HL 23: Quantum wires: Transport properties (with TT)

Time: Monday 16:00–17:45 Location: POT 006

HL 23.1 Mon 16:00 POT 006

Strongly interacting holes in Ge/Si core/shell nanowires — •Franziska Maier, Tobias Meng, and Daniel Loss — Department of Physics, University of Basel, Klingelbergstrasse 82, 4056 Basel, Switzerland

We consider holes confined to the core of Ge/Si core/shell nanowires subject to strong Rashba spin-orbit coupling and screened Coulomb interactions. We find that both, spin-orbit coupling and Coulomb interactions, are largely dependent on wire radius, shell-induced strain and the magnitude of applied electric fields. This tunability allows to drive the system from a Luttinger liquid phase towards a Wentzel-Bardeen singularity.

HL 23.2 Mon 16:15 POT 006

***In-situ* x-ray diffraction during MBE growth of InAs nanowires on Si** — •Andreas Biermanns[1], Anton Davydok[1], Emmanouil Dimakis[2,3], Masamitu Takahasi[4], Takuo Sasaki[4], Lutz Geelhaar[2], and Ullrich Pietsch[1] — [1]Universität Siegen, Festkörperphysik, Germany — [2]Paul-Drude-Institut für Festkörperelektronik, Berlin, Germany — [3]Helmholtz-Zentrum Dresden-Rossendorf, Germany — [4]Quantum Beam Science Directorate, Japan Atomic Energy Agency, Hyogo, Japan

Compared to the vapor-liquid-solid growth modes of group III-V semiconductor nanowires (NWs), e.g. Au-assisted growth or the self-assisted growth of GaAs NWs, it is a matter of intense debate whether or not liquid Indium is involved during the self-assisted growth of InAs NWs. Here, we present the results of an *in-situ* study of the nucleation phase of InAs NW growth on Si (111). X-ray scattering and diffraction methods have been employed during NW-growth at the synchrotron beamline 11XU at SPring-8 using a MBE chamber integrated with a surface diffractometer. The characteristic scattering signals from liquid In as well as the diffracted intensity of the crystalline NWs growing in the wurtzite (WZ) phase have been monitored during growth. We find that liquid In is present during the initial stage of growth, associated with the formation of extended WZ segments in the NWs. After the nucleation phase of the NWs, the liquid In vanishes, accompanied by a more defective crystal structure with a large number of stacking faults. The results are in accordance with a growth model, predicting a transition from locally In-rich to locally As rich conditions.

HL 23.3 Mon 16:30 POT 006

Ga droplet templates: Density control of self-assisted GaAs nanowires — •Hanno Küpers, Faebian Bastiman, Claudio Somaschini, and Lutz Geelhaar — Paul-Drude-Institut für Festkörperelektronik, Hausvogteiplatz 5-7, 10117 Berlin

The self-assisted growth of GaAs nanowires (NWs) on Si is a popular approach for integrating III-V materials on Si. However, growth on unpatterned Si substrates suffers from a lack of control over nanowire density and a high degree of parasitic growth. We report on a new two-step NW density control technique for self-assisted GaAs nanowires grown on Si(111) by molecular beam epitaxy. The first step involves pre-depositing Ga on the substrate utilising a relatively high Ga flux at elevated temperatures. The Ga droplet density can be controlled by changing the magnitude of the Ga flux and the duration of the Ga pre-deposition time. The resulting Ga droplet template provides selective density control for ensuing NW growth. In this second step a maximum of 50% of the Ga droplets can be successfully converted into vertical NWs. The magnitude of the As flux and the size distribution of the Ga droplets underpins both the observed NW yield and the type of parasitic growth. A 10% improvement in the vertical yield can be gained by including a droplet ripening step before As flux exposure in order to narrow the droplet size distribution, but the Gaussian nature of the distribution prevents access to a 100% vertical yield.

HL 23.4 Mon 16:45 POT 006

Transport measurements of ballistic quantum wires exposed to two magnetic spikes. — •Bernd Schüler[1], Mihai Cerchez[1], Hengyi Xu[1], Thomas Heinzel[1], and Andreas Wieck[2] — [1]Heinrich-Heine-Universität, 40225 Düsseldorf, Germany — [2]Ruhr-Universität, 44780 Bochum, Germany

Quantum point contacts (QPC) are still fascinating elementary structures, which can lead in combination with localized magnetic fields to quite interesting effects [A. Tarasov et al., Phys. Rev. Lett. 104, 186801 (2010)]. We have designed a ferromagnet/semiconductor hybrid structure device which consists of a combination of an AFM-defined QPC and localized magnetic fields in the form of two magnetic spikes (magnetic barriers) at sub-micron distances inside the channel. The transport measurements are performed in the open regime of the QPC as function of a superimposed, homogeneous perpendicular magnetic field and as function of the barrier height. On top of the mode depopulation we found transmission resonances which could be explained with theoretically predicted signatures of zero-dimensional states weakly bound by the magnetic field [H. Xu et al. Phys. Rev. B 84, 035319 (2011)].

HL 23.5 Mon 17:00 POT 006

Resistance profiling of freestanding GaAs nanowires by multitip STM — •Stefan Korte[1], Matthias Steidl[2], Hubertus Junker[1], Weihong Zhao[2], Werner Prost[3], Vasily Cherepanov[1], Bert Voigtländer[1], Peter Kleinschmidt[2], and Thomas Hannappel[2] — [1]Peter Grünberg Institut (PGI-3), Forschungszentrum Jülich, 52425 Jülich, Germany, and JARA-Fundamentals of Future Information Technology — [2]Photovoltaics Group, Institute for Physics, Technische Universität Ilmenau, 98684 Ilmenau, Germany — [3]CeNIDE and Center for Semiconductor Technology and Optoelectronics, University of Duisburg-Essen, 47057 Duisburg, Germany

Due to their specific one-dimensional geometry, III-V semiconductor nanowires are promising candidates for future optoelectronic devices. However, for the fabrication of novel high performance nanowire devices a precise control of doping profile is indispensable. We use a multitip STM as nanoprober to reveal the electrical transport properties of freestanding GaAs nanowires. *p*-doped GaAs nanowires are grown by Au-assisted metal-organic vapor-phase epitaxy (MOVPE) on GaAs(111)B and GaP(111)B substrates. Conductance profiles along the nanowires were obtained with four point probe measurements. Nanowires grown on different substrates, using a two temperature step growth mode or constant substrate temperature, all exhibit highly non-linear axial resistance profiles.

HL 23.6 Mon 17:15 POT 006

Investigation of the electrical properties of freestanding Zn-doped GaAs nanowires by a multitip STM — •Matthias Steidl[1], Hubertus Junker[2], Weihong Zhao[1], Stefan Korte[2], Werner Prost[3], Vasily Cherepanov[2], Bert Voigtländer[2], Peter Kleinschmidt[1], and Thomas Hannappel[1] — [1]Photovoltaics Group, Institute for Physics, Technische Universität Ilmenau, D-98684 Ilmenau — [2]Peter Grünberg Institut (PGI-3), Forschungszentrum Jülich, D-52425 Jülich and JARA-Fundamentals of Future Information Technology — [3]CeNIDE and Center for Semiconductor Technology and Optoelectronics, University of Duisburg-Essen, D-47057 Duisburg

The specific geometry of III-V semiconductor makes III-V semiconductor nanowires (NWs) to promising building blocks for novel semiconductor devices in future electronic and opto-electronic applications. In this context a homogeneous distribution of the dopant over the whole NW is of great importance. We have grown p-type Zn-doped GaAs-NWs on GaP(111)B using the Au-assisted vapor-liquid-solid growth mode in a metal-organic vapor phase apparatus with different growth procedures. For the electrical characterization we apply a multitip STM as a nanoprober and conduct four-point probe measurements on single free-standing NWs. With this technique we are able to measure resistance profiles with a high spatial resolution over almost the whole length of a nanowire. These measurements reveal that the resistivity is both dependent on the growth condition and the part of the NW. Generally, the resistivity at the NW base is orders of magnitude larger compared to the upper part of the NW.

HL 23.7 Mon 17:30 POT 006

Investigation of top-gated InAs nanowires with HfO_2 dielectric — •Marion Rosien[1,2], Torsten Rieger[1,2], Sebastian Heedt[1,2], Torsten Jörres[1,2], Thomas Schäpers[1,2], Detlev Grützmacher[1,2], and Mihail Ion Lepsa[1,2] — [1]Peter Grünberg Institute - 9, Forschungszentrum Jülich GmbH, 52425 Jülich, Germany — [2]JARA-Fundamentals of Future Information Technology

Electrical characteristics of top-gated InAs nanowire field effect transistors (FETs) with HfO_2 high-k gate dielectric are presented. The nanowires with diameters of about 60 to 80 nm are grown by molecular beam epitaxy (MBE) and coated with HfO_2. The HfO_2 is deposited ex-situ by atomic layer deposition (ALD), which benefits from a high conformity and a good thickness control. To investigate the impact of the gate, the oxide thickness is varied between 2 and 8 nm. Transfer times between the MBE and ALD are kept as short as possible to avoid any contamination. The nanowires are individually contacted by Ti/Au electrodes. The HfO_2 acts as an omega shaped gate dielectric with Ti/Au gate metal. The quality of the oxide and the interface between the nanowire and the dielectric is analyzed by DC electrical measurements of the FETs. In order to derive transport parameters from the measurements, the capacitance of the top gate is simulated for each individual nanowire. The carrier mobility and concentration, peak transconductance and the on/off ratio are presented and discussed.