HL 60: Quantum Dots: Transport

Time: Wednesday 15:00–16:15 Location: POT 251

HL 60.1 Wed 15:00 POT 251

Light sensing and room temperature memory application of a single-electron memory with positioned InAs quantum dots — •Sebastian Göpfert[1], Lukas Worschech[1], Stephan Lingemann[1], Christian Schneider[1], David Press[2], Sven Höfling[1], and Alfred Forchel[1] — [1]Technische Physik, Physikalisches Institut, Wilhelm Conrad Röntgen Research Center for Complex Material Systems, Universität Würzburg, Am Hubland, D-97074Würzburg, Germany — [2]Stanford University, Edward L Ginzton Lab, Stanford, CA 94305 USA

Electron-beam lithography and try etching techniques were applied for the fabrication of single-electron memories. The device is based on two site-controlled InAs quantum dots (QDs) embedded in a GaAs/AlGaAs quantum-wire transistor. A pattern of nanoholes on a modulation doped GaAs/AlGaAs heterostructure was used to serve as nucleation centers for the QDs. Large shifts of the transistor threshold occur by charging of the QDs with single electrons. At low bias voltages transport spectroscopy shows clear regimes of single-electron transport. Single-electron read and write functionalities up to room temperature were observed. Light with a wavelength in the telecommunication range can be used to control the memory function and to observe single electron charging events at room temperature.

S. Göpfert, L. Worschech, S. Lingemann, C. Schneider, D. Press, S. Höfling, and A. Forchel, Appl. Phys. Lett. accepted (2010)

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All-electrical measurement of the relaxation time of a two-electron spin-triplet state in InAs quantum dots — Bastian Marquardt[1], •Martin Geller[1], Andreas Beckel[1], Benjamin Baxevanis[2], Daniela Pfannkuche[2], Andreas D. Wieck[3], Dirk Reuter[3], and Axel Lorke[1] — [1]Faculty of Physics and CeNIDE, University of Duisburg-Essen, Germany — [2]I. Institut für Theoretische Physik, University Hamburg, Hamburg, Germany — [3]Chair of Applied Solid State Physics, Ruhr University, Bochum, Germany

Many-particle spin states in self-assembled quantum dots (QDs) could serve as qubits in quantum information processing devices [1]. However, in optical experiments always the excitonic states are measured, hence, electrical preparation and detection of pure excited many-particle states without electron-hole interaction are still missing. We demonstrate an all-electrical spectroscopy technique on an ensemble of InAs QDs [2]. It allows us to prepare and detect the pure many-particle electron states with their spin-singlet and -triplet configurations, using a time-resolved measurement detection scheme via a 2DEG [3]. This all-electrical measurement scheme enables us to determine the electron spin-relaxation time without an applied magnetic field and without optical excitation to 5 ms at 4 K. The spin relaxation time is independent on the applied magnetic field (up to 2 T) and slightly decreases down to 3 ms at 50 K.

[1] T. D. Ladd et al., Nature 464, 45 (2010). [2] B. Marquardt et al., submitted (2010), Preprint: arXiv: 1007.0392v1. [3] B. Marquardt et al., Appl. Phys. Lett. 95, 22113, (2009).

HL 60.3 Wed 15:30 POT 251

Quantum dot memories based on antimony — •Tobias Nowozin, Annika Högner, Andreas Marent, Andrei Schliwa, and Dieter Bimberg — Institut für Festkörperphysik, Fakultät II, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin

A promising option to enhance the performance of today's Flash memories is to use quantum dots (QDs) as a storage unit for charge carriers. In contrast to the Si/SiO_2-based Flash, QDs based on III-V semiconductors could facilitate long storage times in combination with fast write speeds (<nanoseconds). Especially type-II QDs based on GaSb with their exclusive hole localization in combination with other materials such as GaP are promising for non-volatile performance (i.e. >10 years storage time at room temperature). We present results of 8-band-k·p calculations for GaSb QDs and investigate the dependence of the localization energy on the size, shape, and composition of the dots. Storage times in various Sb-based QD heterostructures are predicted.

HL 60.4 Wed 15:45 POT 251

Tunable g-factors in SiGe quantum dots — •Georgios Katsaros[1,2], Natalia Ares[1], Panayotis Spathis[1], Mathieu Stoffel[2], Frank Fournel[3], Massimo Mongillo[1], Vincent Bouchiat[4], Francois Lefloch[1], Armando Rastelli[2], Oliver G. Schmidt[2], and Silvano De Franceschi[1] — [1]CEA, INAC/SPSMS/LaTEQS, 17 Rue des Martyrs, 38054 Grenoble, France — [2]IFW-Dresden, Institute for Integrative Nanosciences, Helmholtzstrasse 20, 01069 Dresden, Germany — [3]CEA, LETI, MINATEC, F38054 Grenoble, France — [4]Institut Néel, CNRS and Université Joseph Fourier, BP 166, 38042 Grenoble cedex 9, France

A prominent branch of spintronics aims at exploiting the electronic spin degree of freedom either for encoding and manipulating quantum information or for switching the state of transistors in a more efficient way. While ground-breaking achievements could be made mainly on GaAs-based heterostructures, the importance of exploring alternative material systems with favourable properties such as long spin coherence is now widely recognized. Si and Ge are attractive materials because in these materials electronic spins can have a long coherence time due to the absence of hyperfine interaction (in isotopically purified crystals). Here we report for the first time the realisation of single-hole transistors based on individual self-assembled SiGe quantum dots [1]. Transport spectroscopy reveals largely anisotropic and electrically tunable hole g-factors, which make SiGe self-assembled QDs an interesting material system for performing all-electrical spin coherent manipulations. Ref. : [1] G. Katsaros et al., Nature Nanotechnology , 2010, 5, 458.

HL 60.5 Wed 16:00 POT 251

Transmission phases and conductance through quantum dots in Fano regime of transport — •Elena Roxana Racec — Technische Universität Cottbus, Fakultät 1, Postfach 101344, 03013 Cottbus, Germany — University of Bucharest, Faculty of Physics, PO Box MG-11, 077125 Bucharest Magurele, Romania

We analyze a quantum dot strongly coupled to the conducting leads via quantum point contacts - Fano regime of transport - and report a variety of resonant states that demonstrate the dominance of the interacting resonances in the scattering process in a low confining potential [1]. As effects of the interaction between resonances, the line shapes of the conductance peaks are described by Fano functions with complex asymmetry parameters and the phases of the transmission amplitudes do not increase monotonically by π through each conductance peak anymore. The phase lapses, typical for the universal behaviour, are obtained as a particular case for weak interacting resonances, while the strong interaction regime is associated with the mesoscopic phase evolution.

[1] E. R. Racec, U. Wulf, P. N. Racec, Phys. Rev. B 82, 085313 (2010) [16 pages]