HL 44: Poster Session: Quantum Dots and Wires - Transport & Optical Properties

Time: Tuesday 9:30–12:30 Location: Poster D

HL 44.1 Tue 9:30 Poster D

Two-path Transport Measurements on a Triple Quantum Dot — •Monika Kotzian, Maximilian C. Rogge, and Rolf J. Haug — Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover, Germany

We present transport measurements on a lateral triple quantum dot with a star-like geometry and one lead attached to each dot.[1] Technical and scientific improvement allow the fabrication of triple quantum dots and their analysis.[2] Research on them is motivated by fundamental physics and by the fact that they can work as a single qubit.[3] It also is the smallest system with quantum dots being part of a qubit chain needed for quantum computers. Our sample design allows to simultaneously measure the conductance along two different paths with two quantum dots in each path. The structure is made with local anodic oxidation by AFM on a GaAs/AlGaAs heterostructure. By controlling the potentials via the four gates triple points with two dots and quadruple points with all three dots in resonance can be established.[4,5] Using two of the leads as source contacts and one lead as a drain contact, signatures of three dots can be detected in both transport paths. The setup provides the possibility of applying different bias voltages to the two sources and detecting excited states of the dots.

[1] M. C. Rogge, R. J. Haug, Phys. Rev. B 77, 193306 (2008). [2] D. Schröer, et al., Phys. Rev. B 76, 075306 (2007). [3] P. Hawrylak, M. Korkusinski, Solid State Comm. 136 (2005), pp. 508-512. [4] L. Gaudreau, et al., PRL 97, 036807 (2008). [5] M. C. Rogge, R. J. Haug, NJP 11, 113037 (2009).

HL 44.2 Tue 9:30 Poster D

Real-time charge sensing analysis of metastable states in double quantum dots — •Martin Andreas Brühlmann[1], Daniel Biesinger[1], Dominik Zumbühl[1], Jeramy Zimmerman[2], and Art C. Gossard[2] — [1]Department of Physics, University of Basel, Switzerland — [2]Materials Department, University of California, Santa Barbara, California, USA

We investigate metastable charge states in lateral GaAs few-electron double quantum dots using real-time charge sensing. We use adjacent quantum dots as highly-sensitive charge sensors with a rise time of a few ms and a very good signal-to-noise ratio. Observing the charge stability diagram at very low dot-reservoir tunneling rates of a few Hz, a well defined diamond-shaped area between the (0,0) and the (1,1) triple points appears, showing charge-switching between the (1,0) and (0,1) states as a function of time resulting in a telegraph-like signal.

To further study this telegraph diamond, we gather statistics of the tunneling events and extract tunnel rates as a function of gate voltage using an adaptive algorithm. It measures repeatedly the times the system remains in one state before switching to the other and extracts the tunneling rate from the histogram of those times. Detailed testing with computer generated data shows that the algorithm works properly within statistical accuracy and is only limited by the bandwidth of the setup.

HL 44.3 Tue 9:30 Poster D

Characterization of an electron-accounting circuit — •Michael Wulf, Lukas Fricke, Frank Hohls, Bernd Kaestner, Ralf Dolata, Philipp Mirovsky, Klaus Pierz, Thomas Weimann, and Hans W. Schumacher — Physikalisch-Technische Bundesanstalt, Bundesallee 100, D-38116 Braunschweig

Operating single-electron pumps, based on dynamic quantum dots [1,2], in series while monitoring each of their outputs with single-electron resolution allows the characterization of the individual components by counting. This is complementary to previous measurements of these devices, where the time-averaged pumped current is measured [1,2] or its noise spectrum [3].

It is shown that pump operation is consistent with the required single electron resolution of metallic single-electron transistors (SET) and the rates of pump errors are measured in a low-frequency electron-counting experiment.

Time-domain correlations of the transistor signals allow identification and subsequent accounting for pump errors. This constitutes a first proof-of-principle of our electron accounting scheme [4], which aims to meet the requirements of quantum-current metrology even for a circuit built of imperfect components.

[1] M. D. Blumenthal et al., Nat. Phys. 3, 343 (2007)
[2] B. Kaestner et al., Phys. Rev. B 77, 153301 (2008)
[3] N. Maire et al., Appl. Phys. Lett. 92, 082112 (2008)
[4] M. Wulf and A. B. Zorin, e-print arXiv:0811.3927

HL 44.4 Tue 9:30 Poster D

Thermal white noise measurements of 2D and 1D electron gases — •Philipp Miechowski[1], Sven S. Buchholz[1], Dirk Reuter[2], Andreas D. Wieck[2], and Saskia F. Fischer[1] — [1]Neue Materialien, Humboldt-Universität zu Berlin, D-10099 Berlin — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum

Electron-phonon interactions in semiconductors depend strongly on the lattice temperature, as thoroughly investigated in high-mobility 2D electron gases (2DEG) at temperatures below some 10 K. Open questions with respect to electron-phonon interactions remain for systems at the transition from 2D to 1D and suitable thermometry methods need to be established.

We apply thermal voltage noise measurements in the cross-correlation technique (0-20 kHz) [1]. For the setup calibration, we use discrete resistors. We make use of heating currents to create a temperature gradient over quasi-1D quantum structures. An improved measurement setup allows to eliminate noise contributions of the serial resistances caused by ohmic contacts and leads.

We investigate the influence of the lateral electronic confinement from 2D to 1D on the electron-phonon interaction and observe different temperature dependences for wide and narrow etched structures.

Noise thermometry proves to be an adequate instrument for the investigation of electron-phonon interactions in nano-structured semiconductors.

[1] S.S. Buchholz et.al., arxiv: 1111.1591 (2011).

HL 44.5 Tue 9:30 Poster D

Untersuchung von Leitwertfluktuationen in Quantenpunktkontakten aus GaAs/AlGaAs-Heterostrukturen — •Danilo Kühn[1], Sven Buchholz[1], Olivio Chiatti[1], Dirk Reuter[2], Andreas Wieck[2] und Saskia Fischer[1] — [1]Neue Materialien, Inst. f. Physik, Humboldt-Universität zu Berlin, D-10099 Berlin — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum

Eindimensionale, ballistische elektrische Leiter wie Quantenpunktkontakte (QPCs) in zweidimensionalen Elektronengasen zeigen bei tiefen Temperaturen eine Quantisierung des Leitwerts in Einheiten von $n \cdot e^2/h$. Unterhalb des ersten Leitwertplateaus können Vorplateaus beobachtet werden, deren Ursache noch nicht vollständig geklärt ist. Möglich sind die "0,7"-Leitwertanomalie und resonantes Tunneln über Störpotentiale. Letzteres resultiert aus Ionisationsstörstellen und kann gezielt beeinflusst werden, z.B. durch eine Gate-Abkühlspannung (Potentialmodulation) [1]. In dieser Arbeit wird bei bestimmten Gate-Abkühlspannungen ein Telegrafierauschen zwischen zwei Energiezuständen beobachtet [2]. Dieses Rauschen wird in Abhängigkeit von Temperatur und Gate-Abkühlspannung systematisch untersucht. Die Messungen werden zeitaufgelöst an QPCs basierend auf GaAs/AlGaAs-Heterostrukturen vorgenommen.

[1] S.F. Fischer et al., Appl. Phys. Lett. 81, 2779 (2002).
[2] S.S. Buchholz, Dissertation (2011).

HL 44.6 Tue 9:30 Poster D

Illumination induced charging peaks observed by capacitance-voltage spectroscopy — •Patrick Alexander Labud, Dirk Reuter, Arne Ludwig, and Andreas Dirk Wieck — Angewandte Festkörperphysik, Ruhr-Universität Bochum

Since 1994 electron-electron and hole-hole interaction has been studied intensively in self-assembled InAs quantum dot (QD) samples using capacitance-voltage spectroscopy (C-V). The energetic positions of the charging peaks are considerably affected by the Coulomb interaction energies and in standard C-V spectra only the Coulomb repulsion is seen. In this contribution we present C-V data obtained under illumination. Under these conditions additional charging peaks appear due to attractive Coulomb interaction between illumination induced holes and electrons tunneling into the QD. We could resolve up to

five additional charging peaks belonging to an X^0, X^{1+}, X^{2+}, X^{3+}, X^{4+}-complex formed upon electron charging. The individual Coulomb energies are calculated from the charging gate voltage and the charging dynamics is discussed.

HL 44.7 Tue 9:30 Poster D

Electronic characterization of single GaN nanowires — •Markus Schäfer[1], Christian Länger[1], Pascal Hille[1], Florian Furtmayr[1,2], and Martin Eickoff[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, D-35392 Gießen, Germany — [2]Walter Schottky Institut, Technische Universität München, D-85748 Garching, Germany

Semiconductor nanowires (NWs), and in particular wide-bandgap GaN NWs are promising candidates for nanoscale (opto)-electronic devices with a high integration density such as NW transistor structures. In this context it is important to systematically study the electronic properties of single GaN NWs with different doping levels. For this purpose NWs doped with different concentrations of silicon were grwon by plasma assisted molecular beam epitaxy on silicon (111) substrates and electrically contacted by electron beam lithography. We report on the preparation of samples with contacted single n-type GaN NWs and their electronic properties. We present results of conductivity, photocurrent and thermoelectric measurements.

HL 44.8 Tue 9:30 Poster D

Persistent conductivity in ZnO nanowires in different gas atmospheres — •Davide Cammi, Irma Slowik, Raphael Niepelt, Andreas Johannes, and Carsten Ronning — Institute of Solid State Physics, Friedrich-Schiller-Universität, Max-Wien-Platz 1, 07743 Jena, Germany

Nanostructures of ZnO, due to the high surface to volume ratio, show a strong persistent photoconductivity (PPC). The current induced by above gap illumination persists for a long time after switching off of the excitation, compared to the typical lifetime of photogenerated carriers in the bulk. This effect is based on the up-ward band bending induced by the adsorption of oxidizing molecules at the surface, like oxygen, present in the ambient. The built-in potential tends to separate free electrons and holes generated by the optical irradiation, increasing their lifetime. PPC considerably influences the properties of nanostructure based devices for optoelectronic applications or chemical and biochemical sensors. We compare the PPC observed in untreated and treated ZnO nanowires with different coating layers, which should passivate the surface, reducing the band bending and correspondingly the persistence of the photoconductivity. Furthermore, the influence of hydrogen plasma treatment is presented. We exposed nanowires to different atmospheres, performing measurements in synthetic air (oxygen-rich), nitrogen, carbon dioxide and air, studying the effect of different pressures. A model is proposed to explain the different observed decay rates of the current depending on the chemical species present in the ambient and on the treatment of the surface.

HL 44.9 Tue 9:30 Poster D

Many-particle electron dynamics in InAs self-assembled quantum dots — •A. Kurzmann[1], A. Beckel[1], B. Marquardt[1], M. Geller[1], B. Baxevanis[2], D. Pfannkuche[2], A. D. Wieck[3], D. Reuter[3], and A. Lorke[1] — [1]Faculty of Physics and CeNIDE, University of Duisburg-Essen, Lotharstraße 1, 47057 Duisburg, Germany — [2]Institute for Theoretical Physics, University of Hamburg, Jungiusstrasse 9, 20355 Hamburg, Germany — [3]Chair for Applied Solid State Physics, Ruhr-Universität Bochum, Universitätsstraße 150, 44780 Bochum, Germany

Visionary quantum information processing (QIP) requires the access to excited, i. e. non-equilibrium, charge or spin states to serve as one building block for the needed qubits. With their strong confinement, self-assembled quantum dots (QDs) are ideal candidates for qubits operating at above liquid helium temperatures. We have demonstrated an all-electrical preparation and read out technique of excited many-particle states using a nearby two-dimensional electron gas [1] as charge sensing detector [2]. This new technique is used here to investigate the dynamics of excited electron states in InAs/GaAs QDs evolving from non-equilibrium towards equilibrium configuration. These time-resolved measurements enables separating the many-particle spectrum into the contributions from different equilibrium and excited states and serve as a starting point for further investigations on the spin dynamics in an all-electrical measurement scheme.

[1] B. Marquardt et al., Nat. Commun. **2**, 209 (2011).
[2] B. Marquardt et al., Appl. Phys. Lett. **95**, 022113 (2009).

HL 44.10 Tue 9:30 Poster D

Numerical analysis of few-electron transport in multi-gate nanowire field-effect transistors — •Jose Maria Castelo[1], Klaus Michael Indlekofer[1], and Joerg Malindretos[2] — [1]RheinMain University of Applied Sciences, FB ING / IMtech, D-65428 Rüsselsheim, Germany — [2]Georg-August-Universität Göttingen, IV. Physikalisches Institut, D-37077 Göttingen, Germany

We consider a nanowire-based field-effect transistor (NWFET) with a coaxial gate geometry, which provides ideal electrostatic control and gives rise to a screened Coulomb interaction. For the theoretical description of one-dimensional (1D) non-equilibrium transport, we employ a Green's function formalism (NEGF). Few-electron Coulomb charging effects due to resonantly trapped electrons are taken into account by use of a multi-configurational approach (MCSCG) [1] for application-relevant temperatures. The electrostatics within the channel are described by a Coulomb Green's function. These concepts provide the framework for the open source simulation tool "NWFET-Lab" [2] which is used in the following numerical studies.

Specifically, we consider a multi-gate NWFET. Using multiple bias and control gate electrodes, the channel's axial potential profile can be defined, being equivalent to a position dependent doping. Employing a 1D FET model, we analyze the influence of the position and length of the control gate segment on the electronic transport characteristics.

[1] K.M. Indlekofer et al., Phys. Rev. B **72**, 125308 (2005).
[2] J.M. Castelo and K.M. Indlekofer, http://sourceforge.net/projects/nwfetlab (2011).

HL 44.11 Tue 9:30 Poster D

Phonon-assisted relaxation and linewidth enhancement of exciton states in double quantum dots — •Jonas Daniels[1], Tilmann Kuhn[1], and Pawel Machnikowski[2] — [1]Institut für Festkörpertheorie, Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster — [2]Institute of Physics, Wrocław University of Technology, 50-370 Wrocław, Poland

Here we consider theoretically excitons in a pair of lens-shaped vertically aligned InAs/GaAs QDs in the presence of an external electric field. Single-particle wave functions of the confined carriers are calculated using a variational multicomponent envelope function scheme, while Coulomb interaction is included within the standard configuration-interaction to determine the exciton states. In dependence of the applied field, we study the optical spectrum for different geometries. Changing the applied field leads to a transition of various exciton states from a direct type, where the carriers are mainly localized in the same dot, to an indirect type, where they are mainly localized in different dots. These changes are accompanied by different hole and electron related anticrossings, visible in absorption spectra. The lines of the exciton transitions are broadened due to phonon-related processes such as phonon-assisted relaxations and tunneling. We calculate the linewidths due to deformation potential and piezoelectric coupling of the excitons to acoustic phonons. We show that the linewidths strongly depend on the spatial overlap and the energy separation of the involved electron and hole states and thus both the interdot distance and the applied field.

HL 44.12 Tue 9:30 Poster D

Coherent coupling of quantum dots in a micropillar cavity — •Ferdinand Albert[1], Kanchana Sivalertporn[2], Jacek Kasprzak[3], Micha Strauss[1], Christian Schneider[1], Sven Höfling[1], Martin Kamp[1], Alfred Forchel[1], Stephan Reitzenstein[1,4], Egor Muljarov[2], and Wolfgang Langbein[2] — [1]Technische Physik, Universität Würzburg, D-97074 Würzburg, Germany — [2]School of Physics and Astronomy, Cardiff University, Cardiff CF24 3AA, UK — [3]Institut Néel, CNRS et Université Joseph Fourier, F-38042 Grenoble, France — [4]Present address: Institute of Solid State Physics, TU Berlin, D-10623 Berlin, Germany

Coherent coupling between distant quantum systems is a crucial topic in quantum information science and cavity quantum electrodynamics since it constitutes the basis for future quantum logic gates and networks. Within this context high quality optical microresonators containing quantum dots with individual exciton states have proven to be suitable candidates to study the strong light-matter coupling. In this work we report on the coherent coupling between three individually localized quantum dot excitons via the photonic mode of a micropillar resonator. This is demonstrated by means of two-dimensional spectroscopy of the sample's coherent four-wave mixing response, where the coherent interaction can be controlled by tuning the cavity and ex-

citon energies. Moreover, the experimental results are well reproduced in a quantitative theoretical model of the cavity mediated coupling of the excitons. Our results present a crucial step forward towards a quantum bus technology based on semiconductor photonic structures.

HL 44.13 Tue 9:30 Poster D

Rabi oscillations in single InGaAs/GaAs quantum dots embedded in modified H2 photonic crystal microcavities — •Mohannad Al-Hmoud[1], Wadim Quiring[1], Simon Gordon[1], Stefan Declair[1], Jens Förstner[1], Dirk Reuter[2], Andreas Wieck[2], and Artur Zrenner[1] — [1]Center for Optoelectronics and Photonics Paderborn, Universität Paderborn, Paderborn, Germany — [2]Department of Physics, Ruhr-Universität Bochum, Bochum, Germany

Modification of the inner holes has a great influence on the quality factor of photonic crystal microcavities. So far, only experiments on modified H1 and L3 geometries were performed. Here we report on fabrication and spectroscopic characterization of H2 microcavities with modification of the position of the inner holes. We found that the quality factor can be significantly increased in comparison to non-modified structures. We chose to investigate the H2 cavity, because it has the potential to offer high Q-factors for larger defect regions. This is expected to offer more degrees of freedom for future designs of functionalized defect regions, for example with electric contact pads to the center of the defect region. Using this kind of cavities, we have investigated the p-shell Rabi oscillations of an exciton in a single InGaAs/GaAs quantum dot. We performed pulsed resonant excitation in the p-shell and detected the emission from the s-shell. To study the effect of the cavity on the p-shell Rabi oscillations, we have done experiments where a cavity mode is on- and off-resonance with the s-shell.

HL 44.14 Tue 9:30 Poster D

Effects of longitudinal acoustic phonons to the long-time dynamics in optically driven GaAs quantum dots — •Sebastian Lüker[1], Doris Reiter[1], Vollrath Martin Axt[2], and Tilmann Kuhn[1] — [1]Institut für Festkörpertheorie, Westfälische Wilhelms-Universität Münster, Wilhelm-Klemm-Str. 10, 48149 Münster — [2]Theoretische Physik III, Universität Bayreuth, 95440 Bayreuth

Semiconductor quantum dots are of great importance both for the investigation of fundamental quantum effects and for future optoelectronic applications. We discuss the laser-induced long-time dynamics in a GaAs quantum dot coupled to longitudinal acoustic phonons. In the strong confinement limit we model the quantum dot as a two level system. To study the dynamics of this system we use the density matrix formalism. The many particle nature of the system due to carrier-phonon interaction leads to an infinite hierarchie of equations of motion which we truncate by a fourth order correlation expansion. In the limit of long times the two level system reaches a stationary state close to a thermal distribution of the dressed states as a result of the interaction with phonons. We discuss the influence of external parameters, in particular temperature and intensity of the laser-field, on the state in the long-time limit. Furthermore we analyze the energy flow between the subsystems during the dynamics, revealing details about the role of the phonons. When comparing our results to a numerically exact real-time path integral method, which may act as a benchmark, we find a good agreement in a surprisingly wide range of parameters [M. Glässl, S. Lüker et al., Phys. Rev. B **84**, 195311 (2011)].

HL 44.15 Tue 9:30 Poster D

Optical Phonons in InAs/AlAs Structures with InAs and AlAs Nanocrystals — •Evgeniya Sheremet[1], Alexander Milekhin[2], Alexander Kalagin[2], Alexander Toropov[2], and Dietrich R.T. Zahn[1] — [1]Semiconductor Physics, Chemnitz University of Technology, D-09107 Chemnitz, Germany — [2]Institute of Semiconductor Physics, 630090 Novosibirsk, Russia

Layered InAs/AlAs structures with InAs and AlAs nanocrystals (NCs) formed by Stranski-Krastanov growth on (001)-oriented GaAs substrates were investigated by Raman spectroscopy. Selection rules for the optical phonons in the structures were studied in a backscattering geometry from planar (001) and cleaved (110) surfaces using a micro-Raman setup. Transverse and longitudinal optical (TO and LO) phonons as well as interface (IF) phonons were observed for InAs (AlAs) NCs in AlAs (InAs) matrices. Optical phonon frequencies of InAs (AlAs) NCs are upshifted (downshifted) compared to the ones of the corresponding bulk materials. These shifts result from compressive (tensile) built-in strain in the NCs. The frequencies of optical phonons were used to determine deformationtensor components. It was found that optical phonons of InAs NCs obey Raman scattering selection rules for a superlattice consisting of materias with zinc-blende structure. However the selection rules are weakened since all the optical phonon peaks were detected in forbidden geometries ($z(x,x)\bar{z}$ and $y'(z,z)\bar{y}$', where x, z and y' stand for [100], [001] and [110], respectively). Meanwhile, the selection rules for optical phonons of AlAs NCs are lifted. This effect can be caused by built-in strain and defects.

HL 44.16 Tue 9:30 Poster D

Carrier Trapping and Optical Properties of InAs/InP Quantum Dashes — •Piotr Kaczmarkiewicz[1,2], Paweł Machnikowski[1], and Tilmann Kuhn[2] — [1]Institute of Physics. Wrocław University of Technology, 50-370 Wrocław, Poland — [2]Institut für Festkörpertheorie, Westfälische Wilhelms-Universität, Münster, Germany

We model the optical properties of semiconductor InAs/InP quantum dashes (QDashes), that is, highly elongated quantum dot structures. These structures are often characterized by a non-uniform shape and the presence of width fluctuations. We show that such shape irregularities can act as additional trapping centers within the confinement volume of a QDash and strongly influence its optical properties.

We show how the optical transition rates depend on various QDash shape parameters (e.g., amplitude and position of the widening of the structure) and study the polarization properties of radiation emitted by the system. We confirm that the presence of a QDash width fluctuation leads to a strong localization of the exciton ground state, which results in a reduction of its anisotropy, in spite of the strong elongation of the whole structure. Such a character of the confining potential not only manifests itself by a reduced value of the degree of linear polarization of the exciton ground state, but also strongly affects the properties of higher energy excitonic states.

HL 44.17 Tue 9:30 Poster D

Energy dispersion and 3D magnetic anisotropy of electronand hole g-factors in (In,Ga)As/GaAs self-assembled quantum dots — •Alexander Schwan[1], Britt-Marie Meiners[1], Alex Greilich[1], Anré B. Henriques[2], Álvaro D. B. Maia[2], Alain A. Quivy[2], Steffen Varwig[1], Stefan Spatzek[1], Dmitri R. Yakovlev[1], and Manfred Bayer[1] — [1]Experimentelle Physik 2, Technische UniversitätDortmund, 44221 Dortmund, Germany — [2]Instituto de Física, Universidade de SãoPaulo, C.P. 66318, São Paulo, Brazil

The electron and hole Larmor spin precession was studied by time-resolved pump-probe Faraday rotation on an inhomogeneous ensemble of singly-charged self-assembled quantum dots. Dependence of electron g-factor on optical transition energy was measured. It is shown that the electron g-factors are similar for quantum dots with very different geometrical parameters, and their change with optical transition energy is almost identical[1].

The g-factor anisotropy was derived from the data measured in a vector rotate magnet system, which allows full 360 degrees spherical rotation of a magnetic field up to 3T. We determine all g-factor tensor components, and found nearly isotropic electron g-factor and a strong anisotropic hole g-factor.

[1] A. Schwan, B.-M. Meiners, A. B. Henriques, A. D. B. Maia, A. A. Quivy, S. Spatzek, S. Varwig, D. R. Yakovlev, and M. Bayer. APL 98, 233102 (2011)

HL 44.18 Tue 9:30 Poster D

Optical properties of ultra-low density GaAs Quantum Dots — •Vera Paulava, David Sonnenberg, Andreas Graf, Christian Heyn, and Wolfgang Hansen — Institut für Angewandte Physik, Universität Hamburg, 20355 Hamburg, Germany

We study a novel type of GaAs quantum dots (QDs), which are formed by filling of self-assembled nanoholes in semiconductor surfaces. The holes were drilled using local droplet etching (LDE) during molecular beam epitaxy [1]. In our case, nanoholes are drilled into AlGaAs barrier material with Al droplets and subsequently filled with GaAs to form the quantum dots. The QD size can be precicesly controlled by the filling level. Here we present a study of the optical properties of such GaAs QDs with ultra-low densities of $6 \cdot 10^6$ cm^{-2}. The low density of these dots is achieved without any lithographic or other ex-situ preparation steps, and allows clear single-dot photoluminesence studies of the excitonic states up to high excitation power by using a focused laser for excitation. Especially the exciton energies and the exciton-biexciton splittings are studied in dependence of the QD size.

[1] Heyn et al., Appl. Phys. Let. 94, 183113 (2009)

HL 44.19 Tue 9:30 Poster D

Optical properties of coupled GaAs Quantum Dots fabricated by double-filling of ultra-low density nanoholes — •Achim Küster, David Sonnenberg, Andreas Graf, Vera Paulava, Christian Heyn, and Wolfgang Hansen — Institut für Angewandte Physik, Universität Hamburg, 20355 Hamburg, Germany

The recent fabrication of self-organized ultra-low density nanoholes in AlGaAs surfaces with depths of approximately 25 nm enables the fabrication of a new type of coupled quantum dots (QD). For this, the nanoholes are filled with two layers of GaAs and an AlGaAs barrier layer of a few nm in between. The sizes of each resulting QD as well as of the barrier layer can be controlled seperately by the thickness of the respective filling layer. The ultra-low nanohole density of $6 \cdot 10^6$ cm^{-2} allows for the optical study of a single coupled QD structure without interference from other QDs by using a focused laser for excitation. We study the optical properties of single coupled QD structures using micro-photoluminesence measurements in dependence of the QD size and separation.

HL 44.20 Tue 9:30 Poster D

Micro-magneto-optics and photocurrent-spectroscopy of large $In_{0.3}Ga_{0.7}As$ quantum dots — •Peter Gold[1], Manuel Gschrey[1], Andreas Löffler[1], Sven Höfling[1], Alfred Forchel[1], Martin Kamp[1], and Stephan Reitzenstein[1,2] — [1]Universität Würzburg, Technische Physik, Am Hubland, D 97074 Würzburg — [2]Present address: Institute of Solid State Physics, Hardenbergstrasse 36, Technische Universität Berlin, D-10623 Berlin

Quantum dot (QD) microcavities are of high interest for the observation of cavity quantum electrodynamics (cQED) effects in the weak or strong coupling regime and their application in quantum light sources. An important parameter that influences the strength of the coupling between light and matter is the oscillator strength f of the involved QD exciton. In this context, laterally elongated $In_{0.3}Ga_{0.7}As$ QDs are of particular interest due to their large oscillator strength in the range of $f \approx 40 - 50$. Here we present a comprehensive spectroscopic study on the optical properties of $In_{0.3}Ga_{0.7}As$ QDs by applying high resolution micro-magneto-optical and micro-photocurrent (μPC) spectroscopy. These experimental results are compared to those obtained from standard $In_xGa_{1-x}As$ QDs with an indium content of $x = 0.6$ and $x = 1.0$, respectively, and oscillator strengths of $f \approx 10$. We observe particular large diamagnetic coefficients for the $In_{0.3}Ga_{0.7}As$ QDs and a clear correlation between the diamagnetic coefficient and the Landé g-factor of the QDs. In addition, a strong fano-like asymmetry of the X lineshape is observed in μPC. The experimental results are in good agreement with numerical simulations.

HL 44.21 Tue 9:30 Poster D

Optical Transitions in Si-Ge-Heterostructures — •Petru Tighineanu[1], Inga Anita Fischer[2], Jörg Schulze[2], and Kurt Busch[3] — [1]Institut für Theoretische Festkörperphysik, Karlsruhe Institut für Technologie, Karlsruhe, Germany — [2]Institut für Halbleitertechnik, Universität Stuttgart, Stuttgart, Germany — [3]Institut für Physik, Humboldt-Universität zu Berlin, Berlin, Germany

We investigate optical transitions in low-dimensional Si-Ge-heterostructures such as Ge dots embedded in a Si matrix. The MBE growth of Ge dots on prepatterned Si substrates affords a high degree of control over dot geometry, size homogeneity, and dot positions. Si-Ge intermixing during dot growth can be influenced by the choice of growth temperature. We present results on theoretical predictions for optical transition energies and charge distribution as a function of dot geometry and material composition using a multiband k.p envelope function formalism by taking into account the strain field and spin-orbit coupling. In particular, we show that spatial inhomogeneities in the Ge content of the dot can lead to increased quantum confinement and, therefore, to an effective reduction in dot size. We compare our model predictions with measurements with a view towards functionalizing the structures for Si-Ge optoelectronic applications.

HL 44.22 Tue 9:30 Poster D

Carrier confinement in GaN/AlGaN nanowire heterostructures — •Jörg Teubert[1], Florian Furtmayr[1], Pascal Becker[1], Jan Müssener[1], Alexey Chernikov[3], Sören Schäfer[3], Sangam Chatterjee[3], Jordi Arbiol[2], and Martin Eickhoff[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Germany — [2]ICREA and Institut de Ciencia de Materials de Barcelona, Spain — [3]Faculty of Physics and Materials Science Center, Philipps Universität Marburg, Germany

GaN nanowires (NWs) can be grown by molecular beam epitaxy using a catalyst free growth process. Due to their low density of defects group III-nitride NWs present a promising approach for the realization of improved nano- or optoelectronic devices. With this respect, the realization of heterostructures embedded in NWs is of major importance. We analyzed the three dimensional carrier confinement in GaN nanodiscs (NDs) embedded in $Al_xGa_{1-x}N$/GaN NWs and its effect on their photoluminescence (PL) properties for Al concentrations in the barriers (x_{Al}) between $x_{Al} = 0.04$ and 1 and for different ND heights. Structural analysis by high resolution transmission electron microscopy reveals the presence of a lateral AlGaN shell. In order to obtain a deeper understanding of the relevant effects we performed three dimensional numerical simulations of the confinement which show that the effects of the AlGaN shell have to be considered to explain the observed dependence of the emission energy on x_{Al}. Effects of axial and radial internal electric fields have been investigated using NW samples with different ND thickness.