Strongly size dependent polar exciton-LO-phonon interaction in GaN/AlN quantum dots — Jürgen W. Settele, André Schliwa, Gordon Callisen, Juri Brunsmieier, Axel Hoffmann, and Christian Thomsen — Institut für Festkörperphysik, Technische Universität Berlin, Germany

Recently, strongly dependent exciton-LO-phonon interaction for epitaxial GaN/AlN quantum dots (QDs) was observed experimentally by analyzing the LO-phonon sidebands of single-QD excitonic peaks. Deposition of an arsenic flux during droplet deposition of the GaN/AlN buffer layer from 3.2 eV to 4.3 eV, yields no signature of tunneling any more. Furthermore, we have integrated the QDMs into Schottky-diode structures and observed strong Stark-shifts up to 25 meV at typical fields of 2·10^7 V/m. [1] D. Sonnenberg et al., APL 101, 143106 (2012); [2] M. Reischle et al., PRB 76, 085338 (2007)

MOVPE grown InAs quantum dots with strain reducing layer — Matthias Paul, Jan Ketteler, Michael Jetter, and Peter Michler — IHFG, Universität Stuttgart, Deutschland

In recent years, InAs semiconductor quantum dots (QDs) have been studied extensively due to their potential application in quantum information networks. Based on their good optical properties and small area densities InAs QDs are excellent candidates for sources of entangled or indistinguishable photons. An implementation in fiber-coupled quantum dots with emission wavelengths of 1310 nm or 1550 nm to minimize absorption losses.

Therefore, typical emission energies of InAs QDs need to be red-shifted, e.g. by a strain reducing InGaAs layer on top of the QDs. This leads to both a reduction of the effective band gap and to an increase of the size of the QDs which results in lower emission energies.

The fabrication of InAs QDs for the aforementioned spectral range by metal-organic vapor-phase epitaxy usually leads to high area densities. In this case, a structuring a posteriori is necessary to investigate single QDs. By choosing the presented sample structure and growth parameters our samples show area densities of around 10^5 cm^-2. This renders an additional patterning unnecessary. The emission wavelengths of the QDs are around 1050 nm. Distributed Bragg reflectors (DBR), optimized for this spectral range, are used to increase the collection efficiency for micro-photoluminescence measurements. Correlation experiments and time-resolved measurements show the good optical properties of our InAs QDs.

Spin-flip Raman scattering on GaAs quantum dots using in direct bandgap (In)Al(As)As/AlAs quantum dots — Dennis Kudlacki, J. Debus, D. Dunker, V. F. Sapega, T. S. Shamirzaev, E. L. Ivchenko, D. R. Yakovlev, and M. Bauer — Experimentelle Physik 2, Technische Universität Dortmund, 44227 Dortmund, Germany — 1Institute of Physical and Technical Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia

We studied the fine structure of the indirect exciton in self-assembled (In)Al(As)As/AlAs quantum dots (QDs) by means of spin-flip Raman scattering (SFRS). The QDs are characterized by a type-I band alignment, wherein, dependent on the dot size, a crossover between the energetically lowest conduction-band states of the Γ and X-valley occurs. This Γ-X mixing of the electron and heavy-hole spin scattering strongly depend on the excitation energy across the inhomogeneously broadened QD ensemble. The Γ-valley electron cannot be observed because of its short lifetime and the broad dispersion of its g-factor corresponding to the strong variation in the QD sizes, which is evidenced in experiment and theory.

InAs Quantum Dot Molecules of ultra-low density — Achim Köster, David Sonnenberg, Andreas Graf, Christian Heyn, and Wolfgang Hansen — Institut für Angewandte Physik, Universität Hamburg, 20355 Hamburg, Germany

We present the fabrication and optical properties of GaAs quantum dot molecules (QDM). The QDM are fabricated by filling nanoholes in an AlGaAs surface with GaAs/AlGaAs/AlAs layer sequence. The nanoholes are formed using local droplet etching with Al droplets on AlGaAs substrates. By optimizing the arsenic flux during droplet deposition an ultra-low density of some 10^6 cm^-2 can be achieved [1], allowing the study of single QDM. With our fabrication method we have good and independent control on the dot size and the tunnel barrier in the QDM. The AlGaAs layer between the GaAs layers forms the tunnel barrier with thickness that is tuned from 1 nm to 20 nm in our experiments. Also, the dot size can be tuned separately in these structures. In samples with tunnel barrier thickness below 5 nm we observe non-resonant tunnelling [2] in these QDMs as a clear sign of coupling, while at a barrier thickness of 15 nm the optical spectra show no signature of tunnelling any more. Furthermore, we have integrated the QDMs into Schottky-diode structures and observed strong Stark-shifts up to 25 meV at typical fields of 2·10^7 V/m. [1] D. Sonnenberg et al., APL 101, 143106 (2012); [2] M. Reischle et al., PRB 76, 085338 (2007)

Spectroscopy on single buried InAs quantum dots by scattering scanning near-field infrared microscopy — Markus Feihrenbacher, Rainer Jacob, Stephan Winneki, Jayeta Bhattacharya, Harald Schneider, Marc Tobias Wenzel, Hans-Georg von Ribbeck, Lukas M. Encz, Paola Akenson, Oliver G. Schmidt, and Manfred Helm — 1Helmholtz-Zentrum Dresden-Rossendorf, Dresden, Germany 2TU Dresden, Dresden, Germany — Leibniz Institute for Solid State and Materials Research, Dresden, Germany

Quantum dots are a highly interesting material system for many application purposes such as single photon emitters in the near-infrared, but also for mid- and far-infrared applications. Studying the linewidth of involved optical transitions offers valuable clues to the dephasing mechanisms of the trapped electrons. However, due to size fluctuations of the quantum dots, inhomogeneous broadening of the signals usually hides this information when investigating ensembles of dots.

Therefore, single-dot spectroscopy has to be performed for this purpose. In contrast to studies of interband transitions this is not well established at all for intersublevel transitions. In this work, scattering type scanning near-field optical microscopy (s-SNOM) in combination with a free-electron laser is used to investigate intersublevel transitions in single self-assembled buried InAs quantum dots. Thereby, spectrally resonant optical contrast to the surrounding GaAs substrate is observed at photon energies of 83 meV and 123 meV, which can clearly be assigned to the s-d and p-d transitions of single conduction band electrons.

Coast break

Tailoring the optical properties of single semiconductor quantum dot molecules with metallic planar- and nano-structures — Hongyi Zhang, Klau Lindfors, Yongchao Huo, Armando Rastelli, Oliver G. Schmidt, Harald Giessen, and Markus Lippitz — 1Max Planck Institute for Solid State Research — 2Institute for Integrative Nanosciences, IFW Dresden — 34th Physics Institute, University of Stuttgart

Coupling plasmonic nanostructures with single quantum emitters is of
high interest for both fundamental research and a wide range of applications such as ultra-bright non-classical photon sources. The luminescence properties of the emitter can be significantly modified because of the localized electromagnetic field close to the metal nanostructures.

We have studied the optical properties of single GaAs/AlGaAs QDs at different distances to a gold mirror. Both the luminescence intensity and the dephasing time of the QDs were enhanced because of coupling to surface plasmons. We have also investigated the influence of optical antenna on the luminescence of the QDs. With the help of a state-of-the-art positioning technique, we positioned gold nanorods above single QDs and observed significant modification of the emission properties, which manifests the coupling between the QD and localized plasmons. We have also taken first steps to fabricate plasmonic nanocavities for the self-assembled GaAs QDs.

**HL 74.7 Thu 11:15 H16**

Fabrication of a thin membrane of InP/AlGaInP quantum dots — Hendrik Niederbracht, Elisabeth Koroknay, Fabian Hargart, Christian Alexander Kessler, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen und SCoPE Forschungszentrum, Universität Stuttgart, Deutschland

For applications based on the single photon emission from quantum dots (QDs) like quantum key distribution or quantum communication, high collection efficiency is important. An easy way to achieve this is to guide the emission of semiconductor QDs into the direction of the detection by growing distributed Bragg reflectors below the QDs and using optics with a high numerical aperture. But often the setup can limit the use of such objectives. An alternative is offered by very thin samples in combination with solid immersion lenses.

The QD samples are fabricated via metal-organic vapor-phase epitaxy on a (100) GaAs substrate with a 6 degree miscut. The challenge is the fabrication of the thin membrane of InP/AlGaInP QDs. Therefore the sample is glued topside down on Si and afterwards thinned using mechanical and wet chemical methods. Optical measurements on an 80 nm thick sample are carried out in order to prove the single photon emission and the results are compared with an unprocessed reference.

**HL 74.8 Thu 11:30 H16**

Optical excitation channels of a single site-controlled quantum dot — Ole Hiertzmann, Erik Stock, André Strittmatter, Andrei Schliwa, Jan-Hendrik Schulze, Tim D. Germann, David Quandt, Waldemar Unrau, Udo W. Pohl, Axel Hoffmann, Dieter Bimberg, and Vladimir Haisler — Institut für Festkörperphysik, Technische Universität Berlin, Germany — Institute of Semiconductor Physics, Russian Academy of Sciences, Novosibirsk, Russian Federation

Direct and phonon-mediated channels of optical excitation are studied on a single isolated site-controlled InGaAs/GaAs quantum dot (QD). The nucleation site was precisely defined by a distant buried stressor formed by controlled partial oxidation of a sandwiched AlGaAs layer as part of a mesa structure.

Above a sub-micrometer aperture we observe sharp luminescence lines, originating from a single QD as demonstrated by autocorrela-

**HL 74.9 Thu 11:45 H16**

Cascaded emission of linearly polarized single photons from positioned InP/GaInP quantum dots — Tristan Braun, Vasilii Baumann, Sebastian Unleber, Manuel Gschrey, Sven Rootz, Stephan Zeitzeinsten, Christian Schieder, and Martin Kamp — Technische Physik, Physikalisches Institut and Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Universität Würzburg, Am Hubland, D-97074, Würzburg, Germany — Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstrasse 36, 10623 Berlin, Germany

We report on the in-depth optical characterization of red-emitting site-controlled InP/GaInP Quantum Dots. In order to prove the long-range ordering of the buried emitters scanning cathodoluminescence with a high spatial resolution was performed, revealing a yield of 90% of optically active QDs on the pre-determined positions and the absence of emitters on interstitial positions. Polarization dependent investigations on the emission of single QDs show a pronounced degree of linear polarization along the (1-10) crystal axis with an average degree of polarization as large as 80%. Photon correlation measurements of the biexcitonic and excitonic emission of a single dot are employed to reveal the single-photon character of each emission line as well as the cascaded nature of the photon pair emission.

**HL 74.10 Thu 12:00 H16**

Comparison of the energy transfer in colloidal core-shell Q-dots in solution and in a Q-dot layer — Uwe Kaiser, Robert Malinowski, Wolfgang Heimbach, Faheem Amin, Dorleta Jimnez de Aberasturi Arranz, and Wolfgang Parak — Experimental semiconductors group of Philipps-University Marburg — Biophotonics group of Philipps-University Marburg

There is a great interest in functionalized colloidal Q-dots (CQDs) with diameters of a few nanometers for physical as well as biological applications. A fundamental understanding of the energy transfer processes in these materials for different experimental environments is necessary.

We studied the temporal spectral behavior of CdSe quantum dots functionalized with chromophores with time resolved photoluminescence spectroscopy. With a laser pulse of a few nanoseconds we are able to observe the luminescence decay in the range of nanoseconds up to microseconds for the luminescence of the dot as well as for the chromophore.

Measurements have been done for nanoparticles in solution as well as on particles transferred to a substrate. The fluorescence resonant energy transfer (FRET) between the dot and the chromophores has been studied in a temperature range between 10K and room temperature. A detailed comparison of the FRET process will be presented for the Q-dots in different environments.