excitation of electrons and holes in the ZrO_2 layer and subsequent trapping of a part of these charges in defects of the ZrO_2 layer. At lower laser intensities electron excitation into the ZrO_2 conduction band is the dominant mechanism as it requires only two-photon excitation. Hole excitation into the ZrO_2 valence band requires three-photon excitation and becomes important only at higher intensities.

HL 9.53 Mon 15:15 P3

Diluted magnetic semiconductors Sb(2-x)V(x)Te(3) — •Cestmir Drasar[1], Petr Lostak[1], Zhenhua Zhou[2], and Ctirad Uher[2] — [1]University of Pardubice, Studentska 95, 53210, Pardubice, Czech Republic — [2]Unversity of Michigan,Ann Arbor, Michigan 48109, USA

Recently, a new type of diluted magnetic semiconductors based on the tetradymite-type structure was described [1,2]. In this contribution, we compare the transport and magnetic properties of Sb(2-x)V(x)Te(3) in the single crystalline form (x = 0.0-0.03) with the properties of thin films grown by MBE in which the content of vanadium is much higher (x =

0.0-0.35). It was found that the vanadium-doping in single crystals of Sb(2)Te(3) does not change the concentration of holes yet it gives rise to ferromagnetism at low temperatures. The Curie temperature T(C) increases with the vanadium content and reaches 22 K for a single crystal of Sb(1.97)V(0.03)Te(3). In the case of thin films of Sb(2-x)V(x)Te(3), the concentration of holes determined from the Hall effect increases with the increasing concentration of vanadium and the Curie temperature T(C)of a film with x = 0.35 reaches at least 177 K, the temperature comparable or higher than that obtained with Mn-doped GaAs.

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HL 9.54 Mon 15:15 P3

Molecular Beam Deposition of La_2O_3 as high-k gate dielectric — •Christian Wolff, Sandra Seidel, Andreas Assmuth, Oliver S. Senftleben, Tanja Stimpel-Lindner, Hermann Baumgärtner, and Ignaz Eisele — Institut für Physik, Fakultät für Elektrotechnik, Universität der Bundeswehr München, 85577 München-Neubiberg, Deutschland

One of the big challenges in the shrinking of CMOS devices approach is the gate insulator. To be able to follow the dimension shrinking according to the ITRS, the SiO_2 film thickness should drop below 1nm within the next few years. This means that the direct tunnel leakage current through the insulator will increase to an extent where a replacement for SiO_2 will be needed. The evolving near-term solutions for the gate dielectric problem are materials like silicon oxynitride or aluminium oxide. As a long-term solution with a dielectric constant between 20 and 30, we have studied the rare earth metal oxide La_2O_3. Lanthanum oxide thin films were grown on silicon substrate by molecular beam deposition. The deposition process in UHV was optimised investigating the influence of substrate temperature, the partial pressures of oxygen and ozone, respectively, and post-growth annealing. The La_2O_3 thin films grown with the developed processes have been electrically and physically characterised by I(U), C(U), XPS, AES and SEM measurements.

HL 9.55 Mon 15:15 P3

In-situ characterization of the electronic properties of Si-nanoparticles — •Ingo Plümel[1,2], Hartmut Wiggers[2], and Axel Lorke[1] — [1]Experimental Physics, University of Duisburg-Essen, Lotharstraße 1, 47048 — [2]Institute of Combustion and Gas Dynamics, University of Duisburg-Essen, Lotharstraße 1, 47048

The compaction behavior of nano- and microcrystalline silicon powder under the application of an uniaxial force was characterized in the 37 MPa to 750 MPa range using DC measurements and impedance spectroscopy.

Changes in conductance and impedance are caused by pressure dependent rearrangement of particles within the powder, and deformation of the particle and electrode interfaces. Time dependent measurements at a constant force show three regions which are dominated by different effects. Analysis of this behavior with impedance spectroscopy enables a more precise characterization of the ongoing relaxation processes. With the help of a laser interferometer, the influence of mechanical changes during compaction on the impedance can be taken into account. The different contributions to the total impedance can be separated by designing and applying an equivalent circuit diagram.

Finally, by analyzing the time dependent change of the separated capacity contributions, the powder can be characterized using an effective medium model.

HL 9.56 Mon 15:15 P3

Quantum coherence and transport in mesoscopic (Ga,Mn)As wires and rings — •Daniel Neumaier, Konrad Wagner, Matthias Reinwald, Werner Wegscheider, and Dieter Weiss — Institut für Experimentelle und Angewandte Physik, Universität Regensburg, 93040 Regensburg, Germany

We investigated the coherence length of holes in (Ga,Mn)As mesoscopic wires and rings at mK temperatures. The structures were fabricated using negative elecrton beam lithography and chemical assisted dry etching techniques. Phase coherence is significantly reduced in ferromagnetic conductors, due to magnetism related scattering effects, and coherence phenomena in electronic transport like universal conductance fluctuations (UCF), or the Aharonov-Bohm effect are expected only in samples with very small dimensions. Here we investigate UCFs in (Ga,Mn)As wires with length between 100 and 600 nm and a width of 25 nm as well as in rings with diameters ranging from 100 nm to 200 nm with the same width. We also tried to improve the coherent transport by post-growth low temperature annealing, which significantly reduces the concentration of Mn interstitials. First results will be reported.

HL 9.57 Mon 15:15 P3

Hydrodynamic Effects in a two dimensional Jet of Interacting Electrons — •Xaver Vögele — Center for NanoScience und Sektion Physik, Ludwig-Maximilians-Universität,Geschwister Scholl Platz 1, D-80539 München, Germany

We discuss hydrodynamic effects in a 2dim jet of electrons in a GaAs/AlGaAs heterostructure. According to a prediction by A. Govorov and J. Heremans (Phys. Rev. Lett. 92, 26803 (2004)) an electron beam traversing an aperture creates a pumping effect attracting carriers. Due to electron-electron collisions the injected electrons leave positively charged holes thus generating an attractive potential for the charge carriers. This phenomenon may be compared to classical hydrodynamic effects described by the quadratic Bernoulli equation (e.g. the pumping power of a water pump is proportional to the square of the pressure applied along the tube.) However the predicted quantum pumping effect in a Fermi liquid depends linearly on the source drain voltage applied across the aperture. Our experimental setup to confirm this effect consists of a GaAs/AlGaAs heterostructure with a high mobility two dimensional electron gas. Topgates are used to shape an aperture and define a 3 ym wide and 5 ym long channel along which the characteristic potential of the jet is measured by quantum point contacts. Potential measurements along the channel at different distances from the aperture will be used to extract the electron-electron collision length. We present the planed experiment and discuss first results.

HL 9.58 Mon 15:15 P3

Magnetic focusing phenomena in mesoscopic Hall-bar geometries — •Tobias Feil[1], Kai Bröking[2], Ragnar Fleischmann[2], Werner Wegscheider[1], and Dieter Weiss[1] — [1]Universität Regensburg, 93040 Regensburg — [2]Max-Planck-Institut für Dynamik und Selbstorganisation, 37073 Göttingen

We investigate low field magnetotransport in ballistic Hall-bar geometries with dimensions much smaller than the electron mean free path at low temperatures. For the experiments we use GaAs/AlGaAs heterojunctions with mobilities up to $1000 m^2/Vs$ and a corresponding mean free path of $50\mu m$. Our Hall-bars are manufactured by means of electron beam lithography and dry etching with typical potential probe separations between 2 and $10\mu m$ and potential probe width of ≈500nm.

Driving a constant current along the Hall-bar, we observe pronounced oscillations of the longitudinal resistance as a function of a perpendicular magnetic field. The oscillations, reminiscent of magnetic focusing, show minima with resistance values often below the Drude resistance. The experimental findings are compared to Landauer-Büttiker-type simulations, aiming at the transition from Drude resistance to ballistic transport in such mesoscopic Hall-bars.

HL 9.59 Mon 15:15 P3

Parallel implementation of the recursive Green's function method — •Panagiotis Drouvelis[1,2], Peter Schmelcher[1,3], and Peter Bastian[2] — [1]Theoretische Chemie, Universität Heidelberg, Im Neuenheimer Feld 229, D-69120 Heidelberg, Germany — [2]Interdisziplinäres Zentrum für Wissenschaftliches Rechnen, Im Neuenheimer Feld 368, D-69120 Heidelberg, Germany — [3]Physikalisches Institut, Philosophenweg 12, Universität Heidelberg, D-69120 Heidelberg, Germany

A parallel algorithm for the implementation of the recursive Green's function technique, which is extensively applied in the coherent scattering formalism, will be presented. The algorithm performs a domain decomposition of the scattering region among the processors participating in the computation and calculates the Schur's complement block in the form of distributed blocks among the processors. If the method is applied recursively, thereby eliminating the processors cyclically, it is possible to arrive at a Schur's complement block of small size and compute the desired block of the Green's function matrix directly. The numerical complexity due to the longitudinal dimension of the scatterer scales linearly with the number of processors, though, the computational cost due to the processors' cyclic reduction, establishes a bottleneck to achieve efficiency 100%. The proposed algorithm is accompanied by a performance analysis for two numerical benchmarks, in which the dominant sources of computational load and parallel overhead as well as their competitive

role in the efficiency of the algorithm will be demonstrated.

HL 9.60 Mon 15:15 P3

Hall effect measurements at high temperatures in highly resistive materials (CaF_2) — •Thomas Geruschke[1], Peter Blaum[2], and Reiner Vianden[1] — [1]Helmholtz-Institut für Strahlen und Kernphysik Universität Bonn, Nußallee 14-16, 53115 Bonn — [2]Schott AG, Dept.: "Research and Technology Development/Materials Development-Glass Ceramics", 55122 Mainz

In photolithography for integrated circuit fabrication narrower printed linewidths is achieved by moving to shorter wavelengths. For 157 nm lithography fluorine excimer lasers are used. In process the high energetic laser photons damage the crystallattice of the calcium fluoride lenses. This leads to a change of the optical properties of the material. With Hall effect techniques we try to investigate these defects. Therefore a Hall apparatus for measurements at high temperatures is under construction. The results will be presented and discussed.

HL 9.61 Mon 15:15 P3

Ballistic and mode-controlled rectification in high-mobility Si/SiGe cross junctions — •Egmont Fritz[1], Gang Qiao[1], Ulrich Wieser[1], Ulrich Kunze[1], and Thomas Hackbarth[2] — [1]Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum, D-44780 Bochum — [2]DaimlerCrysler Forschungszentrum Ulm, Wilhelm-Runge-Straße 11, D-89081 Ulm

Mesoscopic multi-terminal junctions prepared from high-mobility semiconductor field-effect heterostructures have attracted much attention in order to study ballistic electron transport. Here we report on the observation of ballistic rectification found in four-terminal Si/SiGe cross junctions. The Ψ-shaped junctions are composed of a central voltage stem and two current-injecting branches. The branches are directed towards the lower voltage probe of the stem and oppositely merge under zero injection angle into the stem. Electrical characterization of the rectifiers is performed at $T = 4.2$ K. The configuration of leads and voltage probes enables to separate between different mechanisms of rectification. The potential at the upper voltage probe displays a mode-controlled signal while the potential difference between both ends of the stem indicates a pure ballistic voltage. Nonlocal effects are studied in a modified cross junction with orthogonal current leads.

HL 9.62 Mon 15:15 P3

Spectral function of externally confined electrons in a strong time-dependent field — •Andrea Fromm[1], Michael Bonitz[1], and James Dufty[2] — [1]Institut für Theoretische Physik und Astrophysik, Universität Kiel, Leibnizstr. 15, 24098 Kiel — [2]Physics Department, University of Florida, Gainesville

Charged particles which are spatially confined in traps or quantum dots are of growing interest in many fields, including semiconductor transport, clusters or ultracold ions. Of special relevance is the particle response to strong AC electromagnetic fields where interesting collective effects (plasmons) and nonlinear phenomena such as high-harmonics generation and multi-photon absorption are expected. A self-consistent gauge-invariant nonequilibrium Green's functions treatment of these phenomena has been developed recently [1,2] for spatially homogeneous systems and was extended to weakly inhomogeneous spatially confined systems [3]. Here we extend this approach to a detailed analysis of the electron spectral function which selfconsistently includes strong fields and confinement effects and present results for the effective quantum potential for various external fields.

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HL 9.63 Mon 15:15 P3

Transient photocurrents of porous semiconductor electrodes permeated with electrolyte — •Sven Rühle[1], Ivan Ivanov[2], Valery Skryshevskyy[2], Jörg Rappich[3], and Thomas Dittrich[3] — [1]Condensed Matter & Interfaces, Debye Institute, University Utrecht, 3508 TA Utrecht, The Netherlands — [2]Taras Shevchenko University, Department of Radiophysics, Volodymyrska st. 64, 01033 Kyiv, Ukraine — [3]Hahn-Meitner-Institut, Glienicker Str. 100, 14109 Berlin, Germany

Photocurrent transients were used to investigate electron transport in mesoporous, nanocrystalline TiO_2 and Si films immersed into aqueous electrolyte. The pH and the conductivity of the electrolyte were changed systematically. It is shown that both trapping and recombination depend strongly on the pH. For porous Si, addition of fluoride into the acidic solution lead to an increase of the diffusion coefficients. Values for the effective diffusion constants are evaluated. A numerical model was used to decouple the impact of recombination and trapping on the transient response.

HL 9.64 Mon 15:15 P3

Inertial ballistic rectification in a top-contact metal-oxide-InAs nanostructure — •Markus Wahle, Thorsten Last, Saskia F. Fischer, and Ulrich Kunze — Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum, 44780 Bochum

Ballistic motion of charge carriers in semiconductors brings about new phenomena which can be explained by a classical billiardlike model. One prominent effect of this kind is the negative bend resistance in cross-shaped devices associated with the current passing around the corner of the junction [1,2]. Here we report on the effect of ballistic rectification in a lateral metal-semiconductor nanostructure. The non-local voltage-current characteristic of a four-probe metal-oxide-InAs structure exhibits a kink centered at zero bias current at low temperatures [3]. At forward current a nearly linear characteristic with an excess resistance of about 2 Ohm can be observed, which gradually decreases with temperature increasing from 2 K up to 20 K. We explain this rectification effect by polarity-dependent ballistic injection of hot electrons from the drift region between the current leads into the adjacent collector region. The experiments indicate a low-temperature ballistic mean free path larger than the distance of 1.8 μm between the nanoscale contacts for current injection and voltage probe.

[1] G. Timp *et al.*, Phys. Rev. Lett. **60**, 2081 (1988).
[2] Y. Hirayama *et al.*, Phys. Rev. B **45**, 13465 (1992).
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HL 9.65 Mon 15:15 P3

Drift velocity of electrons and Existence of the pinch effect in the Ge-n — •Mehdi Vaezzadeh, Majid Vaezzadeh, Mahmoud Jafari, and Ehsan Noroozifar — Dept. of Physics K.N.Toosi University of technology, P.O. Box: 15875-4416 Tehran Iran

A theoretical model has been proposed. Based on this model we have calculated analytically the increasing of longitudinal resistance by applying magnetic field on the Ge-n. Our work is based on decreasing the cross section of conduction electrons which leads to determination of the drift velocity of itinerant electrons. The repulsion of electrons in a direction (Hall Effect) decreases the cross section of the itinerant electrons which causes the longitudinal resistance of the sample increases. With increasing the external magnetic field the longitudinal resistance of the sample increases. By fitting the calculated results with the experimental results of the Ge-n in the range of $0<B<350$ mT we have determined the drift velocity of itinerant electrons. We have also calculated the main cross section of transmitted current in the absence of the magnetic field. The results indicate the existence of the pinch effect in this system.

HL 9.66 Mon 15:15 P3

Indirect transitions and direct current in semiconductor superlattices generated by application of half-cycle pulses — •Andrey Moskalenko, Alex Matos-Abiague, and Jamal Berakdar — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, D-06120 Halle, Germany

We investigate the action of a single half-cycle pulse (HCP) on a semiconductor superlattice. As a model system we choose a superlattice consisting of a lattice of delta function peaks. We calculate matrix elements for transitions between eigenstates of the superlattice and use them to calculate populations in minibands and charge current induced by the HCP having a duration that is short enough. The current consists of an intraminiband part, which is constant in time (neglecting the relaxation), and an oscillating interminiband part. We investigate the dependence of the intraminiband current on the strength of the HCP for different fillings of the lowest miniband at zero temperatures. We show that for a low filling of the lowest miniband the dependence of the intraminiband current on the strength of the HCP has minima when the wave vector transferred by the pulse to the carriers matches an integer of the half of the reciprocal lattice constant. In the case of the filled lowest miniband the dependence of the intraminiband current on the pulse strength has a threshold since for the generation of the intraminiband current the population in the second or higher minibands must be created.

HL 9.67 Mon 15:15 P3

Control of occupations and coherences in semiconductor quantum dots induced by traveling wave packets — •Doris Reiter, Vollrath Martin Axt, and Tilmann Kuhn — Institut für Festkörpertheorie, Westfälische Wihelms-Universität Münster, Wilhelm-Klemm-Str.10, 48145 Münster, Germany

The capture of a traveling electronic wave packet by carrier-phonon interaction from a semiconductor quantum wire into a quantum dot can result in a superpostion of the discrete dot states. We show that we can control not only the resulting occupations but also the coherences between the discrete dot states by suitably creating two wave packets. By varying the starting time, starting position or the mean excess energy of the wave packets we achieve different control mechanism. While usually coherences are controlled directly by optical methods, in our case a decisive element of control is the arrival time of the wave packets at the dot. When we place two wave packets at each side of the dot the two packets cannot interfere, so we can easily control the time difference of the arrival by the starting time or starting position of the wave packets. If we generate two packets at the same side of the dot interference leads to spectral shaping of the pulses, which has great influence on both occupations and coherences. Another interesting case is the excitation with multicolor pulses, where we can address selectively the discrete dot states. More interestingly, we can gain control over the coherences in this case.

HL 9.68 Mon 15:15 P3

Optimized ultrafast optical pumping of a vertical-cavity surface-emitting laser — •Christoph Lange[1], Wendel Wohlleben[2,3], Sangam Chatterjee[1], Wolfgang Stolz[1], Marcus Motzkus[2], and Wolfgang Rühle[1] — [1]Faculty of Physics and Material Sciences Center, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany — [2]Faculty of Chemistry, Philipps-Universität Marburg, Hans-Meerwein-Strasse, D-35032 Marburg, Germany — [3]Present Address: Polymer Physics Research, BASF AG, D-67056 Ludwigshafen, Germany

The emission characteristics of an optically pumped vertical-cavity surface-emitting laser (VCSEL)[1] are optimized by specifically shaping the pump pulse. The temporal variation of amplitude and phase of the excitation are adapted using a genetic algorithm in a learning-loop [2]. Both, the excitation and emission pulses, are live monitored using a spectrometer-streak camera system. The performance of the VCSEL with respect to its emission intensity, pulse width, decay time, or delay after excitation is thus strongly improved.

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[2] H. Rabitz et al., Science **288**, 824 (2000).

HL 9.69 Mon 15:15 P3

Persistent vs. photoinduced currents in semiconductor mesoscopic rings. — •A. Matos-Abiague, A. S. Moskalenko, and J. Berakdar — Max-Planck Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany.

The dynamics of semiconductor mesoscopic rings driven by ultrashort electromagnetic pulses is theoretically investigated. It is shown that by subjecting the ring to a sequence of shaped pulses a charge current can be generated in the ring in absence of any external magnetic field. The dependence of the photoinduced currents (and the associated magnetization of the ring) on the electromagnetic field parameters is studied in details. We also demonstrate that predefined magnetic states of an array of rings can be optically generated and manipulated. Furthermore, when the ring is pierced by a magnetic flux there exist persistent currents that are dynamically modified by the action of the pulses. The influence of the electromagnetic field on the persistent current as well as its coexistence and competition with the photoinduced current are discussed.

HL 9.70 Mon 15:15 P3

Profile of a photoconductive THz Emitter excited by an amplified laser system — •Falk Peter, Stephan Winnerl, Andre Dreyhaupt, Harald Schneider, and Manfred Helm — Forschungszentrum Rossendorf, Institute of Ion Beam Physics and Materials Research, P.O. Box 510119, D-01314 Dresden, Germany

We present a large photoconductive THz emitter[1] consisting of two interdigitated metallization layers on a semi-insulating GaAs substrate. The photoexcited carriers are unidirectional accelerated by a bias voltage providing an electric field. This leads to a subsequent emission of THz radiation. The second metallization inhibits the optical excitation in every second period of the electrode structure in order to prevent destructive interference. We analyse the spatial profile of such an emitter excited with unfocused fs optical pulses from an Ti:sapphire amplifier with an average power of 60mW at a 1kHz repetition rate. The resulting THz beam has a bandwidth from 0.1 THz to 4 THz and a field amplitude of up to 6kV/cm (Ubias = 30V). The focussed THz spot was mapped out and analyzed with respect to the frequency. A strong increase of the beam diameter with decreasing frequency was found.Saturation behavior was observed by changing the excitation density.

[1] A. Dreyhaupt, S.Winnerl, T.Dekorsy, and M.Helm, Appl. Phys 86, 121114 (2005)

HL 9.71 Mon 15:15 P3

Charge carrier dynamics in graphite and carbon nanotubes observed by time-resolved THz spectroscopy — •Tobias Kampfrath, Luca Perfetti, Christian Frischkorn, and Martin Wolf — Fachbereich Physik, Freie Universität Berlin, Arnimallee 14, 14195 Berlin

Ultrafast charge carrier dynamics in graphite and carbon nanotubes have been investigated by time-resolved THz spectroscopy. In graphite, analysis of the transient dielectric function between 10 and 30 THz and model calculations show that more than 90 % of the initially deposited excitation energy is transferred to few strongly coupled lattice vibrations within 500 fs. These hot optical phonons also substantially contribute to the striking increase of the Drude relaxation rate observed during the first ps after photoexcitation. The subsequent cooling of the hot phonons yields a lifetime estimate of 7 ps for these modes [1].

The response of the nantoube sample lacks a distinct free-carrier response which is attributed to the photogeneration of strongly bound excitons in the tubes with large energy gaps. We find a feature of enhanced transmission caused by the blocking of optical transitions in small-gap tubes. The rapid decay of a featureless background with pronounced dichroism is associated with the increased hopping rate of spatially localized charge carriers before thermalization is completed.

[1] Phys. Rev. Lett. **95**, 187403 (2005)

HL 9.72 Mon 15:15 P3

Cotunneling through quantum dots with phonon-assisted spin-flip processes — •Jörg Lehmann and Daniel Loss — Departement für Physik und Astronomie, Universität Basel, CH-4056 Basel, Switzerland

For applications in spintronics and quantum computing a detailed knowledge about relaxation and coherence properties of the considered systems is crucial. Here, we investigate to what extent measurements of the cotunneling current through semiconductor quantum dots can provide information about a major source of decoherence in these systems, namely spin-flip processes induced by the coupling to acoustic phonons of the environment. An expression for the phonon-assisted cotunneling current is derived by means of a generalised Schrieffer-Wolff transformation, which allows one to eliminate to lowest order the dot-lead coupling. Explicit expressions for the elastic and inelastic contributions to the cotunneling current are given and the influence of the spin-phonon coupling on the heating of the dot is considered. The general results are evaluated for the case of a parabolic semiconductor quantum dot with Rashba and Dresselhaus spin-orbit coupling and a method for the determination of the spin-phonon relaxation rate is proposed. [1]

[1] J. Lehmann and D. Loss, `arXiv:cond-mat/0509420`.

HL 9.73 Mon 15:15 P3

Non-invasive detection of charge-rearrangement in a quantum dot — •C. Fricke[1], M. C. Rogge[1], B. Harke[2], F. Hohls[3], M. Reinwald[4], W. Wegscheider[4], and R. J. Haug[1] — [1]Institut für Festkörperphysik, Universität Hannover, D-30167 Hannover — [2]Max-Planck-Institut für biophysikalische Chemie, Göttingen — [3]Cavendish Laboratory, Cambridge, Great Britain — [4]Angewandte und Experimentelle Physik, Universität Regensburg

We show transport measurements in high magnetic field on a coupled system including a quantum dot and a quantum point contact. We use a GaAs/AlGaAs heterostructure containing a two-dimensional electron system (2DES) 34 nm below the surface. The lateral quantum dot and the quantum point contact (QPC) are defined by the atomic force microscope (AFM) using local anodic oxidation (LAO). We demonstrate electron redistribution on the quantum dot caused by the magnetic field [1]. The dot's charge configuration is measured by means of a quantum point contact as non-invasive detector. Our device allows to control in-

dependently the quantum point contact and all tunnelling barriers of the quantum dot. Thus we are able to measure both the change of the quantum dot charge and also changes of the electron configuration at constant number of electrons on the quantum dot. We use these features to exploit the quantum dot in a high magnetic field where transport through the quantum dot displays the effects of Landau shells and spin blockade. We confirm the internal rearrangement of electrons as function of the magnetic field for a fixed number of electrons on the quantum dot.
[1] C. Fricke et al., Phys. Rev. B **72**, 193302 (2005)

HL 9.74 Mon 15:15 P3

Coherent single electron spins manipulation in a quantum dot — •Dawid Kupidura, Stefan Ludwig, and Jörg Kotthaus — Department für Physik der LMU München, Lehrstuhl Prof. Kotthaus, Geschwister-Scholl-Platz 1, 80539 München

Recent progress in solid state quantum dots allowed measurement of the energy relaxation times as well as the phase coherence times of charge and spin qubits. Maybe the most impressive experiment employs the singlet-triplet splitting in a two-electron double quantum dot [1]. The latter measurements indicate the coherence time T_2 ¿ 1.2 μs [1]. This time may be limited due to the Overhauser magnetic field (caused by hyperfine interactions) varying in space and in time. Another origin of decoherence in this experiment might be electrostatic potential fluctuations in time that modify the exchange interaction [1].

In our approach we plan to use the two Zeeman-split spin states of an electron in a single quantum dot as originally proposed by Loss and DiVincenzo [2]. An advantage of this design is its robustness against local potential fluctuations as well as against the fluctuating Overhauser field ($B_{ext} >> B_{nuclear}$). We aim towards a single electron spin resonance experiment by additionally to B_{ext} applying a pulsed RF-magnetic field. Single spin read-out for such an experiment was demonstrated elsewhere [3].

[1] J. R. Petta et. al. Science 309, 2180 (2004) [2] D. Loss and D. P. DiVincenzo PRA 57, 120 (1998) [3] J. M. Elzerman et. al. Nature 430, 431 (2004)

HL 9.75 Mon 15:15 P3

Signatures of Mixed Phase Space in Open Quantum Dot Arrays — •Roland Brunner[1], Ronald Meisels[1], Friedemar Kuchar[1], Jonathan P. Bird[2], Richard Akis[3], and David K. Ferry[3] — [1]Institute of Physics, University of Leoben, Austria — [2]Dept. of Electrical Engineering, University at Buffalo, USA — [3]Dept. of Electrical Engineering, Arizona State University, USA

An interesting aspect of *open quantum dots* is the interplay of regular, quasi-regular and chaotic behavior of the electron transport, where one is concerned with the correspondence of classical and quantum mechanical behavior [1].

In this work we focus on the transport in open quantum-dot arrays regarding the correspondence of classical and quantum-mechanical treatments. We analyze, in particular, a prominent peak that was recently reported in the low-field magneto-resistance, MR, (B ∼0.2 T) of a single dot and arrays with different numbers of dots [2,3]. Certain details of the behavior of this MR peak can be interpreted in the classical treatment only by additionally assuming phase-space tunneling. In the quantum-mechanical interpretation an important result is the opening of gaps in the (complex) band structure and the decay of the wave function along the dot array and its dependence on the energetic position in the gap.
[1] L. E. Reichl, The Transition to Chaos, Springer Verlag (2004).
[2] M. Elhassan et al., Phys. Rev. B 70, 205341 (2004).
[3] R. Brunner et al.,Physica E 21, 491 (2004).

HL 9.76 Mon 15:15 P3

Miscellaneous current measurements through carbon nanotubes — •Christoph Würstle, Jens Ebbecke, and Achim Wixforth — Institut für Physik der Universität Augsburg, Experimentalphysik I, Universitätsstr. 1, 86159 Augsburg

We present measurements where we align carbon nanotubes (CNT) with surface acoustic waves (SAW) over predefined contacts. When the contacts are close enough a contacted CNT behaves like a quantum dot (QD). At low temperatures of around 4.2 K we investigate the effect of a finite Shottky-Barrier and also Coulomb blockade in such a system. Instead of applying a finite source drain voltage, we also use a SAW to induce a current (in dependence of the gate voltage) through the QD. With this method our aim is to measure quantized current through a CNT.

HL 9.77 Mon 15:15 P3

Detection of impurities in a Coulmb blockade device — •D. Tutuc[1], M. C. Rogge[1], M. Reinwald[2], W. Wegscheider[2], and R. J. Haug[1] — [1]Institut für Festkörperphysik, Abteilung Nanostrukturen, Universität Hannover, Appelstrasse 2, 30167 Hannover — [2]Angewandte und Experimentelle Physik, Universität Regensburg, D-93040 Regensburg

In this work we report results on electrical transport in zero and non-zero magnetic field in a multi-terminal quantum dot fabricated by Local Anodic Oxidation (LAO) with an Atomic Force Microscope (AFM). The measurements were performed at low temperatures (approximately 17mK) in a 3He/4He dilution cryostat with magnetic field ranging from 0T to 5T with. In the Coulomb blockade regime we observe charged impurities suppressing the transport through the dot. The measurements are fully reproducible and the effect is also present in the measurements in magnetic field at 1T and 2T. The reproducibility of this effect lets us assume that the impurities are stable and not induced by random telegraph noise. Since magnetic field has almost no detectable effect the impurities seem to be of non-magnetic origin and seem to be situated near the barriers.

HL 9.78 Mon 15:15 P3

Shot noise at a Fermi edge singularity — •N. Maire[1], T. Lüdtke[1], F. Hohls[1,2], R. J. Haug[1], and K. Pierz[3] — [1]Institut für Festkörperphysik, Universität Hannover, D-30167 Hannover — [2]Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge CB3 0HE, UK — [3]Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

We investigate self-assembled InAs quantum dots embedded in a GaAs-AlAs-GaAs heterostructure. We see steps in the I-V characteristic which can be directly linked to resonant tunneling through individual quantum dots. At one of these steps we notice a peak like current overshoot at a magnetic field of 14.9 T. We find that this current overshoot stems from an electron-electron interaction effect, a so-called Fermi edge singularity (FES) effect.

We measure the noise spectra of this step and observe a 1/f noise and a frequency independent noise, the shot noise. We observe a suppressed shot noise compared to the theoretical value $S = 2eI$ of a single tunneling barrier. This suppression is indeed expected for a double barrier resonant tunneling structure (DBRTS). This suppression is characterized by the dimensionless Fano factor $\alpha = S/2eI$; S being the average noise power density. We find that the shot noise is even more suppressed at the voltage position of the current peak induced by the FES. Temperature dependent measurements down to ≈ 300 mK show that this additional suppression decreases with increasing temperature. We find that these effects can be attributed to the varying tunneling rate of the emitter electrons near the FES.

HL 9.79 Mon 15:15 P3

Magnetotransportmeasurements and electron counting on GaAs/AlGaAs quantum rings — •A. Mühle[1], R. J. Haug[1], W. Wegscheider[2], and M. Bichler[3] — [1]Institut für Festkörperphysik, Universität Hannover, D-30167 Hannover — [2]Angewandte und Experimentelle Physik, Universität Regensburg, D-92040 Regensburg — [3]Walter Schottky Institut, TU München, D-85748 Garching

We present transport measurements done in dependence of an external magnetic field on quantum rings on the surface of GaAs/AlGaAs heterostructures. These rings were fabricated by atomic force microscope lithography utilising local anodic oxidation [1]. Using in-plane gates, the energy of the electrons in the arms of the rings as well as the coupling of the structures to the leads can be controlled.

While sweeping the magnetic field in the regime with only few electrons on the ring, it is possible to determine their exact number if certain features in the transport spectrum can be observed namely Kondo effect and spin-flips.

Additionally, a setup with a quantum point contact next to a quantum ring can be used to count the electrons on the ring by utilizing the influence of the ring's charge on the conductance of the point contact.
[1] U. F. Keyser et al., Phys. Rev. Lett. **90**, 196601-1 (2003)

HL 9.80 Mon 15:15 P3

The role of quantum capacitance in coupled low-dimensional electron systems — •Bastian Marquardt[1], Marco Russ[1], Cedrik Meier[1], Axel Lorke[1], Dirk Reuter[2], and Andreas D. Wieck[2] — [1]Experimental Physics, University of Duisburg-Essen, Lotharstr. 1, D-47048 Duisburg, Germany — [2]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, D-44799 Bochum, Germany

We have investigated the charging behavior of a layer of self-assembled InAs quantum dots placed in close vicinity to a two-dimensional electron gas (2DEG). As the gate bias is changed, the charging states of both systems are altered simultaneously. Based on the quantum capacitance of the involved layers we develop a general model to determine the charging state of coupled low-dimensional electron systems from capacitance-voltage (CV) spectroscopy. The model is then applied to the special case of a layer of self-assembled quantum dots, coupled to a 2DEG. As a complementary method to detect the carrier densities we have employed Hall voltage measurements. We find that the measurement of the two-dimensional carrier density through lateral transport provides a direct insight into the vertical charging process of the quantum dot system. In agreement with results from CV spectroscopy Coulomb blockade and quantization energies can be extracted. Moreover, the Hall measurement offers a higher peak to valley ratio and a better estimate for the number of simultaneously charged dots than the capacitance data. This novel DC transport spectroscopy is particularly promising for structures with very slow tunneling times, such as single electron memory devices.

HL 9.81 Mon 15:15 P3

Magneto-capacitance Spectroscopy of Self-assembled InAs Quantum Dots — •R. Roescu, P. Kailuweit, D. Reuter, and A. D. Wieck — Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum, Germany

We have investigated self-assembled InAs quantum dots (QDs) by magneto-capacitance-voltage (C-V) spectroscopy to obtain insight into their energy band structure.

The dispersion of the charging peaks with perpendicular field (i.e. field direction perpendicular to the growth plane) gives information of the orbital angular momentum of the individual charging peaks [1]. Monitoring the height of the capacitance signal as a function of an in-plane field allows mapping the wave functions of the QDs in momentum space [2].

We will discuss the results for electrons as well as for holes and point out the significant differences.

[1] R. J. Warburton et all, Phys. Rev. B 58 no. 24 (1998) 16221-16231
[2] O. Wibbelhoff et all, Physica E21 (2004) 516-520

Financial support from the DFG GRK384 is gratefully acknowledged.

HL 9.82 Mon 15:15 P3

Photoelectronic Transport Imaging (PETI) of Individual Carbon Nanotubes — •Eduardo Lee, Kannan Balasubramanian, Marko Burghard, and Klaus Kern — Max-Planck-Institut für Festkörperforschung, Heisenbergstraße 1, Stuttgart, 70569

Carbon nanotubes (CNTs) display a range of interesting properties, which make them attractive as components of nanoscale electronic devices. However, the operation mechanism of CNT-based devices is still not thoroughly understood. To overcome this limitation, local probe techniques have proven as highly valuable tools. Photoelectronic transport imaging (PETI) is one such methods which involves the acquisition of photo-generated current images while scanning the sample through a diffraction-limited laser spot. The resulting PET images contain signatures of local charge transport barriers that may arise from charge transfer at the interface to attached electrodes or defects along the nanotubes such as intramolecular junctions. In fact, previous PETI studies of both semiconducting and metallic single-wall carbon nanotubes (SWCNTs) revealed strong photocurrent responses at the contacts due to the local Schottky-like barriers. In the present contribution, gate voltage-dependent PETI is applied to investigate these contact barriers in more detail. For the semiconducting tubes, it was observed that the photocurrent signal at the contacts is suppressed upon band flattening through the applied gate potential. This behavior is distinguished from the metallic tubes, for which no significant changes could be detected upon gate potential variation.

HL 9.83 Mon 15:15 P3

Low-temperature electrical transport in semiconducting nanowires — •Marc Scheffler, Jorden van Dam, Floris Zwanenburg, and Leo Kouwenhoven — Kavli Institute of NanoScience, Delft University of Technology, POB 5046, 2600GA Delft, The Netherlands

Semiconductor nanowires offer a new route to the study of electronic transport on mesoscopic length scales, as their diameter sets an intrinsic constriction to the range of 100 nm and below. Additional structures along the longitudinal direction can be defined during growth (heterostructures) as well as by metallic contacts and gates.

We study the electronic transport in InP and InAs nanowires at low temperatures. Here the choice of appropriate metallic contacts can induce new electronic phases, e.g. superconductivity. Even more tunability is given by different gate geometries that we use to deplete the nanowire either as a whole or locally. Local gating can then lead to controllable separation of different sections of a nanowire as required for devices like point contacts or quantum dots.

HL 9.84 Mon 15:15 P3

Acoustoelectric current in single GaN-whiskers — •Simone Maisch[1], Jens Ebbecke[1], Achim Wixforth[1], Raffaela Calarco[2], Ralph Meijers[2], Michel Marso[2], and Hans Lüth[2] — [1]Universität Augsburg, Experimentalphysik I, Universitätsstr. 1, 86159 Augsburg — [2]Institute of Thin Films and Interfaces (ISG1) and CNI-Centre of Nanoelectronic Systems for Information Technology, Research Center Jülich, 52425 Jülich

Selforganization is a powerful tool for information technology. Different kinds of semiconductor wires have already been grown by this technique but their applications to nanostructured electronic devices is still in the beginning. We have contacted single GaN-whiskers by Ti-contacts fabricated by ebeam-lithography. Measurements of acoustoelectric current transport through these selforganized quantum wires will be presented. There a surface acoustic wave is launched on a piezoelectric substrate and the goal is to transport single electrons one by one through the three-terminal device.

HL 9.85 Mon 15:15 P3

Electromigration Forces on Ions in Carbon Nanotube Transistors — •Neng-Ping Wang[1], Stefan Heinze[1], and Jerry Tersoff[2] — [1]Institute of Applied Physics, University of Hamburg, Jungiusstrasse 11, 20355 Hamburg, Germany — [2]IBM Research Division, T.J. Watson Research Center, Yorktown Heights, New York, 10598 USA

Due to their unique structural and electronic properties carbon nanotubes (CNs) are promising candidates for future nanoelectronics. Recently, field-effect transistors (FETs) from single-wall CNs have been a research focus. In particular, ballistic transport has been demonstrated and key transport parameters compare well with state-of-the-art silicon FETs. Doping with alkali metals has been a main route to improve transistor performance. However, current-induced, electromigration, forces on such alkali ions may lead to ion diffusion and alter the device properties.

Here, we report calculations of ballistic transport in carbon nanotube transistors using the non-equilibrium Greens function formalism within a tight-binding approximation. We use a cylindrically device setup [for details, see S. Heinze, N.-P. Wang, and J. Tersoff, Phys. Rev. Lett. 95, 186802 (2005)] and calculate the current-induced forces on ions located either inside or outside the CN. The forces are largest in the turn-on regime of the transistor, and much smaller in the on- and off-state. The electromigration forces are mainly due to momentum transfer from the charge carriers, i.e., due to the "wind"force. The sign of the "effective valence"Z^* is independent of the actual charge sign, but can be reversed with gate voltage.

HL 9.86 Mon 15:15 P3

Spin Injection into Nonmagnetic Semiconductors: Application of a Unified Transport Theory — •U. Wille and R. Lipperheide — Abteilung Theoretische Physik, Hahn-Meitner-Institut Berlin, Glienicker Str. 100, D-14109 Berlin, Germany

In a recent paper [PRB **72**, 165322 (2005)], we have developed a theory unifying ballistic and diffusive spin-polarized electron transport in ferromagnet/semiconductor heterostructures. It is based on our previously formulated "thermoballistic" description of (spinless) electron transport in parallel-plane semiconductor structures [PRB **68**, 115315 (2003)].

In the present contribution, we apply the unified transport theory in

the study of the injection of spin-polarized electrons into nonmagnetic semiconductors, emphasizing the transition from the purely diffusive to the purely ballistic transport regime. We consider various examples: (i) For heterostructures involving ferromagnetic contacts and a homogeneous semiconducting sample without space charge, we study spin injection driven by an external electric field over a broad range of system and material parameters. (ii) The effect of a Schottky barrier piling up at the interface between a metallic ferromagnet and a semiconductor is analyzed. (iii) Within an extended formulation of the unified theory, we consider spin injection out of a (nondegenerate) dilute magnetic semiconductor.

Our results are discussed in comparison with previously obtained theoretical results.

HL 9.87 Mon 15:15 P3

Anisotropic magnetoresistance and planar Hall effect in (100) and (311)A GaMnAs — •Thomas Hummel, Michael Glunk, Joachim Däubler, Wladimir Schoch, Wolfgang Limmer, and Rolf Sauer — Abteilung Halbleiterphysik, Universität Ulm, D-89069 Ulm, Germany

The in-plane longitudinal and Hall resistance (planar Hall effect) of GaMnAs is studied for epitaxial GaMnAs layers grown on (100) and (311)A GaAs substrates. The measurements are carried out at T=4.2K on photolithographically prepared Hall bars with an external magnetic field continuously adjustable in magnitude and orientation. Sweeping the strength of the magnetic field for fixed orientations or stepping its orientation at fixed field strengths results in pronounced jumps of both the longitudinal and Hall resistance due to the magnetic anisotropy of the GaMnAs epilayers. A quantitative analysis of the data within a single domain model reveals that the direction of the magnetization can be significantly deflected from the magnetic easy axes by the external magnetic field even for low field strengths below 50 mT. Specific differences between the (100) and (311)A GaMnAs layers are discussed.

HL 9.88 Mon 15:15 P3

Lattice parameter and hole density of GaMnAs on GaAs(311)A — •Joachim Däubler, Michael Glunk, Wladimir Schoch, Wolfgang Limmer, and Rolf Sauer — Abteilung Halbleiterphysik, Universität Ulm, D-89069 Ulm, Germany

We discuss the structural and electrical properties of GaMnAs layers with Mn concentrations up to 5%, grown on GaAs(311)A substrates by low-temperature molecular-beam epitaxy. High resolution x-ray diffraction studies reveal a higher concentration of As antisites and a weaker linear increase of the relaxed lattice constant with Mn content in the (311)A layers compared to (100) reference layers. The hole densities and Curie temperatures, determined from magnetotransport measurements, are drastically reduced in the (311)A layers. The findings are explained by an enhanced incorporation of Mn atoms on non-substitutional and non-interstitial sites, probably as Mn-Mn or As-Mn complexes, caused by the larger amount of excess As in the (311)A layers.

HL 9.89 Mon 15:15 P3

Magneto-Optical Investigation of InGaAs Quantum Dot Spin-LEDs — •J. Fallert[1], W. Löffler[1,2], D. Tröndle[1,2], C. Mauser[1], M. Hetterich[1,2], and H. Kalt[1,2] — [1]Universität Karlsruhe (TH), Karlsruhe, Germany — [2]DFG Center for Functional Nanostructures (CFN), Karlsruhe, Germany

We investigate p-i-n diode structures in which electrons are spin-polarized using a semimagnetic n-ZnMnSe layer and then injected into InGaAs / GaAs quantum dots. Magneto-optical measurements show efficient electrical spin injection as indicated by a total circular polarization degree (CPD) of up to 30% in the electroluminescence signal. We observe that depending on the emitted photon energy of the quantum dots the spectrally resolved CPD varies from 0% to 75%. HRTEM micrographs have been used to determine the present quantum dot geometries. Numerical calculations of electron and hole states in these quantum dots give quantitative results for the distribution in number and energy of bound states, depending on size and indium concentration.

HL 9.90 Mon 15:15 P3

Electrical Properties of Fe/GaAs-Heterostructures in Cleaved-Edge-Overgrowth Geometry — •Fang-Yuh Lo[1], E. Schuster[2], C. Urban[3], D. Reuter[1], W. Keune[2], U. Köhler[3], and A. D. Wieck[1] — [1]Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum — [2]Laboratorium für Angewandte Physik, Universität Duisburg-Essen, Lotharstr. 1, 47048 Duisburg — [3]Experimentalphysik IV/Oberflächenphysik, Ruhr-Universität Bochum, Universitätsstr. 150, 44780 Bochum

In order to have clean interfaces, thin Fe layers were grown on the UHV-cleaved edge of GaAs-based heterostructures. Then the thin Fe films were patterned into spin-valve structure via the focused ion beam technique. The Fe/heterostructure contact revealed Schottky character, which could act as a tunnel junction for injecting spins from Fe into semiconductors. Magnetoresistances between 0.01% and 0.07% were observed for different heterostructures, and the possible mechanisms will be discussed. We gratefully acknowledge financial support from the DFG SFB491 and DFG GRK384.

HL 9.91 Mon 15:15 P3

Magnetic Anisotropies in (Ga,Mn)As-Hallbars — •S. Hümpfner, K. Pappert, O. Rival, T. Borzenko, J. Wenisch, C. Gould, G. Schmidt, and L.W. Molenkamp — Physikalisches Institut (EP3), Universität Würzburg, Am Hubland, D-97074 Würzburg, Germany

The ferromagnetic semiconductor (Ga,Mn)As has become a widely used material in semiconductor spintronics. For device design and the understanding of its transport behaviour it is crucial to understand the rich anisotropy landscape of this material.

We investigate the magnetic anisotropy of structures made from thin LT-(Ga,Mn)As layers grown on a GaAs buffer. The anisotropic magnetoresistance (AMR) enables us to map the magnetic anisotropy landscape through careful transport studies. We show how non-local longitudinal (R_{xx})and in-plane Hall (R_{xy}) resistance measurements on Hall bars complement each other in this analysis. We then discuss the influence that different parameters such as the Hall bar design, its orientation with respect to the (Ga,Mn)As crystal, and annealing have on the measured (R_{xx}) and (R_{xy})patterns and deduce the underlying magnetic anisotropies at 4.2 K. Conclusions on the possible origin of different (Ga,Mn)As anisotropy terms are drawn, which will help to controllably create or avoid certain magnetic configurations in future device designs.

HL 9.92 Mon 15:15 P3

Magnetotransport properties and dynamics of domain wall in magnetic nanowires — •Jamal Berakdar[1], V. K. Dugaev[2], V. R. Vieira[2], P. D. Sacramento[2], J. Barnas[3], and M. A. N. Araujo[4] — [1]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [2]Departamento de Física and CFIF, Instituto Superior Técnico, Av. Rovisco Pais, 1049-001 Lisbon, Portugal — [3]Department of Physics, Adam Mickiewicz University, Umultowska 85, 61-614 Poznań, Poland — [4]Departamento de Física, Universidade de Évora, P-7000 Évora, Portugal

We investigate theoretically the magnetoresistance of semiconducting ferromagnetic nanowires with a laterally constrained domain wall . The wall is assumed to be sharp on the scale of the Fermi wavelength of the charge carriers. The role of the spin-orbit interaction of the Rashba type as well as the influence of impurity scattering are discussed. In addition, we discuss the current-induced dynamics of a magnetic domain wall and calculate the spin torque exterted by an electric current. We find the torque has two components: one component results in a translational motion of the domain wall while the other leads to a deformation of the domain-wall shape, forcing thus the magnetic moments to deviate from the easy plane.

HL 9.93 Mon 15:15 P3

Spin-polarized injection from ferromagnetic semiconductor (Ga,Mn)As into GaAs. — •Andreas Einwanger, Mariusz Ciorga, Janusz Sadowski, Werner Wegscheider, and Dieter Weiss — Universität Regensburg, Experimentelle und Angewandte Physik, D-93040 Regensburg

We have fabricated devices to investigate spin-polarized injection of electrons from ferromagnetic semiconductor (Ga,Mn)As into n and n+ GaAs epilayers. The measurements are performed in lateral spin valve

configuration. Two spin-aligning contacts with different coercive fields are employed: one to inject spin-polarized carriers and the other to detect obtained spin-polarization through changes in the in-plane magnetoresistance occuring when magnetization of each of the two contacts is separately switched by in-plane magnetic field. To obtain the efficient spin-polarized injection of electrons from a p-type (Ga,Mn)As into a n-type active layer we employ a spin Esaki diode structure p+(Ga,Mn)As/n+GaAs under reverse bias as spin-aligning contacts. This way we avoid problems related to short spin-relaxation times of holes. The distance between spin injector and detector can be varied to investigate spin relaxation length in the material. We report on first results of our experiments on this all-electrical spin-polarized injection and detection scheme.

HL 9.94 Mon 15:15 P3

Acoustically induced spin transport in (110) GaAs quantum wells — •Odilon D. D. Couto[1], Jörg Rudolph[1], Yang Guang[1], Fernando Iikawa[2], Rudolf Hey[1], Paulo V. Santos[1], and Klaus H. Ploog[1] — [1]Paul-Drude-Institut, 10117 Berlin — [2]Universidade Estadual de Campinas, Campinas, Brazil

GaAs quantum well (QW) structures grown along the [110] direction exhibit due to their symmetry much longer relaxation times for spins polarized along the growth direction than conventional (100) QWs. The electronic quality of the (110) structures, in contrast, is substantially lower than for (100) structures, as judged from the efficiency of the transport of carriers by surface acoustic waves (SAWs). In this contribution, we address this limitation for long-range spin transport by SAWs by (i) improving the sample growth process and (ii) increasing the intensity of the acoustic fields. The latter was achieved by coating the samples with a piezoelectric ZnO layer. The steady-state polarization of photogenerated spins increases substantially under a SAW due to the quenching of excitonic spin relaxation mechanisms as the electrons and holes are spatially separated by the piezoelectric field. Optically detected transport measurements under a magnetic field B in the sample plane and perpendicular to the SAW propagation direction show that the coherent transport length reduces from $l_s = 30$ μm for $B = 0$ (corresponding to $T_2 = l_s/v_{SAW} \sim 10$ ns, where v_{SAW} is the SAW velocity) to less than 10 μm for $B = 18$ mT. Mechanisms for this drastic reduction in l_s will be discussed.

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Theory of relaxation oscillations in semiconductor quantum dot lasers — •Ermin Malic, Moritz Jan Philip Bormann, Eckehard Schöll, and Andreas Knorr — Institut für Theoretische Physik, Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Hardenberg Str. 36, 10623 Berlin, Germany

The dynamics of relaxation oscillations in semiconductor quantum dot lasers is investigated theoretically. Our microscopic approach combines rate equations for photon and electron occupations with kinetic equations for the scattering rates between Coulomb coupled localized states and continuum wetting layer states in an InAs/GaAs quantum dot structure. The relaxation oscillations emerging during turn-on processes are on a nanosecond time scale.

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Study of vertical-cavity surface-emitting laser structures in the strong coupling regime by modulation spectroscopy — •B. Metzger, G. Blume, P.J. Klar, and W. Heimbrodt — Dept. Physics and WZMW, 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. Most VCSEL structures employed in devices 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, so far there are no reports of modulation spectroscopic studies of VCSEL structures in the strong coupling regime. Here we present first contactless electroreflectance (CER) results on a VCSEL structure with 12 strain-compensated (Ga,In)As/Ga(P,As) quantum wells in the active region of a 2λ-cavity exhibiting a large Rabi splitting. The degree of cavity detuning was varied by changing the sample temperature. The CER spectra obtained will be analysed and compared with those of VCSEL in the weak coupling regime.

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Characterisation of Ga(N,As,P)/GaP QW structures for III-V lasers on Si substrates by modulation spectroscopy — •C. Karcher, G. Blume, P.J. Klar, B. Kunert, K. Volz, W. Stolz, and W. Heimbrodt — Dept. Physics and WZMW, Philipps-University of Marburg, Germany

Recently lasing was achieved at 100 K in GaP based laser structures employing highly strained Ga(N,As)/GaP and Ga(N,As,P)/GaP single quantum well structures in the active region. This opens the field for achieving III-V lasers on Si substrate as the lattice-mismatch between GaP and Si is rather small. We study these lasers and related quantum well structures of different well width and varying composition grown on (100) GaP substrates by photomodulated reflectance, electroreflectance, and photocurrent spectroscopy. The obtained modulation spectra and photocurrent characteristics are analysed in terms of the band alignment of the quantum well structures. These results yield additional knowledge about the band structure essential for achieving room-temperature lasing in the near future.

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Collective Excitations and Composite Fermions — •G. Meissner and U. Schmitt — Theoretische Physik, Universitaet des Saarlandes, Postfach 15 11 50, D-66041 Saarbruecken

Strong correlations are of significance in incompressible quantun liquid phases of interacting 2D electrons in high perpendicular magnetic fields exhibiting the fractional quantum Hall effect at certain fractional filling factors of the lowest Landau level. Therefore, dispersion relations of resulting collective excitations as magneto-rotons are reexamined and shown to be obtained in a non-perturbative many-body approach using intensively sum-rule techniques. Employing a Chern-Simons gauge theory in the Zeeman low-energy limit, finite wave-vector spin-flip excitations of integer quantum Hall states of Composite Fermions with corresponding integer filling factors are then investigate by summing up diagrams for their Coulomb interaction in shielded potential approximation. Compelling similarities found in the dispersion of these intra-Landau level and inter-Landau level excitations are finally discussed in view of a comparison with inelastic light-scattering experiments in such quantum Hall systems.

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Magnetotransport measurement set-up in pulsed magnetic fields up to 60 T — •N. Kozlova, M. Kozlov, D. Eckert, K.-H. Mueller, and L. Schultz — IFW Dresden

In the present work, the magnetotransport measurement technique is presented and various materials, exhibiting resistances from 1 mOhm up to several tens of kOhm, are investigated in pulsed magnetic fields of up to 60 T. For example, these are semimetals, high-temperature superconductors and ferromagnetic manganites. The developed technique allows performing the magnetoresistance and the Hall-effect measurements simultaneously.

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Experimental and Numerical Investigations of the Terahertz Photoconductivity of QH-Systems — •Gabriel Vasile[1,2], Christian Stellmach[1], Yuri Vasilyev[3], Alexander Hirsch[1], Günter Hein[4], Rolf Gerhardts[5], and Georg Nachtwei[1] — [1]Institut für Angewandte Physik, TU-Braunschweig, D-38106 Braunschweig, Deutschland — [2]National Institute of Research-Development for Cryogenics and Isotopic Technologies, Ro-1000 Rm. Valcea, Romania — [3]A.F. Ioffe Physical Technical Institute, Ru-194021 St. Petersburg, Russia — [4]Physikalisch-Technische Bundesanstalt, D-38116 Braunschweig, Deutschland — [5]Max Planck Institut für Festkörperforschung, D-70569 Stuttgart, Deutschland

We present measurements of the Terahertz (THz) photoconductivity of quantum-Hall systems in GaAs/AlGaAs heterostructures with meander and Corbino geometries by using a pulsed p-Ge laser as the THz source (1.7 to 2.5 THz). The photoconductivity versus the magnetic field shows a two-fold structure: one peak at the cyclotron frequency and the others near the minima of the conductivity around the filling factor 2. In order to understand the features revealed by our measurements we perform calculations of the absorption (Joule heating) for different magnetic fields and laser frequencies. To do so we first calculate the dynamic and static

conductivities within the Drude and self-consistent Born approximations. The quantum effect seems to be smeared out at high frequencies. This work shows important conclusions for the development of tunable THz detectors.

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Photoconductivity measurements on Terahertz-HgTe/HgCdTe-Quantum-Hall-detectors — •R. Bonk[1], C. Stellmach[1], C. Becker[2], V. Hock[2], G. Hein[3], and G. Nachtwei[1] — [1]Institut für Angewandte Physik, TU-Braunschweig, Mendelssohnstr.2, D-38106 Braunschweig — [2]Fakultät für Physik und Astronomie, Julius-Maximilians-Universität Würzburg, Am Hubland, D-97074 Würzburg — [3]Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

Many Terahertz-(THz) applications from material research to biological systems have stimulated an intense research in the field of THz wave detection. Two- dimensional electron systems under quantum hall-(QH) conditions develop energy gaps of the order of 10 meV between the Landau levels. Therefore, these systems can interact effectively with far-infrared radiation with wavelengths of the order of 100 μm. Hence, it was found that QH-systems can be used for fast THz detectors with spectral selectivity. In this work we present THz- photoconductivity-(PR) measurements on MCT-(HgCdTe/HgTe)-quantum wells. A pulsed p-Ge laser (120-180 μm) and a glow bar were used as THz sources. With the pulsed monochromatic laser radiation quasi-time resolved PR is measured. The results are relaxation times-(RT) (dissipative to QH state) limited by the experimental setup in the μm range. Additionally, we are interested in the spectral resolution and in the sensitivity of THz-QH-detectors. MCT samples show a sensitivity of the irradiated FIR power, but no visible reaction in the strong bolometric signal to different laser energies.

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Characterization of AlGaN/GaN - heterostructures by means of magnetotransport measurements in high magnetic fields — •K. Knese[1], F. Vogt[1], N. Riedel[1], U. Rossow[1], E. Sagol[2], Ch. Stellmach[1], and G. Nachtwei[1] — [1]Institut für Angewandte Physik, Technische Universität Braunschweig, Mendelsohnstr. 2, D-38106 Braunschweig — [2]Physikalisch Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

The group-III-nitrides are very promising materials in terms of high power, high temperature and high frequency electronic applications. In this work, we investigate the electronic properties of a two dimensional electron gas (2DEG) in AlGaN/GaN heterostructures grown on sapphire substrates in order to obtain a better understanding of scattering mechanisms and transport properties. Therefore, Shubnikov-de Haas (SdH)- and Hall-measurements were performed on several samples (in Hall bar- and Van der Pauw- geometry) with different Al-content of the AlGaN-barrier in high magnetic fields up to 18 T. From SdH- and Hall- measurements the sheet carrier concentration was determined to be $4{\cdot}10^{12}$ - $1{\cdot}10^{13}$ cm^{-2}. The analysis of temperature-dependent SdH-oscillations yields an electronic effective mass of 0.23 - 0.26 m_0. In addition, the quantum scattering lifetime τ_t, which is related to the Landau level broadening, and the classical lifetime τ_D can be calculated from such measurements, whereas the ratio τ_t/τ_D is an indicator of the type of scattering mechanism present in the sample. Finally, the effective Landé-factor g^* was determined from angular dependent SdH-measurements.

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Anisotropic magnetization and magnetotransport studies of two- and three-dimensional electron systems in GaAs — •A. Krohn, J. I. Springborn, Ch. Heyn, and D. Grundler — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstraße 11, 20355 Hamburg, Germany

The low-temperature magnetization M of quasi-free electrons in conducting metals and semiconductors exhibits the well-known de Haas-van Alphen (dHvA) oscillations which originate from the Landau quantization of the electronic spectrum in a magnetic field B. While the dHvA effect is isotropic for a three-dimensional system (3DES) of free electrons, it is anisotropic for a two-dimensional electron system (2DES). In our experiment we have examined different electron systems realized in Si-doped epitaxial GaAs layers where the thickness was varied from 20 nm (2DES) to several μm (3DES). The carrier density was adjusted to be similar and about 10^{18} cm^{-3}. The mobility was about 2×10^3 cm^2/Vs. We measured the dHvA oscillations by detecting the torque $\tau = M \times B$ acting on a highly sensitive cantilever magnetometer. This technique was in particular sensitive to anisotropic magnetization. At the same time we evaluated the Shubnikov-de Haas oscillations from magnetotransport measurements. All data were taken at B up to 14 T and temperatures $T < 5$ K. We found that also the thick samples exhibited a surprisingly anisotropic magnetization, even for a layer thickness as large as several hundred nm. We thank D. Heitmann for continous support and acknowledge financial support by the Deutsche Forschungsgemeinschaft via SFB 508 and via GR1640/1-3.

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Magnetization of a tunneling coupled double-layer electronsystem and double-layer quantum dots — •O. Rösler[1], J. Topp[1], D. Reuter[2], A.D. Wieck[2], and D. Grundler[1] — [1]Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg, Jungiusstraße 11, D-20355 Hamburg — [2]Ruhr-Universität Bochum, Lehrstuhl für Angewandte Festkörperphysik, Universitätsstraße 150, D-44780 Bochum

We have experimentally investigated the magnetization of a double-layered two dimensional electron system and of double-layered quantum dots. The heterostructure was grown by molecular-beam epitaxy. It consisted of two 15 nm wide GaAs quantum wells. These were separated by a narrow tunneling barrier consisting of $Al_{0.33}Ga_{0.66}As$ with a thickness of 1 nm. Delta-doping layers on both sides of the double-quantum well was integrated to provide electrons. The doping layers were optimized to get an approximately symmetric conduction band profile i.e., a balanced electron system. The magnetization shows sawtooth like quantum oscillations at even and odd total filling factors in magnetic fields B up to 33 T. With increasing angle between double-layer normal and B specific filling factors appear and disappear. This unexpected behaviour will be studied in further detail in a mixing chamber cryostat providing a temperature down to 10 mK. Here, we will also investigate quantum dots prepared from the same wafer. We report on our last results.

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De Haas-van Alphen effect in a two-dimensional electron system with variable carrier density and mobility — •N. Ruhe, J. I. Springborn, M. A. Wilde, Ch. Heyn, and D. Grundler — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung der Universität Hamburg, Jungiusstraße 11, 20355 Hamburg, Germany

We have studied simultaneously the de Haas-van Alphen (dHvA) and the quantum Hall effect in a gated two-dimensional electron system (2DES) at temperatures down to 300 mK. The 2DES was formed in a modulation-doped GaAs/AlGaAs heterostructure and integrated into a micromechanical cantilever. Using a fiber-optics interferometer we measured the quantum oscillatory behavior of the magnetization in a magnetic field B up to 14.5 T. The high sensitivity of $4.5\cdot10^{-16}$ J/T at $B = 10$ T allowed us to measure the dHvA oscillations for carrier densities n_S ranging from 5 to $33\cdot10^{10}$ cm^{-2}. Leads were integrated to measure simultaneously the zero-field mobility μ_e. It was found to vary by a factor of five between 1 and $5\cdot10^5$ cm^2/Vs. Unexpectedly we observed that the sawtooth like dHvA amplitude per electron did not depend on n_S and μ_e for even integer filling factors ν at fixed B. The behavior is consistent within a density-independent quantum scattering time of $7\cdot10^{-13}$ s. For the dHvA amplitude at $\nu = 1$ we find a characteristic dependence on B and n_S which we explain by exchange enhancement.

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Magneto-resistance studies on evenly curved Hall bars — •Olrik Schumacher, Miriam Stampe, Christian Heyn, and Wolfgang Hansen — Institut für Angewandte Physik, Jungiusstr. 11, 20355 Hamburg, Germany

We present transport measurements on evenly curved two-dimensional electron systems in InGaAs-microtubes. The method of self-rolling strained semiconductor double layers enables us to build tubes with tuneable radii [1][2]. Using an optimized epitaxial layer design combined with a special lithographic procedure we fabricate GaAs/InGaAs-microtubes with Hall bars containing a two-dimensional electron system (2-DES). When brought into a magnetic field the field component perpendicular to the 2-DES plane is strongly modulated. Transport measurements on

such curved Hall bars with current direction along the axis of the microtube will be shown. By rotating the curved Hall bar in the magnetic field one can tune the perpendicular field component such that there is a zero-crossing on the Hall bar. In that case, this field component has opposite sign at the edges of the bar and new electron trajectories like snake orbits are predicted [3]. We discuss ac- as well as dc-measurements in view of the signatures of such orbits.

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Local properties of disordered fractional quantum hall systems — •Christian Mueller and Daniela Pfannkuche — Jungiusstrasse 9 20355 Hamburg

We propose a new method to study the local properties of highly correlated FQH states when disorder is present. The method is based on the correlations between electrons and wavefunction vortices which characterizes different fractional quantum Hall states. We calculate the conditional electron-vortex correlation function $g_{x,y}^{r_0}$ for finite size systems at different filling factors and disorder potentials. Monte-Carlo-techniques are used to evaluate the multidimensional integrals involving few-electron-wavefunctions obtained from an exact diagonalization of the Hamiltonian. Usage of the method is demonstrated in a fully spin polarized $\nu = \frac{1}{3}$ state with up to 6 electrons. The system is disturbed by several disorder potential types. Regions of different filling factors can de distinguished by comparison of the conditional correlation functions.