HL 46 Quantum dots and wires: Preparation and characterization II

Time: Thursday 15:15–16:30 Room: POT 51

HL 46.1 Thu 15:15 POT 51

Charge-State and Magnetic-Field Dependence of Electron Emission from self-assembled InAs quantum dots — •Andreas Schramm, Jan Schaefer, Stephan Schulz, Christian Heyn, and Wolfgang Hansen — Institut für Angewandte Physik, Jungiusstraße 11C, 20355 Hamburg

Using capacitance transient spectroscopy, we probe electron states in self-assembled InAs/GaAs quantum dots (QD). In our sample a single QD layer is embedded in a Schottky diode grown on (001) GaAs in a solid source MBE system. With a pulse bias applied at the gate we control the charge state of the QDs. The emission rate is found to be strongly dependent on the charge state. In the DLTS-spectra the peak associated to emission from the s-level is therefore split. Here we present data that demonstrate in addition fine structure in the maximum associated to the emission of p-electrons. We associate it to the emission of the four distinct charge states for p-electrons. To confirm our assignment of the DLTS-maxima we apply magnetic fields normal to the quantum dot layer. The observed behavior of the peak positions and the activation energies in the magnetic field is consistent with a harmonic oscillator model. Furthermore, in magnetic fields oriented parallel to the dot layer we clearly observe a suppression of tunneling processes.

HL 46.2 Thu 15:30 POT 51

Observation of the Aharonov-Bohm effect in self-assembled nano-volcanoes — •V.M. Fomin[1,2,3], V.N. Gladilin[1,3], N.A.J.M. Kleemans[2], I.M.A. Bominaar-Silkens[4], D. Granados[5], J.M. García[5], P. Offermans[2], U. Zeitler[4], P.C.M. Christianen[4], J.C. Maan[4], J.T. Devreese[1,2], J.H. Wolter[2], and P.M. Koenraad[2] — [1]TFVS, Departement Fysica, Universiteit Antwerpen, B-2610 Antwerpen, Belgium — [2]Department of Semiconductor Physics, TU Eindhoven, NL-5600 MB Eindhoven, The Netherlands — [3]Department of Theoretical Physics, State University of Moldova, Kishinev, MD-2009, Moldova — [4]HFML, Institute for Molecules and Materials, Radboud University Nijmegen, NL-6525 ED Nijmegen, The Netherlands — [5]Instituto de Microelectrónica de Madrid, CSIC, E-28760 Madrid, Spain

Our X-STM data indicate that self-assembled InGaAs/GaAs nano-volcanoes are characterized by an asymmetric rim and a depression rather than an opening at the center. We show that these asymmetric singly connected structures still can effectively manifest the electronic properties, like the Aharonov-Bohm (AB) oscillations, peculiar to doubly connected geometry of ideal rings. AB oscillations in the persistent current are observed in low temperature magnetization measurements using the torsion magnetometry in magnetic fields up to 15 T and are in excellent agreement with theoretical predictions for strained nano-volcanoes. This work was been supported by the GOA BOF UA 2000, IUAP, FWO-V projects G.0274.01N, G.0435.03, the WOG WO.035.04N (Belgium), MCYT NANOSELF project (Spain) and the EC SANDiE Network of Excellence.

HL 46.3 Thu 15:45 POT 51

Transport through a (double) quantum dot fabricated with resorcinarene resist — •Monika Fleischer[1], Friedhelm Panteleit[1], David A. Wharam[1], David A. Ritchie[2], and Michael 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

As an alternative to the conventional split-gate approach, quantum dots can be created in the 2dim electron gas of a GaAs/AlGaAs-heterostructure by using continuous metallic gates in combination with a resist pattern. The resist marks out regions in which the gate voltage V_g is screened from the electron gas. Using this technique, multiple structures can be defined by a single gate. At high negative gate voltages, the screening breaks down and the gate region turns into a tunable barrier. We have investigated C-methyl-calix[4]resorcinarene as a novel high resolution negative resist for electron beam lithography, which has excellent properties for the envisaged applications. A single quantum dot was fabricated via a dot-shaped resist pattern crossed by three continuous gates. Transport measurements show Coulomb blockade oscillations, which at high $|V_g|$ change into the characteristics of a double dot with decreasing interdot coupling.

HL 46.4 Thu 16:00 POT 51

Theory of spin-orbit effects and spin relaxation in single and coupled quantum dots. — •Peter Stano and Jaroslav Fabian — Institut I - Theoretische Physik, Universität Regensburg

Spin-orbit effects and phonon-induced spin relaxation in laterally coupled quantum dots in the presence of magnetic field are investigated by exact numerical diagonalization. Both Bychkov-Rashba and Dresselhaus spin-orbit couplings are included. Several new phenomena are predicted. In particular, we shown that coherent tunneling between the dots depend on the spin, enabling a scheme for spin-to-charge conversion by spin separation in a *homogeneous* magnetic field. Furthermore, we show that spin relaxation is highly anisotropic, both in terms of the direction of the double-dot axis as well as the direction of the magnetic field. The anisotropy comes from spin-orbit coupling. Calculated spin relaxation rates of GaAs single dots agree with a recent experiment.

HL 46.5 Thu 16:15 POT 51

Transition from the multiple quantum dot mode to a quasi-single quantum dot mode formed in individual ropes of single-walled carbon nanotubes — •Klaus Seemann, Jens Ebbecke, and Achim Wixforth — Institut für Physik der Universität Augsburg, Universitätsstraße 1, D-86159 Augsburg

We report on conductance oscillations in a field effect device based on an individual rope of single-walled carbon nanotubes at 1.5 K. A newly developed fabrication method was employed to deposit and align carbon nanotubes onto pre-structured metal contacts of a silicon chip. Crucial for the deposition and alignment process of carbon nanotubes are micro fluidic flow fields combined with electric dipole fields being generated by surface acoustic waves within a gap filled with aqueous carbon nanotube suspension. This gap is formed, when the pre-structured silicon chip is flipped onto the piezoelectric lithium niobate substrate facilitating surface acoustic waves. The electrical characterization of the carbon nanotube junction at low temperatures exhibits very well reproducible current oscillations in the carbon nanotube rope. This indicates the formation of quantum dots between two tunneling contacts being separated by 500 nm. These quantum dots inside the carbon nanotube rope have an energy level spacing of about 10 meV. For source-drain bias beyond the height of the effective tunneling barrier the carbon nanotube junction reveals a transition to coherent tunneling akin a single quantum dot with an energy level spacing of about 1 eV. We interpret this behavior as a voltage induced transition from a multiple quantum dot system to a single larger quantum dot within the carbon nanotube.