HL 58 Poster IIb

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

HL 58.1 Di 16:30 Poster TU F

Two-particle correlations in crystalline systems — K. Morawetz[1,2], E. P. Nakhmedov[3], B. Schmidt[1], M. Schreiber[1], and C. Radehaus[3] — [1]Institute of Physics, Chemnitz University of Technology, 09107 Chemnitz, Germany — [2]Max-Planck-Institute for the Physics of Complex Systems, Nöthnitzer Str. 38, 01187 Dresden, Germany — [3]Opto- and solid state electronics, Chemnitz University of Technology, 09107 Chemnitz, Germany

Correlations of two vacancies or defects in crystalline dielectrics are studied by means of a DFT based ab initio method. The dependence of the interaction energy on the defect separation is computed to study the leakage current through a gate dielectric of MOSFET devices. Simulation of the critical radius of the two-particle correlation allows us to suggest a percolation path formation in the dielectrics. As a toy model, the correlated two-particle problem is solved analytically in the presence of a finite cavity. The method is demonstrated here in terms of exactly solvable models for both the cavity as well as the two-particle correlation where the two-particle potential is chosen in separable form. The two-particle phase shift is calculated and compared to the single-particle one. We find a Fano resonance behavior due to the interference of single- and two-particle channels. The two-particle bound state behavior is discussed and the influence of the cavity on the binding properties is calculated.
[1] K. Morawetz, M. Schreiber, B. Schmidt, A. Ficker, P. Lipavský, Phys. Rev. B submitted, cond-mat/0409325
[2] E. P. Nakhmedov, M. Trentzsch, C. Schubert, I. Kabadshow, E. Nadimi, K. Wieczorek, and C. Radehaus, in preparation, 2004

HL 58.2 Di 16:30 Poster TU F

Magnetotransport measurements 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 of different sizes 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 one occupied subband and a conductivity of a few e^2/h, Aharonov-Bohm oscillations appear that show a modulation of their amplitude with a period of several hundred mT.

We attribute this phenomenon to spin-orbit effects.
[1] U. F. Keyser et al., Phys. Rev. Lett. **90**, 196601-1 (2003)

HL 58.3 Di 16:30 Poster TU F

Noise measurements of vertical coupled InAs quantum dots — •P. Barthold[1], N. Maire[1], F. Hohls[1], A. Nauen[2], R. J. Haug[1], K. Pierz[3], and T. Bryllert[2] — [1]Institut für Festkörperphysik, Universität Hannover, D-30167 Hannover — [2]Div. of Solid State Physics, P.O. BOX 118, SE-221 00 Lund — [3]Physikalisch- Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

We present noise measurements of resonant single electron tunnelling through individual and vertical coupled self-organised InAs quantum dots (QDs) at temperatures down to 1.5 K.

In the first case our samples consist of a GaAs/AlAs/GaAs tunnelling structure with self-organised InAs QDs embedded in the AlAs. Depending on the bias voltage we find that the shot noise is suppressed in respect to the full Poissonian value $2eI$. This suppression is characterised by the Fano factor $\alpha = S/2eI$ whose modulation was perceived in the experiment. We investigate the noise generated by the sample with a current amplifier in a range from 0 to 10 kHz, and a spectrum analyser that uses Fast Fourier Transformation. Above 1 kHz the noise shows a frequency-independent behaviour indicating the presence of shot noise.

In the second case we investigate with the same setup two different types of samples, GaInAs/InP/GaInAs and GaAs/AlAs/GaAs heterostructures in which two layers of vertical coupled InAs QDs are embedded. With both samples we observe definite peaks in the I-V-characteristic as aspected. Due to the bias voltage modulations of α are found. While the peaks in the I-V-characteristic show a slight change at different temperatures the modulation of α shows a distinct behaviour.

HL 58.4 Di 16:30 Poster TU F

Wave-function mixing in tunnel-coupled quantum point contacts — •G. Apetrii[1], U. Kunze[1], D. Schuh[2], and G. Abstreiter[2] — [1]Werkstoffe und Nanoelektronik, Ruhr-Universität Bochum, D-44780 Bochum — [2]Walter Schottky Institut, Technische Universität München, D-85748 Garching

Closely spaced vertically stacked quantum point contacts (QPCs) were prepared on a GaAs/AlGaAs heterostructure comprising two 14.5 nm wide GaAs quantum wells (QWs) separated by a 1 nm wide $Al_{0.32}Ga_{0.68}As$ barrier. The tunnel interaction of the two-dimensional electron systems contained in the two QWs is characterized at equilibrium by a symmetric-antisymmetric energy gap of 4 meV. The QPCs were processed by lithography with an atomic force microscope and subsequent wet-chemical etching. In two-terminal conductance and transconductance measurements at 4.2 K two series of signals originating in the two QPCs were identified. A top-gate/back-gate system together with a cooling bias technique were used for tuning the energy spectra of the tunnel-coupled QPCs in order to obtain degeneracies of 1D subbands. Clear anticrossings with mixing of the 1D wave functions are observed in grey-scale transconductance plots versus top-gate and back-gate voltage. Large anticrossing energy gaps amounting to 5 meV were determined experimentally by means of measurements under dc drain voltage.

HL 58.5 Di 16:30 Poster TU F

Conductance anomalies in a quantum point contact — •D.J. Schefzyk[1], M. Fleischer[1], S. Jauerneck[1], D.A. Wharam[1], D.A. Ritchie[2], and M. Pepper[2] — [1]Institut für Angewandte Physik, Universität Tübingen, Auf der Morgenstelle 10, D-72076 Tübingen — [2]Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge CB3 0HE, UK

Transport measurements of quantum point-contacts exhibit conductance quantisation in units of $G_0 = \frac{2e^2}{h}$. Often additional steps are observed which cannot be accounted for in the simple picture of perfectly transmitting one-dimensional subbands. In the linear gate characteristics, the observed transconductance structure moves parabolically towards lower absolute values of gate voltage with increased perpendicular magnetic field. In addition, we see distinct side plateaux at finite magnetic field. The zero field differential conductance in the nonlinear regime exhibits plateaux at integer multiples of G_0 and half-integer plateaux at finite bias as well as distinct steps below the first and second plateau. At finite bias, they develop into side plateaux, leading to a pattern of intersecting diamonds in the transconductance. The possible origin of additional steps has been considered in a numerical calculation of one-dimensional subbands.

HL 58.6 Di 16:30 Poster TU F

Transport spectroscopy of quantum point contacts — •F. Hohls, A. C. Graham, M. Pepper, and D. A. Ritchie — Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge CB3 0HE, UK

The conductance of a quantum point contact (QPC) is quantized to $G = n(2e^2/h)$ as expected for a non-interacting one-dimensional system. Additional features were observed for clean QPCs, the so called 0.7 structure [1] which is an additional plateau or shoulder at a conductance of $0.7(2e^2/h)$. Recently additional structures were discovered at higher conductance, the so called 0.7 analogue [2]. These features are a manifestation of electron-electron interaction. Different explanations were offered, e.g. spontaneous spin polarization or a Kondo like effect, but the experimental results are not yet unambiguous in favour of one of them.

One of the key questions is the opening of additional energy gaps and their dependence on external parameters. We address this issue using non-linear transport spectroscopy on high quality QPCs. Beside the traditional technique measuring the nonlinear response of the QPC we also employ a new method using a quantum dot as an energy sensitive detector for ballistic electrons.
[1] K. J. Thomas *et al.*, PRL **77**, 135 (1996).
[2] A. C. Graham *et al.*, PRL **91**, 136404 (2003).

HL 58.7 Di 16:30 Poster TU F

Optical properties of phase change materials for optical and electronic data storage with ab initio methods — •Wojciech Wełnic[1,2], Silvana Botti[2], Lucia Reining[2], and Matthias Wuttig[1] — [1]I. Physikalisches Institut, RWTH Aachen, 52056 Aachen, Germany — [2]Laboratoire des Solides Irradiés, École Polytechnique, 91128 Palaiseau cedex - France

In this work excited state calculations are presented for GeTe, the basic phase-change-material. Due to a significant change of optical reflectivity and electric conductivity upon phase transition from the amorphous to the crystalline state these materials are promising candidates for future data storage applications.

The focus of the project is on the optical and electronic properties in different phases of GeTe, ranging from the two crystalline phases, to defect structures and the amorphous phase. The origin for the difference of these properties in the different states is examined. The amorphous structure is obtained in two different ways: on one side we employ *ab initio* MD within a 64-atom supercell and on the other side we use a simple model structure which reproduces the local configuration reported in earlier experimental work. The electronic structure is presented in the GW-correction and the spectra are calculated within TDDFT and GW-RPA. They are compared with experimental data of thin film GeTe-samples. Differences between theory and experiment are discussed as well as the changes in the optical and electronic properties upon phase transition from the crystalline to the amorphous state.

HL 58.8 Di 16:30 Poster TU F

Interferometric cantilever magnetometer for de Haas-van Alphen effect studies — •N. Ruhe, J.I. Springborn, Ch. Heyn, D. Heitmann, and D. Grundler — Institut für Angewandte Physik, Uni Hamburg, Jungiusstr. 11, 20355 Hamburg

The magnetization M provides access to the ground state energy and electron-electron interaction of a two-dimensional electron system (2DES) [1]. At low temperature T and in a high magnetic field B, the de Haas-van Alphen effect occurs. We detect these oszillations by means of the torque $\vec{M} \times \vec{B}$ acting on a quasistatic micromechanical cantilever magnetometer (MCM), which is made from a GaAs/AlGaAs heterostructure. The deflection of the flexible Cantilever is measured by a fiber-optics interferometer at $T = 300$ mK up to $B = 15.5$ T. The resolution of the interferometer is about 0.4 nm corresponding to a sensitivity of $2 \cdot 10^{-14}$ J/T at $B = 10$ T. In comparison to a capacitive read-out technique [1] the fiber-optics interferometer has the advantage that (i) a higher sensitivity might be reached and that (ii) electrical contacts and field-effect electrodes can be attached to the 2DES without degrading to the sensitivity. In current experiments we study the magnetization and magneto-transport simultaneously. Our latest results will be presented. We thank A. Schwarz for continuous support of the work and the DFG for financial support via GR1640/1 and via SFB508.
[1] M. Schwarz *et al.*, Phys. Rev. B **65**, 245315 (2002).

HL 58.9 Di 16:30 Poster TU F

THz-Photoleitung an HgTe/HgCdTe-Quanten-Hall-Detektoren — •R. Bonk[1], C. Stellmach[1], C. Becker[2], V. Hock[2], G. Hein[3] und G. Nachtwei[1] — [1]Inst. f. Techn. Physik, TU-Braunschweig, Mendelssohnstr.2, D-38106 Braunschweig — [2]Fakultät für Physik und Astronomie, Julius-Maximilians-Universität Würzburg, Am Hubland, D-97074 Würzburg — [3]Phys.-Tech. Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

Die Arbeit behandelt die Terahertz-Photoleitung an zweidimensionalen MCT-Quantenwall-Strukturen (HgTe/HgCdTe) im Quanten-Hall-(QH)-Regime.Im Materialsystem GaAs/GaAlAs werden für Ferninfrarot-(FIR)-QH-Detektoren tiefe Temperaturen (ca. 4K) und hohe Magnetfelder (ca. 5T) benötigt. Bei MCT-Proben hingegen sind auf Grund der kleineren effektiven Masse auch deutlich kleinere Magnetfelder möglich, was MCT-Systeme zu einem viel versprechenden Material für empfindliche FIR-Quanten-Hall-Detektoren, z.B. zur Festkörperspektroskopie, werden lässt. Für spektrale sowie zeitaufgelöste Untersuchungen werden impedanzangepasste Photoleitungsmessungen an verschiedenen MCT-Systemen mit Hallbar- und Corbinostrukturierung unter Verwendung eines p-Ge-Lasers (Wellenlängen von 120-180 μm) respektive Glowbars (thermischer Strahler) im FIR durchgeführt. Damit werden Relaxationszeiten der Ladungsträger beim optisch bewirkten Zusammenbruch des QH-Effektes in Hinblick auf die Anwendung eines schnellen Detektors untersucht.

HL 58.10 Di 16:30 Poster TU F

Magnetotransport zur Charakterisierung von AlGaN/GaN-Heterostrukturen — •K. Knese, F. Vogt, N. Riedel, U. Rossow, C. Stellmach und G. Nachtwei — Inst. f. Techn. Physik, TU-Braunschweig, Mendelssohnstr. 2, D-38106 Braunschweig

Die Gruppe III-Nitride bilden eine viel versprechende Möglichkeit für Anwendungen als elektronische Bauelemente, die bei hohen Temperaturen und hohen Frequenzen arbeiten. Allerdings weisen Bauelemente dieser Materialklasse oft noch unbefriedigende elektrische Kenndaten auf. Dies ist eine Folge von teilweise noch unverstandenen Streumechanismen, welche die Beweglichkeit der Elektronen limitieren. Diese Arbeit beschäftigt sich mit den Magnetotransport-Eigenschaften des zweidimensionalen Elektronensystems in AlGaN/GaN-Heterostrukturen, aus denen die Streumechanismen ermittelt werden können. Es werden Shubnikov-de Haas-Messungen an verschiedenen Proben zur Bestimmung der Elektronenkonzentrationen, Beweglichkeiten, effektiven Elektronenmassen, Transport- und Quantenstreuzeiten durchgeführt. Zusätzlich werden SdH-Oszillationen bei unterschiedlichen Neigungswinkeln des Magnetfeldes gemessen, die eine Bestimmung der Spinaufspaltung und des effektiven Landé-Faktors der Elektronen ermöglichen.

HL 58.11 Di 16:30 Poster TU F

Echtzeitmessung der Relaxation des Photosignals von Quanten-Hall-Terahertz-Detektoren in Corbino-Geometrie — •C. Stellmach[1], Yu. Vasilyev[2], A. Hirsch[1], G. Hein[3] und G. Nachtwei[1] — [1]Inst. f. Techn. Physik, TU-Braunschweig, Mendelssohnstr. 2, D-38106 Braunschweig — [2]A.F. Ioffe Physical Technical Institute, Polytekhnicheskaya 26, 194021 St. Petersburg, Russia — [3]Phys.-Techn. Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

Wir präsentieren Photoleitfähigkeits-Messungen im Ferninfrarot an Quanten-Hall-(QH)-Systemen. Es wurden mehrere QH-Proben untersucht, die in Corbino Geometrie mit großer photoaktiver Fläche strukturiert waren ($A \approx 6$ mm^2). Als Strahlungsquelle stand ein ein p-Ge Laser im Pulsbetrieb zur Verfügung, der Messungen im Wellenlängenbereich zwischen ca. $120\mu\text{m} \leq \lambda \leq 180\mu$m (entspricht 2.5THz bis 1.5THz) erlaubt. Der Laser wird mit einer speziellen FET basierten Hochspannungs-Pulsquelle mit kurzer Schaltzeit betrieben. Das Photosignal wird impedanzangepasst erfasst. Dies erlaubt es intrinsische Zeitskalen des QH-Systems aufzulösen. Es zeigt sich, dass die Relaxationszeit des Photosinals spannungsabhängig ist und im Bereich von ca. 20ns bis 150ns liegt. Zusätzlich wurde das Photosignal in Abhängigkeit von Magnetfeld, Ladungsträgerkonzentration (steuerbar über eine Gate-Spannung) und Probenspannung gemessen um die spektrale Selektivtät zu bestimmen. Es zeigt sich, dass die spektrale Auflösung der QH-Detektoren eine Funktion Probenspannung ist.

HL 58.12 Di 16:30 Poster TU F

Spin-Flip Excitations and Composite Fermions — •G. Meissner and U. Schmitt — Theoretische Physik, Universität des Saarlandes, Postfach 15 11 50, D-66041 Saarbrücken

Dispersion relations for spin-flip modes of composite Fermions are examined by employing a Chern-Simons gauge theory in the limit of low Zeeman energy. The calculated finite-wave-vector excitations, in which a spin-reversed composite Fermion of the spin-polarized filled lowest Landau level is promoted to the next, are compared with the collective excitations of Laughlin's incompressible quantum liquid at the corresponding fractional filling factor one third. Modifications due to finite thickness effects in this interacting two-dimensional electron system at high magnetic fields are considered in view of a comparison of the calculated dispersion relations with inelastic light-scattering experiments.

HL 58.13 Di 16:30 Poster TU F

Measurements of the electrical excitation of QH-devices in the real time domain — •G. Vasile[1,2], C. Stellmach[1], and G. Nachtwei[1] — [1]Inst.f.Technische Physik, der TU Braunschweig, Mendelssohnstrasse 2, D-38106 Braunschweig — [2]National Institute of Research-Development for Cryogenics and Isotopic Technologies, Str. Uzinei Nr. 4, R-1000 Rm. Valcea, Romania

We have performed real time domain measurements of the electrical excitation on Corbino devices (measured with impedance-matching circuit) in order to determine the excitation and relaxation times. We have used Corbino devices of inner radius $R_1 = 100\mu$m, outer radius $R_2 = 150\mu$m and various mobilities ($\mu = 8 \times 10^5$ cm^2/Vs, $\mu = 1.6 \times 10^6$ cm^2/Vs). A pulse generator send through a high frequency cable rectangular pulses to the Corbino disc and via another high frequency cable the sample

response, picked up from a 50 Ω serial resistor with the Corbino disc, is read on the oscilloscope. We have used rectangular shapes of 90-180 ns pulse width, 300 ns pulse period and from 0.2 V up to 1.0 V applied voltages. In this way we were able to determine relaxation times of a few nanoseconds according to previous measurements. The higher voltage the shorter response time due to the fact by increasing the applied voltage, the Landau levels are tilted more and more resulting in smaller tunnelling distance between the initial and final tunnelling states, therefore a higher tunnelling rate and consequently a smaller drift length of electrons. According to the drift model, at constant drift length, the response time of the sample should be inverse proportional to the applied voltage, but our measurements yield another dependence.

HL 58.14 Di 16:30 Poster TU F

Nonchiral Edge States and the Chiral Metal Insulator Transition — •Stefan Kettemann[1], Alexander Struck[1], Bernhard Kramer[1], and Tomi Ohtsuki[2] — [1]1. Institut fuer Theoretische Physik, Uni Hamburg, Jungiusstrase 9, 20355 Hamburg — [2]Sophia University , Tokyo

The quantum phase diagram of disordered quantum wires in a strong magnetic field is studied. Sharp localization transitions of chiral edge states are found. These are shown to result in zero temperature discontinuous transitions of the 2–terminal conductance between exactly integer plateau values and zero, reminiscent of first order phase transitions. This transition, the chiral metal insulator transition (CMIT)[1], is studied as function of wire width, steepness of the confinement potential and the strength and correlation length of the disorder potential. A unique state is identified at the transition, corresponding to a superposition of edge states with opposite chirality. The bulk contribution to this state is found to decrease with the increase of the wire width, characterising this state as a new state, distinguishable from the other states, existing in the quantum Hall wire [2], namely, extended edge states, 2D localised states, quasi-1-D localised states, and 2D critical states. [1] S. Kettemann, B. Kramer, T. Ohtsuki, JETP Letters 80, 316 (2004) [2] S. Kettemann, Phys. Rev. B 69, 035339 (2004).

HL 58.15 Di 16:30 Poster TU F

Transition between incompressible states of different spin polarization: a half-polarized ground state? — •Karel Výborný and Daniela Pfannkuche — 1st Institute of theoretical physics, Jungiusstr. 9, University of Hamburg, 20355 Hamburg

Incompressible fractional quantum Hall states are not always fully spin polarized and even transitions between ground states of different spin (but at fixed filling factor) can be achieved by tuning the Zeeman splitting. This is also the case at $\nu = 2/3$ where the transition between a spin-singlet ground state (GS) and a fully polarized GS was observed experimentally as a huge longitudinal magnetoresistance effect. Experiments suggested that the system constitutes a quantum Hall ferromagnet [1] or that a stable half-polarized ground state in the middle of the transition occurs [2].

We study this transition using exact diagonalization with electrons on torus. For homogeneous systems we find a low excited half-polarized state around the transition which might become the GS in the thermodynamical limit. We study its structure and compare it to the singlet and polarized GS's.

Adding magnetic inhomogeneities into the system we investigate stability of all three involved GS's and tendency to build up domains like in conventional ferromagnets.

[1] S. Kronmüller et al., *Phys. Rev. Lett.*, **81**, 2526 (1998); J. Smet et al., *Nature*, **415**, 281 (2002)

[2] I. V. Kukushkin et al., *Phys. Rev. Lett.*, **82**, 3665 (1999)

HL 58.16 Di 16:30 Poster TU F

Composite fermions in disordered systems — •Christian Müller and Daniela Pfannkuche — Institut für Theoretische Physik Universität Hamburg

The electronic properties of a disordered system in the fractional quantum Hall regime are studied. To this end, the correlation of wavefunction vortices (Composite Fermions) and electrons are studied in a system subject to periodic boundary conditions using exact diagonalization methods for up to 5 spin-polarized electrons. The model impurity is of gaussian shape.

For a strong gaussian-shaped impurity potential a quantized charging of the resulting quantum dot is found. The vortex-vortex correlation becomes weaker for stronger disorder potentials, pointing to a possible breakdown of the FQH regime.

HL 58.17 Di 16:30 Poster TU F

Interactions at the Integer Quantum Hall Transition — •Christoph Sohrmann and Rudolf A. Römer — Department of Physics, University of Warwick, Coventry CV47AL, UK

Electron-electron interactions seem to play a surprisingly small role in the description of the integer quantum Hall effect, considering that for just slightly different filling factors the interactions are of utmost importance causing the interaction-mediated fractional quantum Hall effect. However, recent experiments by Cobden et al. [1] constitute strong evidence for the importance of electron-electron interactions even in the integer effect. Measurements of the conductance on mesoscopic MOSFET devices show regular patterns along the plateau transitions when viewed as a function of the two parameters magnetic field and gate voltage. In contrast to the expected random behaviour of the sample specific conductance fluctuations those patterns are most likely interaction driven and demand explanation. Starting from the random Landau matrix approach as an effective numerical model for non-interacting quantum Hall physics, we treat interactions in an approximative Hartree-Fock scheme and investigate the role of the interactions in the integer quantum Hall effect.

[1] D.H. Cobden, C.H.W. Barnes, and C.J.B. Ford, Phys. Ref. Lett. **82**, 4695 (1999)

HL 58.18 Di 16:30 Poster TU F

Storing of arbitrary light pulses in resonant 1D photonic crystals — •Martin Schaarschmidt, Jens Förstner und Andreas Knorr — Institut für Theoretische Physik, Technische Universität Berlin, Germany

The considered 1D photonic crystal consists of semiconductor planes with localized excitons spaced at $\lambda/2$. The excitons couple dynamically to a propagating light pulse. Stationary (trapped) field distributions of this coupled system are numerically observed for resonant excitation inside the resonant photonic band gap. Within slowly varying envelope approximation analytic solutions based on the Maxwell-Bloch-Equations for these trapped light pulses are presented. It is shown that pulses of nearly arbitrary shape and intensity can exist as zero-velocity pulses inside an active photonic crystal. The preparation of a whole class of these pulses is demonstrated. In a similar system consisting of an InGaAs multiple quantum well with free excitons such solutions could not be found[1].

[1]Linear and nonlinear pulse propagation in a multiple-quantum-well photonic crystal, PRB 70 075306 (2004)

HL 58.19 Di 16:30 Poster TU F

Resonance Fluorescence of Semiconductor Quantum Dots: Signatures of the Electron-Phonon Interaction — •Kwang Jun Ahn, Jens Förstner, and Andreas Knorr — Institut für Theoretische Physik, AG Nichtlineare Optik und Quantenelektronik, Technische Universität Berlin, Hardenbergstr.36 PN7-1, 10623 Berlin

Compared to an atom in vacuum, which is considered as an isolated quantum optical system, excitons in semiconductor quantum dots are embedded in a complex solid state environment and interact with phonons. We investigate the influence of acoustic phonons on incoherent photon emission. The equations of motion of the density matrix are derived for the coupled system of quantum dot electrons, phonons and photons using the correlation expansion up to second order. The corresponding resonance fluorescence spectra are calculated depending on pulse duration and temperature. The appearance of sideband broadening by electron-phonon interaction in the spectrum depends on the pulse duration compared to the typical electron-phonon scattering time. In addition, nonclassical signatures of the emitted light are discussed.

HL 58.20 Di 16:30 Poster TU F

Aharonov-Anandan phase and the quasistationarity of driven quantum systems — •Alex Matos-Abiague and Jamal Berakdar — Max-Planck Institut für Mikrostrukturphysik,

We derive necessary and sufficient conditions for the quasistationarity of a time-dependent quantum system and point out the relationship between the degree of quasistationarity, the Fubini-Study metric, and the Aharonov-Anandan geometric phase. As an illustration we analyze the dynamical localization of an electron in a double quantum well as well as the sustainability of field-induced orientation of polar molecules.

HL 58.21 Di 16:30 Poster TU F

Spontaneous Emission in Photonic Crystals: Experiment vs. Calculation — •Michael Barth and Frank Cichos — Photonics and Optical Materials, Institute of Physics, Chemnitz University of Technology

We have performed single-domain spectroscopy and time-resolved measurements on dye molecules and CdSe-nanoparticles in three-dimensional photonic crystals. The high spatial resolution of our microscopy setup provides an excellent basis for probing the local optical density of states (LDOS) in these crystals. The measurements are supplemented by corresponding numerical calculations of the LDOS, incorporating anisotropy effects and the spatial distribution of the emitters. It is found experimentally as well as theoretically, that, while the total radiative lifetime may stay nearly unaffected, strong modifications of the radiation pattern can be achieved in certain frequency ranges. We show that these effects depend sensitively on the ordering-quality of the crystal domains and the spatial position of the emitters.

HL 58.22 Di 16:30 Poster TU F

Nanophotonic Applications of Silicon Carbide — •Bettina Friedel and Siegmund Greulich-Weber — Universität Paderborn, Department Physik, Paderborn

3D photonic crystals for the visible spectrum are preferably prepared from sub-micron-spheres made from silica or organic materials which by self-organization form colloidal crystals. However, these crystals are fragile and exhibit a low refractive index and thus are not suitable for photonic devices. Infiltration of the interparticle voids with materials of appropriate refractive index, followed by removal of the spheres, leads to inverted opals for which a complete photonic bandgap is expected. A number of materials have been infiltrated, however not all are suitable for the visible range and in addition mechanically stable enough. We prefer infiltration by sol-gel routes because of its easy and time-saving application at low cost. Most infiltrates are rather porous and therefore do not feature the expected effective refractive index. We will discuss sol-gel wide-bandgap semiconductors, especially SiC, as possible infiltrates. In view of future photonic applications in-situ tuning of photonic properties becomes necessary, which might be realized by 'electronic' doping of the semiconductor material. Thus practical doping procedures for sol-gel semiconductor materials are additional requirements.

HL 58.23 Di 16:30 Poster TU F

Photonic Crystal Microwave Resonators for Magnetic Resonance Applications — •A. von Rhein, E. von Rhein, M. Wanjek, and S. Greulich-Weber — Universität Paderborn, Department Physik, Warburger Straße 100, 33098 Paderborn

Electron paramagnetic resonance and multiple resonance techniques like electron nuclear double resonance and optically detected magnetic resonance are powerful tools for the investigation of defects in solids. Recently high frequency sources (100 GHz) at reasonable costs became available for magnetic resonance (MR) spectroscopy providing higher spectral resolution and in principle higher sensitivity compared to lower frequencies. Usually the microwave absorption due to the MR signal is measured using a microwave bridge balanced by a microwave resonator containing the sample. At high frequencies the resonator becomes rather small which requires the development of new resonator designs. Especially for optical detection of MR optical access to the sample is needed which at high frequencies only allows the use of Fabry-Perot resonators, which provide relatively small quality factors. We present new resonator designs on the basis of photonic crystals also suitable for low frequency MR providing additional features not known from conventional resonators.

HL 58.24 Di 16:30 Poster TU F

II-VI/III-V semiconductor optical cavities fabricated by chemical etching, selective growth or FIB — •J. Lupaca-Schomber[1], B. Daniel[1], M. Hetterich[1], D. Tröndle[1], H. Kalt[1], F. Perez-Willard[2], J. Hawecker[2], and D. Gerthsen[2] — [1]Institut für Angewandte Physik and Center for Functional Nanostructures (CFN), Universität Karlsruhe, D-76131 Karlsruhe, Germany — [2]Laboratorium für Elektronenmikroskopie and CFN, Universität Karlsruhe, D-76128 Karlsruhe, Germany

We present three different methods for the production of (sub-) micrometer optical cavities with pyramidal shape made of II-VI/III-V semiconductors. One method is the selective etching (H_3PO_4:H_2O_2:H_2O solution) of an AlAs/GaAs structure. The AlAs sacrificial layer controls the lateral etching rate and influences the cross-sectional profile of the GaAs pyramidal objects. Another possibility is the selective growth of self-organized CdSe/ZnSe structures on pre-patterned GaAs (001) surfaces. Growth was performed by molecular beam epitaxy (MBE). A more direct method is Focussed Ion Beam (FIB). Structures in CdSe/ZnSe multiple quantum wells were prepared by this technique using a Ga ion beam without the necessity of further process steps. All samples were examined for their optical quality using μ-PL.

HL 58.25 Di 16:30 Poster TU F

Control of colloidal crystal growth by external fields — •E. von Rhein, O. Gudi, and S. Greulich-Weber — Universität Paderborn, Department Physik, Warburger Straße 100, 33098 Paderborn

Since the introduction of the concept of a photonic crystal much effort has been targeted at producing 3D photonic crystals working in the visible wavelength range. The most promising way is by self-assembly of monodisperse sub-micron spheres made of silica or organic materials resulting in fcc and hcp colloidal crystals. However, the large scale fabrication and thus their application in photonics suffer from the reproducible growth of defect-free extended bulk crystals. Commonly used 'natural' sedimentation is unacceptably slow and often results in low crystal quality showing cracks and stacking faults or reveals a disordered bulk below an apparently ordered surface. In literature there are several examples, where additional external fields such as electric or acoustic fields were applied, which to a certain extent enhanced the crystal quality. However, the reproducibility of such experiments depends on many parameters like the chemical composition of the spheres, the solvent, the density ratio of spheres and solvent, and many more. To have control of all this parameters during crystal growth is one of our current projects. We will present details of our computer controlled crystal growth experiments using specific external fields.

HL 58.26 Di 16:30 Poster TU F

Fabrication of templates and 3D nanostructuring of positive photoresists — •Sven Passinger, Carsten Reinhardt, and Boris Chichkov — Laserzentrum Hannover e.V., Hollerithallee 8, 30419 Hannover

So far, two-photon polymerization technique has been applied for the fabrication of photonic crystal structures only in negative photoresists. These materials have relatively low refractive index and, due to their high chemical stability, it appears difficult to use them as templates for the realization of high refractive index replicas.

In this contribution, positive photoresist S1813 (which can be easily removed) is used for the first time for the fabrication of photonic crystal templates. 3D nanostructuring of positive photoresist by two-photon irradiation technique is studied. We will report on resolution limits, first 3D photonic crystal structures fabricated by these methods, and their properties.

HL 58.27 Di 16:30 Poster TU F

Photoprocessable polymer opals — •Birger Lange and Rudolf Zentel — Institute of Organic Chemistry, Department of Chemistry and Pharmacy, University of Mainz, Duesbergweg 10-14, D-55099 Mainz

Progress in electronics and photonics can be seen in the development of new materials, which broadens our ability to manipulate electron and photon transport respectively. Photonic crystals are a new class of materials first discussed in 1987. Eli Yablonovitch and Sajeev John introduced the idea of controlling light and its emission with photonic crystalline materials. For a good control of light we need first a photonic crystal, this is here accomplished by the synthesis of monodisperse colloids from the acid labile polymer poly-tert.-butyl-methacrylate and a subsequent crystallization into polymer opals. Second we need the possibility to structure the photonic crystals, this could be achieved by loading the colloids with photoacid generator before crystallization. Irradiation with UV-light followed by baking and development with aqueous base allows subsequent patterning of the opaline films. This chemical approach makes it possible to use the self-assembly of this colloids (opal formation) to form a large scale periodic structure, and introduce optical defects with UV-lithography.

HL 58.28 Di 16:30 Poster TU F

Active and passive doped microstructured and photonic crystal fibres: — •Jens Kobelke, Johannes Kirchhof, Kirsten Gerth, Kay Schuster, Klaus Mörl, Claudia Aichele, and Hartmut Bartelt — Institut für Physikalische Hochtechnologie e.V., Albert-Einstein-Strasse 9, D-07745 Jena, Germany

The rapid development of novel designs of microstructured optical fibres (MOFs) and photonic crystal fibres (PCFs) as well as various material concepts open up improved technical implementations for fibre functionality: e.g. for fibre lasers, amplifiers, frequency filters, switching modules. We prepared and investigated high silica based MOFs with holey structure and with germanium and phosphorus doping. The aim of this design is to enlarge the possibility of tailoring the fibre properties, e.g. pulse dispersion and mode field shape. Novel types of laser fibres have been prepared by doping the core of PCFs with rare-earth elements. Such fibres are typically composed of a double-clad structures for efficient pumping. In current fibres the numerical aperture and the thermal stability are limited by the coating material. Its thermal behaviour typically reduces the power stability in longitudinal pumped ytterbium doped high power fibre lasers. We prepared different types of ytterbium doped PCFs with an air cladding in order to overcome this power limitation. The air cladding results in optical decoupling from the fibre coating and allows higher pump power levels compared with conventional polymer coated laser fibres due to an increase of the numerical aperture by a factor of about 2. The results of first laser tests show the high potential for power upgrading of this novel laser fibre concept.

HL 58.29 Di 16:30 Poster TU F

Realisation of a high efficiency gas sensing device — •Daniel Pergande[1], Torsten M. Geppert[1,2], Andreas von Rhein[1], Stefan L. Schweizer[1], Ralf B. Wehrspohn[1], Thomas Beyer[3], Iliyana Hinkov[3], and Armin Lambrecht[3] — [1]Universität Paderborn, Dept. Physik, Warburger Str. 100, 33098 Paderborn, Germany — [2]Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle, Germany — [3]Fraunhofer-Institut für Physikalische Messtechnik, Heidenhofstr. 8, 79110 Freiburg

We present the conception of a gas sensor as a application of a 2D photonic crystal (PC). The PC consists of a membrane made of electrochemical etched pores in Silicon. The gas measurement makes use of the light absorption of the gas. Due to the effect of low group velocities a stronger interaction of the light with the gas is achieved. So the detection distance required for a certain sensitivity can be drastically decreased. One obtains a significant minituarisation of the device. The PC has to be designed according to the absorption frequency of the gas(in this case alcohol). This occures by the variation of the diameter and the pitch of the pores. A novel taper concept will be introduced and the fabrication of the device will be described.

HL 58.30 Di 16:30 Poster TU F

Focusing microwaves with a concave lens based on a 2D photonic crystal — •E. Foca[1], S. Frey[1], F. Daschner[1], V.V. Sergentu[2], J. Carstensen[1], R. Knöchel[1], I.M. Tiginyanu[2] und H. Föll[1] — [1]Faculty of Engineering, Christian-Albrechts-University, Kiel, Germany — [2]LLDSP, Technical University of Moldova, Chisinau, Moldova

Photonic crystals (PC) can be considered as optically homogenous materials for the long wave length limit, thus they can be ascribed an effective electric permittivity, and an effective refractive index. However, it is more complicated when the radiation wavelength is comparable with the PC irregularities. Even in this regime there remain frequency regions where the PC can be attributed an effective refractive index.

We present a new method to find the effective refractive index of a PC in non-trivial regimes, especially for the case of $0 < n_{eff} < 1$. We prove the correctness of our calculations by designing and measuring a concave lens with a $0 < n_{eff} < 1$ in the microwave regime. For such a case the lens focuses the radiation and we measured that this is indeed the case. We show a good correlation between the theoretical predictions and measured data and a good focusing quality of the lens. We estimate the focusing power of the lens in terms of the transmission coefficient that reaches values as high as 40 for frequencies close to 7.5 GHz, which is extremely good since nearly no other tool for focussing of microwaves exists.

HL 58.31 Di 16:30 Poster TU F

Selective Thermal Emitters in 2D Photonic Crystals — •B. Gesemann, M. Milbradt, A. von Rhein, S.L. Schweizer, and R.B. Wehrspohn — Universität Paderborn, Department Physik, Warburger Str. 100, 33098 Paderborn

We study the fabrication and optical properties of thermal emitters placed directly into the holes of a 2D-Photonic Crystal. The influence of the photonic band structure and DOS on the emission characteristics of the emitter is analyzed theoretically. For the realisation, we use Fe_2O_3 nanoparticles as inductive heaters which are selectively infiltrated into 2D macroporous silicon photonic crystals. We present structural and optical characterisation of the infiltration.

HL 58.32 Di 16:30 Poster TU F

High quality opals from organic-inorganic material — •Jianhui Ye and Rudolf Zentel — Department of Chemistry, University of Mainz, Duesbergweg 10-14, D-55099 Mainz

An attractive feature of synthetic opals, in comparison with their natural counterparts, arises from the possibility to use the lattice of sphere as a template that can be infiltrated with a variety of ferroelectric, nonlinear, and photorefractive materials. This permits the preparation of diverse materials compositions for optoelectronic applications. The photonic crystal properties of such diverse materials compositions are strongly dependent (I) on the quality of the initial opal and (II) on the filling factor of the opaline voids. We use high quality polymer opals as template and infiltrate with an organic-inorganic monomer (ORMOCER). This monomer can be photopolymerized within the opaline voids leading to "perfect" replica structure with filling factor above 90%. This is different from inorganic materials prepared by chemical vapor deposition or a sol-gel process.

HL 58.33 Di 16:30 Poster TU F

Photonic bandgap in two-dimensional octagonal quasi-periodic lattice — •Dmitry Chigrin and Johann Kroha — Physikalisches Institut, Universität Bonn, Nussallee 12, 53155 Bonn

A systematic study of a photonic bandgap formation in two-dimensional octagonal quasi-periodic lattice of dielectric rods is presented. Photonic bandgap maps are obtained for different dielectric constants and radiuses of rods for both fundamental polarizations. It is shown that for fairly high dielectric constant of rods, complete photonic bandgaps in both fundamental polarizations can overlap leading to a full bandgap. It is also shown, that in the case of TM polarization the first complete photonic bandgap remains open down to very small dielectric constants. The threshold dielectric constant can be as small as $\varepsilon = 1.6$. Possible optoelectronic applications of two-dimensional octagonal photonic quasi-crystals are discussed. The physical mechanisms of the photonic bandgap formation in a quasi-periodic lattice are addressed. Finite-difference time-domain and plane wave expansion methods were used for density of states and band structure calculations, respectively.

HL 58.34 Di 16:30 Poster TU F

Durchstimmbare Lasertätigkeit in ein- und zweidimensionalen photonischen Kristallen — •Stroisch Marc[1], Gerken Martina[1], Lemmer Uli[1], Forberich Karen[2] und Gombert Andreas[3] — [1]Lichttechnisches Institut, AG Visuelle Informationstechnik und Optoelektronik, Universität Karlsruhe — [2]Freiburger Materialforschungszentrum, Universität Freiburg — [3]Fraunhofer Institut für Solare Energiesysteme ISE, Freiburg

Organische Photonische Kristall-Laser lassen sich durch das Aufbringen von organischen Farbstoffen auf ein mikrostrukturiertes Substrat herstellen. Die Durchstimmbarkeit der Laserwellenlänge erfolgt dabei durch die Variation der Schichtdicke, der chemischen Zusammensetzung und der Gitterperiode des Substrates. Durch die Kombination der drei Elemente ist es mögliche den sichtbaren Spektralbereich abzudecken. Unterschiedliche Lasergitter (Linien-, Kreuz- und Hexagonalgitter) beeinflussen zudem Laserparameter wie die Abstrahlcharakteristik, die Laserschwelle und die Modenform der Laser. Als optisch aktive Materialien werden nach dem Spiro-Konzept verknüpfte organische Farbstoffe (Oligomere) und handelsübliche Laserfarbstoffe verwendet. Die experimentelle Charakterisierung erfolgt durch winkel- und wellenlängenabhängige Detektion der spontanen Emission, der stimulierten Emission und der Transmission.

HL 58.35 Di 16:30 Poster TU F

Ultraschnelles optisches Schalten in dreidimensionalen Photonischen Kristallen aus Silizium — •C. Becker[1], S. Linden[1], M. Wegener[1,2], N. Tetreault[3], V. Kitaev[3], G. von Freymann[3] und G. A. Ozin[3] — [1]Institut für Nanotechnologie, Forschungszentrum Karlsruhe in der Helmholtz-Gemeinschaft — [2]Institut für Angewandte Physik, Universität Karlsruhe — [3]Department of Chemistry, University of Toronto

Photonische Kristalle weisen vielversprechende Möglichkeiten zur Realisierung von optischen Schaltelementen auf. Verantwortlich hierfür ist die

Existenz einer teilweisen oder kompletten Photonischen Bandlücke, deren spektrale Position vom Brechungsindex abhängt. Eine ultraschnelle optisch induzierte Veränderung des Brechungindex ermöglicht daher interessante Schaltprozesse. Es gab in der Vergangenheit diesbezüglich nur wenige Experimente, die auf resonanter Erzeugung freier Ladungsträger beruhten und daher lange Relaxationszeiten hatten.[1]

Wir haben in einem Anrege-Abfrage-Experiment mit zwei voneinander unabhängigen optisch parametrischen Verstärkern invertierte Silizium-Opale untersucht, deren Bandlücke im nahen Infrarot liegt. Die Variation des Brechungsindex kann jedoch auch durch nichtresonante Effekte verursacht werden. Bei diesen Prozessen, insbesondere beim optischen Kerr-Effekt, sind die Relexationszeiten wesentlich kürzer. In der Analyse der Daten wurde ein besonderes Augenmerk auf die Unterscheidung der verschiedenen resonanten und nichtresonanten nichtlinearen Effekte gerichtet.

[1] S. W. Leonard et al., PRB, **66**, 161102 (2002)

HL 58.36 Di 16:30 Poster TU F

Integration of three-dimensional photonic crystals onto structured silicon wafers — •Jianhui Ye[1], Rudolf Zentel[1], Sanna Arpiainen[2], and Jouni Ahopelto[2] — [1]Department of Chemistry, University of Mainz, Duesbergerweg 10-14, D-55099 Mainz — [2]VTT Centre for Microelectronics, P.O. Box 1208, FIN-02044 VTT

The strong research effort devoted to photonic crystals is motivated by their potential to build a generation of optoelectronic devices of reduced size, combining high integration, and high-speed processing. Advanced photonic circuits will need complex architectures, which can be achieved by using structured silicon substrates as a container, onto which high-quality photonic crystals of controlled size and shape have to be grown.

We report on crystallization of silica spheres of diameter 900 nm on structured silicon wafers with the help of a "drawing apparatus". The crystallization can, thereby, be directed exclusively to the lower lying parts. We optimize the conditions of the crystallization and obtain opals of good quality on patterned substrates, i.e.: (I) good infilling of the structures, flat top surface; (II) 3D order; and (III) absence of cracking. The influence of the complex pattern on the quality of the opals will be discussed.

HL 58.37 Di 16:30 Poster TU F

Larger bandgaps of photonic crystals fabricated by holographic lithography can be realized by the beam design — •Xiulun Yang[1] and L.Z. Cai[2] — [1]Institute of Applied Physics, University of Bonn — [2]Department of optics, Shandong University, 250100, P. R. China

The existence of photonic band gaps (PBGs) is the most important property and the basis of many applications of photonic crystals (PhCs). One of the fundamental tasks of PBG engineering is how to obtain and maximize a PBG for a given structure. A unique feature of the PhCs produced by the holographic method is that the shape and size of the resultant element spots, referred to as atoms of the structure, take the form of the equal- intensity surfaces of the interference field. Naturally they vary with the beam design and the choice of the threshold intensity, and they are usually different from the regular shapes like a cylinder or a sphere reported before. Therefore a more specific PBG study of the PhCs of this kind considering their special atom shape and size becomes necessary. In our recent work we have taken two-dimensional triangular and square lattices as an example to investigate the PBG property of holographically recorded PhCs, and shown that the holographic method gives us a new freedom for PBG engineering. This work was supported by BMBF(13N8340), DFG (SPP1113), the National Natural Science Foundation of China (50173015 and 60177002), foundation NSFC/RGC of China (50218001), and the China Postdoctoral Foundation.

HL 58.38 Di 16:30 Poster TU F

Negative refraction in 2d square lattice photonic crystals at millimetre waves — •Rados Gajic[1], Ronald Meisels[2], Friedemar Kuchar[2], Javad Zarbakhsh[3], and Kurt Hingerl[3] — [1]Institute of Physics, University of Belgrade, Yugoslavia — [2]Institute of Physics, University of Leoben, Austria — [3]Christian Doppler Laboratory, Institute for

We investigated the negative refraction of microwaves in a 2D photonic crystal (PhC) made of alumina rods in air. The experiments were performed in the 26 – 40 GHz range. Negative refraction was experimentally verified of the TM mode for the Gamma-M surface of the crystal in the range 35 to 37 GHz for an incidence of 45 degree. In addition we studied collimation and self-focusing effects in our PhC.

The refraction of an incident beam was determined by measuring the lateral displacement of the beam by a plane parallel slab made from the PhC. The beam was collimated using a pyramidal horn. The intensity distribution after the slab was scanned using an open-ended waveguide connected to a power meter.

Experimental findings are in agreement with calculations determining the direction of the beam as that of the group velocity which is obtained from the equifrequency contours (from band structure calculations). In addition real space FDTD simulations of the beam propagation were also found to validate the experiments.

HL 58.39 Di 16:30 Poster TU F

Tuning of the defect mode in a three dimensional photonic crystal made of macroporous silicon and a liquid crystal — •Guido Mertens[1], Sven Matthias[2], Ralf Wehrspohn[1], and Heinz Kitzerow[1] — [1]Faculty of Science, University of Paderborn, Warburger Str. 100, 33098 Paderborn — [2]Max Planck Institute of Microstructure Physics, Weinberg 2, 06120 Halle

Variations of the refractive index can be utilized in order to shift the stop band in photonic crystals. We report on investigations of three-dimensional macroporous silicon structures which are filled with a liquid crystal. The sample contains a two-dimensional array of pores with periodically varying diameter. A plane with constant pore diameter embedded between two three-dimensional structures with varying pore diameter forms a micro resonator. FTIR measurements indicate a defect mode that can be shifted by changing the temperature. In transmission, a peak at the wavelength 7.184 micrometers appears in the centre of the second stopband, which can be attributed to a localised defect mode. Filling the structure with the liquid crystal 5CB (Merck) causes a red-shift of the stopband. Together with the stopband, the wavelength of the defect state is shifted by 191 nm to the larger wavelength 7.375 micrometers at 24 centigrades. An additional shift by 20 nm to a wavelength of 7.395 micrometers is caused when the liquid crystal is heated from the nematic phase (24 centigrades) to the isotropic phase (40 centigrades). These results are in qualitative agreement with theoretical calculations based on a transfer matrix model.

HL 58.40 Di 16:30 Poster TU F

Photonic Crystal Waveguides Based On The Insulator-On-Silicon-On-Insulator Material System — •Cécile Jamois[1,2], Christian Hermann[2], Alexey Milenin[1], Torsten Geppert[1,3], Kosmas Tsakmakidis[2], Ralf Wehrspohn[3], and Ortwin Hess[2] — [1]Max-Planck Institut für Mikrostrukturphysik, Weinberg 2, 06108 Halle (Saale) — [2]Advanced Technology Institute, University of Surrey, Guildford, Surrey, GU2 4LE, UK — [3]Department Physik, Nanophotonische Materialien, Universität Paderborn, Warburgerstr. 100, 33098 Paderborn

In this paper, we discuss the properties of planar photonic crystal (PPC) waveguides in the insulator-on-silicon-on-insulator (IOSOI) material system. IOSOI-based PPCs are very attractive, since they are compatible with the standard silicon technology and offer a high light confinement, due to the high vertical index contrast and to the vertical symmetry of the structure. Using FDTD simulations as well as a plane-wave method (MIT package) we study the properties of PPCs based on IOSOI and put into evidence intrinsic loss mechanisms associated with the planar nature of PPCs, which may restrict their application range. Next, we discuss the consequences of these loss mechanisms on the properties of waveguides made in IOSOI-based PPCs, and propose solutions to the possible restrictions on the device functionalities. The experimental fabrication of these waveguides is achieved by F-based ICP etching through a Cr mask, which is patterned by e-beam lithography and Cl-based RIE. Optical measurements on the fabricated structures are performed and compared to the theoretical predictions.

HL 58.41 Di 16:30 Poster TU F

Purcell effect of colloidal semiconductor nanocrystals in microcavities — •Robert M. Kraus[1], Pavlos G. Lagoudakis[1], Dmitry Talapin[2], Andrey L. Rogach[1], John M. Lupton[1], Jochen Feldmann[1], and Horst Weller[2] — [1]Lehrstuhl für Photonik und Optoelektronik, Ludwig-Maximilians-Universität München — [2]Institut für Physikalische Chemie, Universität Hamburg

The theory of cavity quantum electrodynamics focuses on the fundamental questions of light matter interaction. Photon confinement in a planar microcavity geometry changes the photon mode density. An emit-

ter embedded in the cavity has a modified spontaneous emission rate depending on its spectral and spatial overlap with the cavity mode. In our case the emitters are colloidal semiconductor nanocrystal quantum dots. Due to their polydispersity they exhibit a spectrally broad emission. A suitable resonator was built by a dielectric Bragg reflector and a silver mirror separated by a 200nm thick polymer/nanocrystal layer. By tuning the layer thickness one can choose the emission wavelength within the spectra of the nanocrystals. Q-factors of up to 300 demonstrate the excellent controllability of the fabrication process. Time resolved fluorescence decay measurements reveal an intriguing dependence of the spontaneous emission rate on temperature and Q-factor.

HL 58.42 Di 16:30 Poster TU F

DLTS-Untersuchungen an III-V-Halbleitern für Solarzellen — •Severin Müller[1,2], Frank Dimroth[2], Sascha van Riesen[2] und Andreas W. Bett[2] — [1]Freiburger Materialforschungszentrum, Universität Freiburg, Stefan-Meier-Strasse 21, 79104 Freiburg — [2]Fraunhofer ISE, Heidenhofstrasse 2, 79110 Freiburg

Voraussetzung für einen hohen Wirkungsgrad einer Solarzelle ist, dass die durch Lichteinstrahlung im Halbleiter erzeugten Minoritätsladungsträger eine hohe Lebensdauer erzielen. Rekombinieren diese bevor sie den p/n-Übergang erreicht haben, tragen sie nicht zum Strom der Zelle bei. Dabei wirken tief in der Bandlücke des Halbleiters liegende Defekte als besonders effektive Rekombinationszentren. Diese gilt es daher zu verringern. Am Fraunhofer ISE werden GaAs-basierende Schichtstrukturen für Solarzellen mittels MOVPE (metallorganische Gasphasenepitaxie) auf GaAs- und Ge-Substraten abgeschieden. Insbesondere das Material GaInNAs ist als Mittelzelle einer Kaskadensolarzelle auf Germanium-Substraten von besonderen Interesse. Bisher wurden mit diesem Material allerdings nur geringe Solarzellenwirkungsgrade erzielt, was auf eine geringe Diffusionslänge bzw. Lebensdauer zurückzuführen ist. Mittels DLTS-Messungen (Deep-level transient spectroscopy) können tiefe Rekombinationszentren identifiziert werden. Somit besteht die Möglichkeit, unterschiedliche Wachstumsbedingungen zu bewerten und sie zu optimieren. Ergebnisse dieser Arbeiten werden vorgestellt.

HL 58.43 Di 16:30 Poster TU F

Optimierung von Tunneldioden in III-V Mehrfach-Solarzellen — •Wolfgang Guter[1], Frank Dimroth[1], Matthias Meusel[1,2] und Andreas Bett[1] — [1]Fraunhofer ISE, Heidenhofstrasse 2, 79110 Freiburg — [2]RWE Space Solar Power GmbH, Theresienstr. 2, 74072 Heilbronn

Solarzellen mit mehreren *p-n* Übergängen eröffnen neue Möglichkeiten für die Steigerung des Wirkungsgrades bei Solarzellen, da jede Teilzelle einem speziellen Band des Sonnenspektrums angepasst werden kann. Um monolithisch aufeinander gewachsene Zellen elektrisch miteinander zu verbinden, wünscht man sich optisch transparente, hoch leitfähige Schichten, welche den Wirkungsgrad nicht schmälern; sogenannte *Intercell Ohmic Contacts* (*IOCs*). Eine wichtige Realisierung eines *IOC* ist die Interband-Tunneldiode (*TD*) nach Esaki. Speziell in Konzentratorsystemen, welche Solarzellen aus *III-V* Halbleitern auch auf der Erde wirtschaftlich machen, werden in den Zellen hohe Stromdichten von etwa $15\,A/cm^2$ erreicht. Diese Arbeit befasst sich mit der Optimierung von Tunneldioden in *GaInP/Ga(In)As/Ge*-Tripelzellen bezüglich hoher Tunnelstromdichten. Numerische Simulationen der Bandstruktur und Ausheil-Experimente an *MOVPE* (metall-organische Gasphasenepitaxie) gewachsenen Tunneldioden zeigen den Einfluss der die *TD* umgebenden Barriereschichten auf Bandverbiegung, Dotierstoffdiffusion und Tunnelverhalten.

HL 58.44 Di 16:30 Poster TU F

Local characterisation of multicrystalline silicon solar cells with the front metal grid on grain boundaries — •Viktor Schlosser[1], Rita Ebner[2], and Johann Summhammer[2] — [1]Institut für Materialphysik, Universität Wien — [2]Atominstitut der Österreichischen Universitäten, Wien

Light beam induced current mapping (LBIC) is used to investigate large area solar cells. Multicrystalline silicon solar cells were equipped with a front metal grid which was applied onto the grain boundaries. The LBIC experimental set up works with two fibre coupled luminescence diodes at centre wavelengths of 650 nm and 870 nm respectively. The two LEDs were driven by the same current and individually intensity modulated. By the use of two Lock In amplifiers the total light generated current from the device was split into its two components. A feed back loop for the LED current was used to maintain a constant LBIC signal of the red LED. The current caused by the infrared LED was recorded as a function of the light spot position on the solar cell. By this method the contribution of many of the surface's electrical and optical inhomogenities to the LBIC were eliminated. The scanned signal merely is altered by the local bulk properties of the carriers. The results made on cells under different operating conditions will be presented and discussed.

HL 58.45 Di 16:30 Poster TU F

Radiative recombination coefficient in crystalline silicon above room temperature — •Sebastian Meier, Rudolf Brüggemann, Saioa Tardon, and Gottfried Heinrich Bauer — Institute of Physics, Carl von Ossietzky University Oldenburg, Germany

Typical operating temperatures of solar cells are in the temperature range above room temperature. In these devices radiative recombination is one of the recombination channels that determine the excess carrier density and luminescence efficicency. We concentrate on radiative recombination in crystalline silicon for which some discrepancy exists in the literature on the values for the rate coefficient B(T) of radiative recombination. Trupke et al. [1] reviewed this discrepancy and determined B(T) in the temperature range between 77 K and 300 K from relative photoluminescence measurements that were calibrated with literature data of the absorption coefficient. In order to extend the temperature range reported in the literature, we determined B(T) for crystalline silicon between room temperature and 393 K from absolute photoluminescence measurements on crystalline silicon wafers passivated with thin amorphous silicon films. For temperatures below room temperature good agreement is found between data from [1] and the present values. Above room temperature B(T) is almost independent of temperature with a value around 3.9×10^{-15} cm^3 s^{-1}.

[1] T. Trupke et al., J. appl. Phys. 94 4930 (2003).

HL 58.46 Di 16:30 Poster TU F

Transmissionselektronenmikroskopie und hochauflösende Röntgendiffraktometrie an GaInP/GaInAs/Ge Heterostrukturen für Tripel Solarzellen — •Jan Schöne[1,2], Erdmann Spiecker[1], Wolfgang Jäger[1], Frank Dimroth[2] und Andreas W. Bett[2] — [1]Technische Fakultät der CAU Kiel, Kaiserstrasse 2, 24143 Kiel — [2]Fraunhofer ISE, Heidenhofstrasse 2, 79110 Freiburg

Eine maximale Effizienz von sogenannten Stapelsolarzellen aus III-V-Halbleitern mit 3 pn-Übergängen wird mit einer metamorphen Struktur aus GaInP/GaInAs/Ge erzielt. Hierzu ist es notwendig, gitterfehlgepasste Materialien mit einem Mismatch bis zu 2% auf das Ge-Substrat aufzuwachsen. Bei gitterfehlgepasstem Wachstum entstehen Spannungen, die ab einer gewissen Schichtdicke durch den Einbau von Fehlpassungsversetzungen relaxieren. Neben diesen Versetzungen entstehen auch sogenannte Fadenversetzungen (threading dislocations). Diese Versetzungen stellen starke Rekombinationszentren für Minoritätsladungsträger dar und wirken sich daher negativ auf die Diffusionslängen der Ladungsträger aus. Durch das Aufwachsen von geeigneten Pufferschichten zwischen den gitterfehlgepassten Schichten wird die Gitterkonstante stufenweise oder kontinuierlich angepasst. Die Wachstumsbedingungen während des Pufferschichtwachstums haben einen wesentlichen Einfluss auf die Qualität der anschließend gitterangepasst abgeschiedenen Solarzellenstruktur. Ergebnisse von Analysen der Versetzungsnetzwerke mittels Transmissionselektronenmikroskopie und der Restspannungen mittels hochauflösender Röntgendiffraktometrie werden vorgestellt.

HL 58.47 Di 16:30 Poster TU F

Local partial density of states in CuInS2 upper valence band determined by x-ray emission spectroscopy-evidence for In 5p contribution — •L. Zhang[1], I. Konovalov[2], D. Wett[2], M. Nagel[1], D. Schulze[2], R. Szargan[2], and T. Chassé[1] — [1]Institut für Physikalische und Theoretische Chemie, Universität Tübingen, Auf der Morgenstelle 8, 72076 Tübingen, Germany — [2]Wilhelm-Ostwald-Institut für Physikalische und Theoretische Chemie, Universität Leipzig, Linnéstrasse 2, 04103 Leipzig, Germany

The Cu L2,3, In M4,5 and S L1 soft x-ray emission spectra of single crystalline CuInS2 were measured using synchrotron radiation as excitation source at ROSA endstation of U41-PGM beamline in BESSY. These spectra reflect the local partial density of states (LPDOS) of Cu 3d, In 5p and S 3p valence states, and they correspond to the features in the total density of states of the upper valence band represented in the valence band photoelectron spectrum. A density functional calculation of the LPDOS confirms two components occurring in both S 3p and In 5p

partial density of states. From the similarity of the positions and the intensity ratios of these two components, an admixture of In 5p states to the S 3p states in the upper valence band was suggested.

HL 58.48 Di 16:30 Poster TU F

Nichtinvasive Charakterisierung fabrikationsbedingter Defekte in Solarzellen — •D. Ragusch[1], J. Beyer[2], E. Cikos[3], D. Drung[2], S. Rolle[1] und Th. Schurig[2] — [1]Technische Fachhochschule Wildau, Bahnhofstr. 15745 Wildau — [2]Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin — [3]University Skopje, Macedonia

Das in [1] vorgestellte Messsystem zur berührungslosen Detektion von Fotostromverteilungen und Defekten in Solarzellen, basierend auf der SQUID-Photoscanning Methode [2], wurde von uns im Hinblick auf eine fabrikationsbegleitende Kontrolle weiterentwickelt.

Die Frontseite der zu untersuchenden Solarzelle wird mittels einer geeigneten und amplitudenmodulierten Lichtquelle abgetastet. Die von den Fotoströmen verursachten magnetischen Felder werden von einer Induktionsspule detektiert. Die Ausgangsspannung der Spule wird frequenzselektiv und phasenempfindlich gemessen. Aus diesen Messdaten können Rückschlüsse auf Defekte der Solarzelle gezogen werden.

Um die Eignung des Messsystems für den industriellen Einsatz zu verbessern, wurde die optische Anregung und die Sensorik auf den schnellen Nachweis typischer Defekte, wie Kontaktierungsfehler und Brüche zugeschnitten. Der Messaufbau und die gewonnen Ergebnisse werden vorgestellt.

[1] D.Ragusch et al., Poster, DPG Frühjahrstagung 2002

[2] J.Beyer et al., IEEE Trans.Appl.Supercond., Vol.11, pp. 1162-1167, March 2001

HL 58.49 Di 16:30 Poster TU F

InP-based III-V solar cells — •H.-J. Schimper, Z. Kollonitsch, K. Möller, U. Seidel, U. Bloeck, K. Schwarzburg, F. Willig, and T. Hannappel — Hahn-Meitner-Institute, Glienicker Str. 100, 14109 Berlin, Germany

New materials were introduced for multi junction solar cells based on the lattice constant of InP, in particular GaAsSb (E_{gap} = 0.75eV) and InAlGaAs (E_{gap} = 1.15eV). These materials were grown via metalorganic vapor phase epitaxy (MOVPE) using the alternative precursors TBP and TESb.

The new absorber materials were compared with the more established materials InGaAs (E_{gap} = 0.75eV) and InGaAsP (E_{gap} = 1.15eV). The values of short-circuit current and open-circuit voltage achieved with the new GaAsSb pn-solar cells were in the same range as the best InGaAs pn-cells. The substitution of Ga by Al in InAlGaAs leads to III-V-compounds lattice matched to InP(100) with band gaps between 0.75eV < E_{gap} < 1.5eV. A pn-junction solar cell was prepared from $In_{0.53}Al_{0.26}Ga_{0.21}As$ with E_{gap} = 1.15eV and compared to the InGaAsP (E_{gap} = 1.15eV) cell. It will be shown that the latter cell with 26% Al reached an internal quantum efficiency close to that of the InGaAsP cell.

HL 58.50 Di 16:30 Poster TU F

Growth and Characterization of 3C-SiC thin films on Si substrates — •Rakesh Sohal, Karsten Henkel, Klaus Müller, and Dieter Schmeisser — Angewandte Physik Sensorik, BTU Cottbus

This work reports on the growth and characterization of cubic silicon carbide thin films. A cold wall low pressure chemical vapour deposition (LPCVD) system has been used to grow the cubic silicon carbide. The two step method, carbonization and subsequent growth, has been used to grow good quality 3C-SiC thin films. The composition and structure of deposited thin films have been analysed by Fourier Transform Infrared Spectroscopy (FTIR), XPS and X-Ray Diffractometry (XRD). The structural quality of the films has been optimized as a function of substrate temperature during carbonization and growth. X-rays diffraction measurements shows that the grown layers are highly oriented crystalline cubic silicon carbide.

HL 58.51 Di 16:30 Poster TU F

Oxide-free transfer of silicon layers in UHV — •Alin Mihai Fecioru, Stephan Senz, and Ulrich Michael Gösele — Max-Planck-Institut für Mikrostrukturphysik, 06120 Halle

We combine ultrahigh vacuum (UHV) wafer bonding with hydrogen implantation in order to transfer single crystal silicon layers on (100) and (111) silicon substrates. The smart-cut procedure used for SOI fabrication requires SiO_2 to SiO_2 bonding followed by a high temperature annealing step. Unlike the smart-cut approach, we were able to achieve direct transfer without the involvement of any oxide layers by means of UHV bonding. Hydrogen desorption was done in-situ, by 248 nm excimer laser pulses with energy densities around 300 mJ/cm^2. TEM investigations were performed in order to confirm that our interfaces are smooth and oxide-free. The electrical properties were characterized by temperature-dependent current-voltage (I-V) measurements correlated with deep level transient spectroscopy (DLTS) measurements, showing the presence of interface and bulk electrically active defects which alter the device performance to some extent. A high temperature annealing step following the splitting procedure improves both the interface properties and the smoothness of the transferred layer.

HL 58.52 Di 16:30 Poster TU F

Preparation and Characterization of FeS films — •Ganhua Fu[1], Angelika Polity[1], Wilhelm Kriegseis[1], Dietmar Hasselkamp[1], Bruno K. Meyer[1], Boris Mogwitz[2], and Jürgen Janek[2] — [1]I.Physikalisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 16, D-35392, Giessen — [2]Physikalisch-Chemisches Institut, Justus-Liebig-Universität Giessen, Heinrich-Buff-Ring 58, D-35392, Giessen

Bulk FeS exhibits a metal-semiconductor transition at 420 K. Below 420 K, it is a semiconductor with troilite structure, while it transforms into a poor metal with NiAs-type structure above 420 K, accompanied by a change of two orders of magnitude in electrical conductivity. In this work, FeS films on float glass were prepared by RF reactive sputtering. The structure and morphology of the layers were studied by X-ray diffraction (XRD) and scanning electron microscopy (SEM), respectively. Rutherford back-scattering spectroscopy (RBS) and secondary ion mass spectroscopy (SIMS) were used to determine the compositon of the films. In addition, the effects of the growth parameters, such as power and substrate temperature, on the structure of FeS films were investigated. It's found that the films show substrate temperature dependent preferred orientation, which varies from (112) plane to (110) plane with the decline of substrate temperature from 773 K down to 473 K.

HL 58.53 Di 16:30 Poster TU F

Electrical properties of semiconducting PZT films on gold surfaces — •F. Müller[1], J. Yukecheva[2], A.-D. Müller[1], and M. Hietschold[1] — [1]Chemnitz University of Technology, Institute of Physics, Solid Surfaces Analysis Group, 09107 Chemnitz — [2]630092 Novosibirsk State Technical University (NSTU), Karl Marx avenue 20, Novosibirsk, Russia

PZT (lead zirconium titanat) is mainly known as ferroelectric material with a high dielectric permittivity and bistable polarization states, which leads to its application in actuators, nonvolatile memories and pyroelectric infrared sensors. Besides this, PZT is a semiconducting material with a band gap of 3.5 eV. The electrical investigation of the semiconducting properties, however, is difficult, because the typical dependencies are hidden behind the larger ferroelectric effects. In this work, we have shown that it is possible to prepare PZT thin films, which are semiconductive and not ferroelectric. The electrical properties of these films have been studied with various methods. From C(V)-curves, it was derived that the prepared PZT films are p-doped. The stability of the material was investigated with time dependent current spectroscopy.

HL 58.54 Di 16:30 Poster TU F

Focused ion beam implantation of magnetic ions — •Alexander Melnikov, Safak Gök, Sinan Ünlübayir, Rolf Wernhardt, Dirk Reuter, and Andreas Wieck — Ruhr-Universität Bochum, Lehrstuhl fr Angewandte Festkrperphysik, Universittsstrasse 150, D-44780 Bochum

For focused ion beam (FIB) implantation of magnetic ions, liquid metal ion sources (LMIS) with long operation times were developed on the basis of appropriate binary and ternary alloys. Alloys such as AuCrGe, AuDyGe, AuDySi, AuErSi, AuFeGe, AuGdSi, AuGeMn, AuGeNi, AuHoSi, AuSiTb, CoDy, DyNi, and HoNi were used to obtain Cr, Mn, Fe, Co, Ni, Gd, Tb, Dy, Ho and Er ions. The mass spectra were analyzed for the developed sources. As an example, FIB implantation of Mn was investigated. Lines with width about 200 nm were implanted with doses $2\times10^{11}-2\times10^{14}cm^{-2}$ in a $GaAs/Al_xGa_{1-x}As$ heterostructures (HEMTs) with two-dimensional electron and two-dimensional hole systems, respectively. Subsequent rapid thermal annealing was performed with typical temperatures of $750°C$ during 30 s. Transport properties through such lines have been investigated as function of magnetic fields up to 5 T in the temperature range from 4.2 to 300 K.

HL 58.55 Di 16:30 Poster TU F

Fabrication of closed single-walled semiconductor microtubes — •T. Kipp, S. Mendach, H. Welsch, Ch. Heyn, D. Heitmann, and W. Hansen — Institut für Angewandte Physik und Zentrum für Mikrostrukturforschung, Universität Hamburg

The epitaxial lift-off of pseudomorphically strained semiconductor bilayers results in the formation of cylindrical microtubes [1]. These three-dimensional objects have extremely smooth surfaces and thus, they are promising candidates for the realization of novel high-Q optical resonators for light guided along the cylinder perimeter.

Applying the conventional preparation process, microtubes have the shape of rolled-in carpets. Here, we report on a novel technique to prepare closed single-walled microtubes. We define two starting edges on two opposite sides of a thickness modulated strained InGaAs/GaAs mesa and provide both starting edges with unstrained tines. During the final selective etching step the mesa bends up from both starting edges and the straight tines of the opposite sides interlock centrically resulting in a closed single-walled semiconductor tube. Due to its steadiness and the fact that all parameters of the forming tubes can be tuned precisely this interlocking mechanism is a key point for the realization of closed pathways along the perimeter of semiconductor tubes for photons, but possibly also for electrons.

[1] V.Ya. Prinz *et al.*, Physica E **6**, 828 (2000).

HL 58.56 Di 16:30 Poster TU F

Strukturelle und optische Eigenschaften von β-FeSi$_2$-Filmen auf Si(100) und MgO(100) — •Kirill Trounov[1], Marco Walterfang[1], Werner Keune[1] und Vasyl Kravets[2] — [1]Angewandte Physik, Universität Duisburg-Essen, 47048 Duisburg — [2]Experimentalphysik, Universität Duisburg-Essen, 47048 Duisburg

Seit einigen Jahren sind Fe-Disilizide von Interesse für Anwendungen in der Silizium-Technologie. Viele Untersuchungen haben sich aufgrund seines direkten Bandübergangs von 0.85 eV (1.46 μm), der sich nahe am Absorptionsminimum von Glasfasern befindet, auf das halbleitende β-FeSi$_2$ konzentriert, welches aufgrund seiner besonderen Eigenschaften als potentieller Kandidat für den Bau von optischen Detektoren bis in den infraroten Wellenlängenbereich gilt. Der große Brechungsindex von β-FeSi$_2$ (5.6) gegenüber dem von Si (3.5) macht die β-FeSi$_2$/Si Doppel-Heterostruktur interessant für LEDs.

β-FeSi$_2$-Filme wurden auf Si(100)- oder MgO(100)-Substraten molekularstrahlepitaktisch hergestellt und mößbauerspektroskopisch (^{57}Fe-CEMS) sowie mittels Röntgenbeugung untersucht. Dabei wiesen β-FeSi$_2$-Filme auf Si(100) eine geringfügig bessere strukturelle Qualität auf als auf MgO(100). Mittels IR-Transmissionsspektroskopie wurde für den Bandabstand der β-FeSi$_2$-Phase ein Wert von 0.85 eV (auf Si(100)) bzw. 0.90 eV (auf Mg(100)) ermittelt. Für dickere β-FeSi$_2$-Filme (> 1500 Å) wurden in den IR-Spektren für Energien unterhalb des Bandabstandes Oszillationen in den Transmissionskurven beobachtet.

Gefördert durch die Deutsche Forschungsgemeinschaft (Ke 273/17-1).

HL 58.57 Di 16:30 Poster TU F

Electrical transport investigation of platinum salt nanowires — •J. M. Becker[1], L. Ren[2], M. Wark[2], and R. Haug[1] — [1]Institute of Solid State Physics, Nanostructure Group, Hannover — [2]Institute of Physical Chemistry, Hanover

The investigation of electrical transport properties and the growth mechanism of platinum salt $[Pt(NH_3)_4][HCO_3]_2$ nanowires will be presented. These nanowires have a thickness of $50-100$ nm and a length of 500 $nm-2.5$ μm. Electrical contacts (Cr/Au) are fabricated by using e-beam lithography and vacuum evaporation. The current-voltage characteristic shows a ohmic behavior at room temperature. This can be related to a metallic structure of these platinum salt nanowires, which means that delocalized states exist at room temperature in growth direction of the wires. The unit cell (space group P 4/m b m) of the platinum salt was determined by using X-ray diffraction.

HL 58.58 Di 16:30 Poster TU F

Infrared behaviour and plasmon properties of single metal nanowires — •Torsten Kolb[1], Maria Eugenia Toimil Molares[2], Thomas Cornelius[2], Florian Kost[1], Robert Lovrincic[1], Reinhard Neumann[2], Annemarie Pucci[1], and Gerhard Fahsold[1] — [1]Kirchhoff-Institut für Physik, Universität Heidelberg, Im Neuenheimer Feld 227, D-69120 Heidelberg — [2]Gesellschaft für Schwerionenforschung (GSI), Planckstraße 1, D-64291 Darmstadt

We investigate the IR-optical properties of single metal (Cu) nanowires. The wires were prepared by template directed growth of Cu in etched ion tracks in polycarbonate membranes. We dispersed these wires on IR-transparent substrates by dissolving the membranes. For IR spectroscopy we used the synchrotron radiation source ANKA at the Forschungszentrum Karlsruhe. Investigations of broadband IR-optical properties in the range from 600 cm^{-1} to 6000 cm^{-1} of single nanowires were done by performing IR-microscopy in transmission with an IR-beam of about 8.3 micrometer width. For few-micrometer long Cu wires we observed antenna-like plasmon resonances dependent on size and shape of the wires. By varying polarisation of the incident beam we proved that an electric field component parallel to the wire is necessary for an excitation of these resonances.

Project ist supported by DFG (SPP 1165)

HL 58.59 Di 16:30 Poster TU F

Investigation of lateral Stark effect in InAs-quantum dots — •Victorina Stavarache[1], Dirk Reuter[1], Andreas D. Wieck[1], Matthias Schwab[2], Ruth Oulton[2], and Manfred Bayer[2] — [1]Angewandte Festkörperphysik, Ruhr- Universität Bochum, Universitätsstr.150, 44780 Bochum — [2]Experimentelle Physik II, Universität Dortmund, Otto-Hahn Strasse 4, 44221 Dortmund

We have investigated the effect of an in-plane (lateral) electric field on self-assembled InAs-quantum dots (QDs) by photoluminescence (PL) and time-resolved spectroscopy measurements. For this, we have fabricated in-plane p-i-n diode structures by implanting Si^{2+} ions (n-type region) and Be^{+} ions (p-type region). The width of the intrinsic region was $2-3\mu m$ which results in an electric field higher than $\sim 10^5 Vm^{-1}$.

Time resolved PL spectroscopy has been performed on a sample with a relatively high QD density ($10^{10} cm^{-2}$). The PL intensity decreases with increasing reverse bias as the radiative lifetime increases with increasing electrical field. To observe the change in the emission wavelength as function of the applied electric field (lateral Stark-effect), we have also fabricated devices with low QD density ($10^8-10^9 cm^{-2}$). This may also lead to perform single dots spectroscopy. The results will be discussed.

HL 58.60 Di 16:30 Poster TU F

Nanolithography on AlGaAs-GaAs heterostructures by Atomic Force Microscope — •Kevin Rachor, Steffen Groth, Christian Heyn, Detlef Heitmann, and Can-Ming Hu — Institut für Angewandte Physik , Universität Hamburg, Jungiusstr. 11, 20355 Hamburg

We have explored two different techniques to pattern AlGaAs-GaAs heterostructures with a two dimensional electron gas (2DEG) confined 35 nm below the surface by AFM: (i) The "dynamical ploughing", where the AFM tip scribes a pattern into a very thin photoresist on top of the sample and the pattern is transferred by wet chemical etching into the AlGaAs. (ii) We have also performed local anodic oxidation with a bias voltage between tip and sample. Both methods yield a depletion of the 2DEG underneath, respectively, the etched or the oxidized lines. We fabricate ballistic quantum point contacts (QPC's) with geometrical width between 50 and 150 nm. Conductance measurements at 4.2 K are performed, which can demonstrate the formation of 1D subbands in the QPC's by varying the electron density using a top gate.

HL 58.61 Di 16:30 Poster TU F

Ionenimplantation von N+ und Al+ in ZnO Nanodrähte — •Sven Müller, Daniel Stichtenoth, Daniel Schwen, Christine Borchers und Carsten Ronning — II. Physikalisches Institut, Universität Göttingen, Friedrich-Hund-Platz 1, 37077 Göttingen, Germany

ZnO Nanodrähte, die mit Hilfe eines einfachen CVD-Prozesses hergestellt wurden, wurden mittels Ionenimplantation dotiert. Dabei wurden die Elemente N+ (als Akzeptor) oder Al+ (als Donator) mit einer Energie von 25 keV eingesetzt. Die strukturellen Veränderungen innerhalb der Nanodrähte nach der Ionenimplantation wurden mit hoch-auflösender TEM untersucht. Sowohl Punktdefekte als auch ausgedehnte Defekte wurden lokalisiert, die nach Anlassen auf 800°C nahezu komplett ausgeheilt werden konnten. Die optische Aktivierung der implantierten Atome wird auf diesem Poster anhand von parallel durchgeführten PL/CL-Messungen diskutiert.

HL 58.62 Di 16:30 Poster TU F

Growth Direction of Epitaxially Grown Silicon Nanowires — •Volker Schmidt, Stephan Senz, and Ulrich Gösele — Max-Planck-Institut für Mikrostrukturphysik, Halle, Germany

We found that silicon nanowires grown epitaxially on Si (100) via the vapor-liquid-solid growth mechanism change their growth direction from <111> to <110> at a crossover diameter of approximately 20 nm. A model is proposed for the explanation of this phenomenon. We suggest that the interplay of the liquid-solid interface energy with the silicon surface energy is responsible for the change of the growth direction. For large diameters the direction with the lowest interface energy is dominant, while for small diameters the surface energy of the silicon nanowire determines the preferential growth direction. In addition, results concerning the growth of silicon nanowires with other catalyst materials than gold will be presented.

HL 58.63 Di 16:30 Poster TU F

GaN Nanowhiskers: Epitaxial Growth — •Thomas Richter[1], Ralph Meijers[1], Raffaella Calarco[1], Toma Stoica[1,2], and Hans Lüth[1] — [1]Institute of Thin Films and Interfaces (ISG1) and CNI - Centre of Nanoelectronic Systems for Information Technology, Research Center Jülich, 52425 Jülich, Germany — [2]INCDFM, Magurele, POB Mg7, Bucharest, Romania

The study of GaN-based nanostructures, whose electrical and optical characterization is at its infancy, can help to elucidate the link among structural, optical and electrical features, allowing for a deeper understanding of the physical mechanisms controlling the material behavior in these nanostructures.

In our experiments, GaN nanocolumns are reproducibly grown by plasma-assisted molecular beam epitaxy on Si(111). The nanocolumns density and diameter (10-150 nm) are controlled by means of the III/V ratio. The substrate temperature during growth is chosen between 770^0C and 800^0C. For higher growth temperatures higher Ga fluxes are needed to reach the same growth rate, due to the Ga desorption process. In our experiments we did not change the nominal III/V ratio but the growth temperature, which results in different stoichiometry and deposition rates. The signature of a tapering process can be observed.

The GaN-nanocolumns have been studied and characterized by means of XRD, TEM, Raman spectroscopy, photo- and cathodo- luminescence. A correlation between growth parameter and defects has been found.

HL 58.64 Di 16:30 Poster TU F

Size Reduction of Silicon / Silicon Dioxide Nanowires — •Florian M. Kolb, Herbert Hofmeister, Margit Zacharias, and Ulrich Gösele — Max-Planck-Institut für Mikrostrukturphysik, 06120 Halle (Saale)

Nanowires consisting of a crystalline silicon core and an amorphous silicon dioxide shell can be obtained by combining thermal evaporation of silicon monoxide with the vapor-liquid-solid (VLS) process. The resulting nanowires show silicon core diameters between 15 nm and 75 nm and lengths up to several micrometers. In order to reach the quantum size regime even smaller diameters are necessary. It is possible to remove the oxide shell and further reduce the silicon core by a thermal dry oxidation step. We will present results on how the thickness of the oxide shell depends on the duration and temperature of the oxidation process as well as the core diameter. In addition, we observe the formation of silicon nanocrystals embedded in silicon dioxide nanowires after the oxidation process. A model for the Rayleigh instability-based formation of these nanocrystals will be presented and the results will be compared to morphological instabilities that can be observed during the growth of the nanowires.

HL 58.65 Di 16:30 Poster TU F

Gas-source C Predeposition and Ge Dot Formation on Si(001): Effects of Anneal Temperature for Hydrogen Desorption — •Takeshi Murata, Yuzuru Narita, and Maki Suemitsu — CIR, Tohoku University, Aoba, Aramaki, Aoba-ku, Sendai 980-8578 Japan

Self-assembled Ge dots on Si(001) surface attract much attention for their possible applications in electronics and optoelectronics. Knowing that submonolayer C predeposition is effective in minimizing and densifying the Ge dots and that gas-source processings are much favored in actual device fabrications, we have conducted Ge dot deposition with C predeposition using monomethylsilane (MMS) and germane as the C and Ge source, respectively. While the Ge growth temperature was fixed at 500C, the anneal temperature for hydrogen desorption after MMS adsorption was varied for 500, 700 and 900C. The dots were a mixture of mounds and domes, with the former being most densified after annealed at 500C. Infrared absorption spectroscopy in multiple-internal-reflection geometry as well as reflection-high-energy-electron-diffraction observation have shown that C atoms from MMS molecules diffuse into the subsurface below 500C and nucleate as SiC at around 900C. These results indicate importance of uniform distribution of C atoms in the subsurface in obtaining densified Ge dots on Si(001).

HL 58.66 Di 16:30 Poster TU F

Formation of Ge dots on Si(111)-7x7 surface and effects of C predeposition using monomethylsilane — •Yuzuru Narita, Masashi Sakai, Takeshi Murata, and Maki Suemitsu — Center for Interdisciplinary Research, Tohoku University, Aramaki aza-Aoba, Aoba-ku, Sendai 980-8578, Japan

Germanium (Ge) dots are promising as a new material for Si-based opto-electronic integrated circuits (OEICs). To reduce the size of the Ge dots on Si, carbon (C) predeposition prior to Ge deposition has recently proved itself. Most of previous studies, however, have used solid-source MBE for both C and Ge depositions, which may be problematic when applied in practical use. Also, few studies have ever been made on Si(111)-7x7 surface, which could nevertheless affect the adsorption and diffusion of Ge atoms and therefore be a possible template for dot alignment. In this study, we have formed Ge dots on Si(111)-7x7 surface by using germane and monomethylsilane (MMS) as Ge and C sources, respectively. By exposing the Si(111)-7x7 surface at RT to 80-L MMS flux and by desorbing the surface hydrogen with an anneal at 900C for 1 min, the subsequent dot density increased about two orders of magnitude and the dot size decreased by a factor of six as compared to the case without the C predeposition. From the Raman-scattering microscopy, the Ge dots formed with C predeposition using MMS are found to be nearly dislocation-free.

HL 58.67 Di 16:30 Poster TU F

Low-ohmic contacts to two-dimensional electron gases in GaAs/AlGaAs heterostructures — •S. Raiser[1], U. Graumann[2], M. Fleischer[1], J. Schmid[2], S. Jauerneck[1], J. Weis[2], and D.A. Wharam[1] — [1]Institut für Angewandte Physik, Universität Tübingen, Auf der Morgenstelle 10, D-72076 Tübingen — [2]Max-Planck-Institut für Festkörperforschung, Heisenbergstr. 1, D-70569 Stuttgart

The reliable contacting of two-dimensional electron gases is an essential prerequisite for the low-temperature characterisation of heterostructure-devices. In the past it has often been difficult to produce high quality ohmic contacts. For the low-resistance ohmic contacts presented here we use standard AuGe/Ni/Au-metallisation with significantly different parameters than conventional recipes. We are now able to produce low-ohmic contacts with perfect reliability. The quality of the contacts has been investigated with respect to processing parameters such as the thickness of the metallisation layers, alloying temperature, and alloying time. The dependence of the contact geometry has been examined, whereby a dependence upon the orientation with respect to the crystallographic direction has been found. Initial studies of the contact structure have been performed using electron microscopy.

HL 58.68 Di 16:30 Poster TU F

Growth of highly homogeneous InGaAs islands on GaAs using a stressor layer technique — •H. J. Krenner, D. Heiss, D. Schuh, M. Bichler, G. Abstreiter, and J. J. Finley — Walter Schottky Institut and Physik Department,TU Muenchen, Am Coulombwall 3, D-85748 Garching, Germany

We present a detailed study of single and multi-layer structures containing self-assembled InGaAs islands on GaAs. Growth parameters were optimized in order to observe a transition to low QD surface densities for optical single QD spectroscopy. As a stressor layer we introduced a highly strained 3nm InGaAs quantum well 10nm below the islands. We observe a pronounced blue-shift of the QD emission and furthermore in improved homogeneity resulting in a narrower linewidth (FWHM < 20meV). We attribute these effects to altered growth conditions on the strained surface. First studies of multi-layer structures indicate that this novel stressor layer technique enables preparation of a well defined strained surface for the first QD layer. The buffer thickness between the following QD layers can be set to achieve similar strain conditions for each layer. This is the opposite approach compared to proposed strain-reduction layers since it takes advantage of island growth on strained substrates to achieve homogeneous ensembles. Variation of In-content and buffer layer thicknesses gives rise to a versatile technique which is particularly attractive to grow active media for laser applications.

HL 58.69 Di 16:30 Poster TU F

$CoSi_2$ nanowires synthesized by FIB — •L. Bischoff, B. Schmidt, and C. Akhmadaliev — Research Center Rossendorf, Dresden

Nanowires and chains of nanoparticles are of emerging interest in nanoelectronics, nano-optics and plasmonics as well as for their monolithic integration into microelectronic devices. $CoSi_2$ is a promising material due to its CMOS-compatibility microelectronics technology. Two fabrication methods of $CoSi_2$ -nanowires by using ion beam synthesis (IBS) with Focused Ion Beams (FIB) technique are presented. In a first approach, an oxide layer, structured by sputtering with a focused Ga^+ ion beam, have been used as an implantation mask for large area homogeneous Co^+ implantation. Alternatively, a mass separated FIB of cobalt ions, emitted from a $Co_{36}Nd_{64}$ alloy liquid metal ion source, is applied for a direct writing IBS process. Implantation into Si with doubly charged Co^+ ions emitted from the Co source allows ion energies up to 60 keV, which result in $CoSi_2$ nanostructures buried in silicon. The processes of damaging and annealing of the substrate due to extremely high current density of the FIB were investigated. The fabrication of nanowires down to 30 nm diameter has been demonstrated.

HL 58.70 Di 16:30 Poster TU F

Elektrische Charakterisierung einzelner Silizium und Silizium/Germanium Heterostruktur- Nanodrähte — •Frank Fleischer, Jan Bauer, Luise Schubert, Peter Werner und Margit Zacharias — Max-Planck-Institut für Mikrostrukturphysik, Weinberg 2, 06120 Halle

Für die angestrebte technologische Verwendung von Nanomaterialien ist die elektrische Charakterisierung einzelner Nanoobjekte unumgänglich. Die Kontaktierung einzelner Nanodrähte wurde mit Hilfe eines Nanomanipulators im SEM mittels Pt/Ir-Spitzen von rund 60nm realisiert. Es wurden die elektrischen Eigenschaften einzelner freistehender als auch liegend angeordneter Si und Si/Ge Nanodrähte gemessen.

Es wurde eine Methodenkombination aus der Rasterelektronenmikroskopie und EBIC (electron beam induced current) angewandt, um Grenzregionen unterschiedlicher Bandstrukturen direkt sichtbar zu machen, z. B. zwischen semi-isolierenden bzw. dotierten Nanodrähten und dem Substrat. Die Messungen werden am Beispiel von Drähten mit einem Durchmesser kleiner 200nm demonstriert.

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Atomistic Computer Simulations on Ion Beam Synthesis and Decay of $CoSi_2$ Nanowires — •Lars Röntzsch and Karl-Heinz Heinig — Research Center Rossendorf, Institute of Ion Beam Physics and Materials Research, Dresden

Nanowires (NWs) and chains of nanocrystals (NCs) embedded in dielectrics or semiconductors are intensively studied regarding their potential application in nanoelectronics. $CoSi_2$ nanostructures in Si are particularly interesting because of the full compatibility of $CoSi_2$ with CMOS technology.

Here, we present predictive atomistic computer simulations on the ion beam synthesis of $CoSi_2$ NWs in Si and their decay into chains of $CoSi_2$ NCs which are applicable as plasmon waveguides. In order to simulate the Co implantation, the binary collision codes TRIDYN and TRIM were adapted to the particular experimental situation of a finely-focused Co ion beam of 50nm in width. The resulting 3D implantation profile serves as input for a kinetic lattice Monte-Carlo code by means of which nucleation and growth of $CoSi_2$ precipitates and their coalescence into a $CoSi_2$ NW are described. From an evolutionary viewpoint, NW synthesis and decay proceed on different time scales. The NW decay into a NC chain (Rayleigh instability) is driven by the minimization of interfacial free energy. In this regard, it will be demonstrated that the orientation of the Co implantation profile to the single crystalline Si matrix influences the stability of the synthesized $CoSi_2$ NW. Since the system energetically favors the $CoSi_2(111)/Si(111)$ interface, driving faceting forces may occur which accelerate the NW decay into a NC chain.