HL 49: Quantum dots and wires II

Time: Wednesday 15:00–18:15 Location: POT 151

HL 49.1 Wed 15:00 POT 151

Charge tuning of GaAs quantum dots using Schottky diode structure — •Nand Lal Sharma[1], Robert Keil[1], Caspar Hopfmann[1], Fei Ding[2], and Oliver Schmidt[1,3] — [1]Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstrasse 20, 01069 Dresden, Germany — [2]Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover, Germany — [3]Chemnitz University of Technology, Reichenhainer Strasse 70, 09107 Chemnitz, Germany

Semiconductor quantum dots (QDs) are promising candidates for high quality photon sources and the biexciton cascade decay in such dots is most advanced technique for the generation of entangled photon pairs. In this work the GaAs/AlGaAs QDs are grown by droplet epitaxy [1] employing a n-i Schottky diode structure. The back contact is prepared by thermal diffusion and the top contact is prepared by deposition of semi-transparent 2 and 4nm Cr and Au, respectively. The GaAs QD photoluminescence from different charging states is controlled by application of an external bias. The effects of quantum dot charging, quantum confined Stark effect, exciton fine structure and photon coherence are investigated as a function of bias voltage.

[1] Keil et. al. Nat. comm. 8, 15501(2017)

HL 49.2 Wed 15:15 POT 151

Aligning quantum dots on non-structured surfaces using roughness modulation — •Nikolai Bart[1], Christian Dangel[2], Jonathan Finley[2], Kai Müller[2], Aimeric Courville[3], Marcel Schmidt[1], Andreas D. Wieck[1], and Arne Ludwig[1] — [1]Ruhr-Universität Bochum, Lehrstuhl für Angewandte Festkörperphysik, Universitätsstraße 150, 44801 Bochum — [2]Technische Universität München, Walter Schottky Institut, Am Coulombwall 4, 85748 Garching bei München — [3]CNRS, Université Côte d'Azur, CRHEA, Rue Bernard Grégory, 06560 Valbonne, France

We present a novel approach to site selective growth of InAs/GaAs quantum dots on a smooth surface (miscut $< 0.1^{\circ}$), without the use of ex-situ preparation of the wafer. For this, we deposit a layer of GaAs onto a (1 0 0) GaAs substrate during stopped rotation of the wafer, thereby creating a periodic modulation of the surface roughness on an atomic scale. If we deposit InAs onto this, QD nucleation is enhanced at locations of high roughness, thus creating a stripe pattern of high and low QD density. With this method, we can create stripes with periodicities between 3 and 0.3 mm and combine stripe patterns to create two-dimensional lattice patterns. Macro photoluminescence maps performed on these structures are in good agreement with simulations using a geometric approach.

HL 49.3 Wed 15:30 POT 151

Self-organized linear alignment of high-density Stranski-Krastanov quantum dots — •Tommy Müller, Udo W. Pohl, Laura Meissner, and Tore Niermann — Technische Universität Berlin, Germany

The linear alignment of high-density quantum dot (QD) ensembles is interesting for active waveguide structures. We present the fabrication of a self-organized linear array of such an ensemble in a multilayer structure without the application of post-growth lithography.

We applied the buried-stressor principle [F. Kießling et al., PRB 91, 075306 (2015)]: by selectively oxidizing buried AlGaAs-AlAs-AlGaAs layers, we produce a stripe-shaped tensile strain field in the GaAs cap layer. Here InGaAs Stranski-Krastanov QDs prefer to nucleate on top in a second epitaxy. Nucleation control of linear stressors proved more challenging than on circular stressors due to the reduction to a single lateral strain component. We still achieved a high density of QD stripes with high contrast to the side areas. Further increased QD density decreases the contrast. An improved contrast was obtained for stacked stripe structures, where a second QD layer was nucleated on top of a site-controlled buried first QD layer. The presentation outlines essential parameters for the lateral site control of the QD ensemble, confirmed by strain simulations.

HL 49.4 Wed 15:45 POT 151

Electronic structure analysis of GaAs quantum dots using correlation spectroscopy — •Robert Keil[1], Nand Lal Sharma[1], Caspar Hopfmann[1], Fei Ding[2], and Oliver Schmidt[1,3] — [1]Institute for Integrative Nanosciences, IFW Dresden, Helmholtzstrasse 20, 01069 Dresden, Germany — [2]Institut für Festkörperphysik, Leibniz Universität Hannover, Appelstrasse 2, 30167 Hannover, Germany — [3]Chemnitz University of Technology, Reichenhainer Strasse 70, 09107 Chemnitz, Germany

Droplet etched GaAs quantum dots are promising candidates for many quantum light sources and have already demonstrated to be the best entangled photon sources to date [1]. In order to employ these devices also in other quantum optical schemes - such as carrier spin coherence based generation of photonic cluster states - a comprehensive understanding of the electronic level structure is essential. In this work we will present an electronic structure analysis based on comparative correlation spectroscopy of single photons combined with traditional photoluminescence spectroscopy methods.

[1] Zopf et. al. PRL 123, 160502 (2019)

HL 49.5 Wed 16:00 POT 151

Electrical control of spins and giant g-factors in ring-like coupled quantum dots — Heidi Potts[1], I-Ju Chen[1], •Athanasios Tsintzis[1], Malin Nilsson[1], Sebastian Lehmann[1], Kimberly Dick[1,2], Martin Leijnse[1], and Claes Thelander[1] — [1]Division of Solid State Physics and NanoLund, Lund University, SE-221 00 Lund, Sweden — [2]Centre for Analysis and Synthesis, Lund University, SE-221 00 Lund, Sweden

Emerging theoretical concepts for quantum technologies have driven a continuous search for structures where a quantum state, such as spin, can be manipulated efficiently. Central to many concepts is the ability to control a system by electric and magnetic fields, relying on strong spin-orbit interaction and a large g-factor. Here, we present a mechanism for spin and orbital manipulation using small electric and magnetic fields. By hybridizing specific quantum dot states at two points inside InAs nanowires, nearly perfect quantum rings form. Large and highly anisotropic effective g-factors are observed, explained by a strong orbital contribution. Importantly, we find that the orbital contributions can be efficiently quenched by simply detuning the individual quantum dot levels with an electric field. In this way, we demonstrate not only control of the effective g-factor from 80 to almost 0 for the same charge state, but also electrostatic change of the ground state spin.

HL 49.6 Wed 16:15 POT 151

Electronic structure of (InGa)(AsSb)/GaAs/GaP quantum dots — •Petr Klenovský[1,2], Elisa Maddalena Sala[3,4], Petr Steindl[1,5], Andrei Schliwa[3], and Dieter Bimberg[3,6] — [1]Masaryk University, Brno, Czech Republic — [2]Czech Metrology Institute, Brno, Czech Republic — [3]TU Berlin, Berlin, Germany — [4]EPSRC National Epitaxy Facility, The University of Sheffield, North Campus, Sheffield, United Kingdom — [5]Leiden University, Leiden, Netherlands — [6]Bimberg Chinese-German Center at CIOMP, Changchun, China

The electronic structure of self-assembled (InGa)(AsSb)/GaAs/GaP QDs is studied. These QD structures present an excellent example for systems exhibiting concurrently direct and indirect transitions both in real and momentum space. The structures were grown via MOVPE [1]. Our results show that they provide an easier access to applications in quantum information technology, as compared to the currently studied InGaAs/GaAs QDs. [2]. Our theoretical results are compared to and are verfied by detailed photoluminescence measurements [3]. We also compare results obtained for QDs grown on both GaP and GaAs substrates, revealing the influence of the large hydrostatic stress, particularly on valence band states, enabling the realization of the QD-Flash memory concept [1], where holes in type-II QDs act as storage units.

[1] Sala, E. M., et al., Phys. Stat. Sol. B, 1800182 (2018).
[2] Klenovsky, P., et al., Phys. Rev. B **100**, 115424 (2019).
[3] Steindl, P., et al., Phys. Rev. B **100**, 195407 (2019).

30 min. break.

HL 49.7 Wed 17:00 POT 151

Excess noise in quantum ring interferometers — Christian Riha[1], Sven S. Buchholz[1], Olivio Chiatti[1], Andreas D.

Wieck[2], Dirk Reuter[3], and •Saskia F. Fischer[1] — [1]Novel Materials Group, Humboldt-Universität zu Berlin, 10099 Berlin, Germany — [2]Angewandte Festkörperphysik, Ruhr-Universität Bochum, 44780 Bochum, Germany — [3]Optoelektronische Materialien und Bauelemente, Universiät Paderborn, 33098 Paderborn

Cross-correlated noise measurements are performed in etched $Al_xGa_{1-x}As/GaAs$ based quantum rings in equilibrium at a bath temperature of $T_{bath} = 4.2$ K. The measured white noise exceeds the thermal noise expected from the measured electron temperature T_e and the electrical resistance R. This excess part of the white noise decreases as T_{bath} increases and vanishes for $T_{bath} > 12$ K. Excess noise is not observed if one arm of a quantum ring is depleted of electrons or in 1D-constrictions that have a length and width comparable to the quantum rings. A model is presented that suggests that the excess noise originates from the correlation of noise sources, mediated by phase-coherent propagation of electrons.

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Exciton recombination dynamics in CdSe nanocrystals in glass matrix — •Gang Qiang[1], Elena V.Shornikova[1], Dmitri R.Yakovlev[1,2], Aleksandr A. Golovatenko[2], Anna V. Rodina[2], Evgeniy A. Zhukov[1], Aleksei A. Onushchenko[3], and Manfred Bayer[1,2] — [1]Experimentelle Physik 2, Technische Universität Dortmund, 44221 Dortmund, Germany. — [2]Ioffe Institute, Russian Academy of Sciences, 194021 St. Petersburg, Russia. — [3]ITMO University, 199053, St.-Petersburg, Russia.

In this work, we studied CdSe nanocrystal (NC) with diameter from 2.8 to 6.2 nm grown in glass matrix. Temperature and magnetic field dependence of photoluminescence (PL) decay measurements demonstrate the exciton nature of the emission state. With the decreasing of NC size, due to the quantum confinement effect, the band gap of samples is blue shifted, and the bright-dark exciton splitting also becomes larger which is indicated by the deceleration of the dark exciton recombination process where a larger time constant for the long tail of the PL decay curve in the smaller sample is observed.

HL 49.9 Wed 17:30 POT 151

Carrier and energy transfer in colloidal quantum dot semiconductor hybrids — •Mikko Wilhelm, Shyam Kommadath, Salwa Khokhar, and Wolfram Heimbrodt — Philipps-Universität Marburg

Colloidal quantum dots are attractive for functionalization of semiconductors in electronic and opto-electronic devices like solar cells, field effect transistors or spintronic devices. CdS/ZnS and CdSe/ZnS core/shell quantum dots of different sizes synthesized in solution are deposited via knife coating on different semiconductor substrates. Depending on the band alignment between the quantum dots and the semiconductor substrate, energy and charge transfer is observed. The interaction between the quantum dots and semiconductor substrate is studied with optical spectroscopy. The results of continuous wave and time resolved photoluminescence measurements at different temperatures from 10K to room temperature are presented and discussed.

HL 49.10 Wed 17:45 POT 151

High-precision determination of Silicon nanocrystals — •Ronja Köthemann, Nils Weber, Jörg K. N. Lindner, and Cedrik Meier — Universität Paderborn, Deutschland

Silicon nanocrystals have atom-like discrete energy levels and exhibit strong luminescence in the visible spectral range. However, for particles embedded in a host matrix, size determination is challenging when the nanocrystals are smaller than 5 nm in diameter. Therefore, we evaluate different approaches to determine the size of the silicon nanocrystals. The nanocrystals are fabricated using a plasma-enhanced chemical vapor deposition (PECVD) process with subsequent annealing in a tube furnace. For characterization, different experimental techniques are used, including optical measurements such as photoluminescence or nonlinear optical response and analytical transmission electron microscopy. Furthermore, preliminary results for integrating the nanocrystals into photonic crystal disks are shown.

HL 49.11 Wed 18:00 POT 151

Optical properties of a double-dot rod semiconductor — •Marcel Dohrmann, Tobias Kipp, Christian Strelow, and Alf Mews — University of Hamburg, Institute of Physical Chemistry

Due to their heterogenic semiconductor band system, double dot-rod semiconductors have very interesting properties. With three different semiconductor materials, not only classical Type I or Type II systems can be achieved, but also combinations of these. For example, a system like CdSe/CdS/PbS can have two trap regions of holes and electrons. This system has been synthesized in our group and will be analyzed via confocal spectroscopy. The electron and hole wave functions and exciton energies are calculated by a numerical Schrödingers equation solver within the effective mass approximation. Our emission spectra shows two emission maxima, which are in good alignment with our calculations. Therefore this semiconductor system consist of two type I regions, is a double emitter, and could have different decay curves for each wavelength area.