HL 94: Quantum wires and nanocrystals: Optical properties

Time: Friday 9:30–11:00 Location: H13

HL 94.1 Fri 9:30 H13

GaN nanowires as opto-chemical sensors — •Jens Wallys[1], Sara Lippert[1], Florian Furtmayr[1,2], Sebastian Koslowski[1], Jörg Schörmann[1], Jörg Teubert[1], and Martin Eickhoff[1] — [1]I. Physikalisches Institut, Justus-Liebig-Universität Gießen, Germany — [2]Walter Schotky Institut, Technische Universität München, Germany

GaN nanowires (NWs) grown by plasma-assisted molecular beam epitaxy (PAMBE) feature a low density of structural defects and a high surface to volume ratio. Their electrochemical stability and strong luminescence at room temperature make them promising candidates for opto-chemical sensor applications.

In this contribution we examine Si-, Ge-, and Mg-doped GaN NW ensembles with different doping concentrations in contact with an electrolyte by photoluminescence (PL) spectroscopy and investigate the PL changes related to variations in the chemical environment. With a three electrode setup the potential at the NW electrode can be precisely controlled to optimize the signal response for specific sensing applications e.g. detection of small pH variations caused by biological systems.

The influences of doping with shallow donors (Si or Ge) or acceptors (Mg) on the response characteristics are discussed in terms of achievable sensitivity, detection energy, and measurement stability. The results will be discussed using a qualitative model for the PL response taking non-radiative surface recombination and charge transfer from the NWs to the electrolyte into account.

HL 94.2 Fri 9:45 H13

Optical properties and gas sensing capabilities of Ge and Si doped GaN nanowires — •Pascal Becker[1], Svenja van Heeswijk[1], Pascal Hille[1], Jörg Schörmann[1], Jörg Teubert[2], Sangam Chatterjee[2], Alexej Chernikov[1], and Martin Eickhoff[1] — [1]I.Physikalisches Institut, Justus-Liebig-Universität Gießen — [2]Philipps-Universität Marburg, Fachbereich Physik

We report on the optical properties and the optical gas response of Si- and Ge-doped self-assembled GaN nanowires (NWs) grown by plasma-assisted molecular beam epitaxy. GaN:Si and GaN:Ge NWs were grown on n-type Si(111) substrates with typical lengths of approx. 1.5 μm.

The NW ensembles were analyzed by temperature dependent and time resolved photoluminescence (PL) spectroscopy and the influence of Ge- and Si-doping was compared to undoped NW samples. Their emission properties are influenced by the doping concentration possibly by variation of the surface band bending (SBB).

Furthermore, the presence of oxidizing gases leads to a significant decrease of the PL-intensity. The doping concentration significantly influences this PL-quenching which will be interpreted in terms of SBB-variations.

HL 94.3 Fri 10:00 H13

Optical characterization of In(Ga)As/In(As)P nanowires with micro photoluminescence and absorption spectroscopy — •Michael M. Bormann, Julian Treu, Mengyu Liang, Simon Hertenberger, Stefanie Morkötter, Christian Grasse, Stephan Sprengel, Max Bichler, Markus-Christian Amann, Jonathan J. Finley, Gerhard Abstreiter, and Gregor Koblmüller — Walter Schottky Institut and Physik Department, TU München, Garching, Germany

In this work we present the optical properties of high-In content In(Ga)As nanowires (NW) and InAs/InAsP core-shell NWs grown by molecular beam epitaxy (MBE) and hybrid MBE-metal-organic vapor phase epitaxy on Si substrates. The emission characteristics of these NWs are measured either directly in free-standing geometry or after transfer in horizontal geometry by a specific micro photoluminescence (uPL) setup designed for the infrared spectral range. Both temperature and power-dependent measurements are performed highlighting the dynamics of the PL peak energy and intensities. The InGaAs NWs show a characteristic transition in PL peak energy with increasing Ga content and also with dominant wurtzite crystal phase [1]. In addition, we elucidate the effect of the InAsP shell thickness onto the intensity and near-band edge emission of InAs NWs. Furthermore, we present absorption measurements of homogeneous InGaAs NW arrays obtained with a UV/VIS/NIR setup. [1] S. Hertenberger, et al., Appl. Phys. Lett. 101, 043116 (2012).

HL 94.4 Fri 10:15 H13

Single core-shell GaAs/AlGaAs nanowires: a close look by near-field optical spectroscopy — •Alexander Senichev[1], Vadim Talalaev[1,2], Jörg Schilling[2], George Cirlin[3,4,5], and Peter Werner[1] — [1]Max-Planck-Institut, Halle, Germany — [2]Martin-Luther-Universität, ZIK "SiLi-nano", Halle, Germany — [3]A. F. Ioffe Physico-Technical Institute, St. Petersburg, Russia — [4]St. Petersburg Physics and Technology Center for Research and Education, St. Petersburg, Russia — [5]Institute for Analytical Instrumentation, St. Petersburg, Russia

We report on the growth and the study of optical properties of self-catalyzed GaAs/AlGaAs core-shell nanowires (NW). These GaAs/AlGaAs NWs were generated by molecular beam epitaxy. The presence of zincblende (ZB) and wurtzite (WZ) crystal phases in NW is discussed. We investigate a homogeneity of photoluminescence (PL) intensity along a NW and the appearing of features in PL spectra, corresponding to the exciton emission from ZB and WZ structure, with a high spatial resolution ($<$ 200 nm). For this purpose a low-temperature near-field scanning optical microscope operating at a temperature 10 K inside a high vacuum chamber was applied. Selecting of specific NW allow us to get PL and transmission electron microscopy measurements of the same single NW. Preliminary measurements showed inhomogeneous PL intensity distribution along NW and presence of additional spectral line in vicinity of NW apex. For statistical analysis, other NWs from the same growth series are under investigation.

HL 94.5 Fri 10:30 H13

Acousto-electric control of exciton dynamics in GaAs/AlGaAs core-shell nanowires containing a single radial GaAs quantum well — •Matthias Weiss[1], Jörg Kinzel[1], Daniel Rudolph[2], Max Bichler[2], Gregor Koblmüller[2], Gerhard Abstreiter[2], Jonathan Finley[2], Achim Wixforth[1], and Hubert Krenner[1] — [1]Lehrstuhl für Experimentalphysik 1 / Universität Augsburg, 86159 Augsburg,Germany — [2]Walter Schottky Institut / TU München, 85748 Garching, Germany

Radio frequency (RF) surface acoustic waves (SAW) represent a versatile tool to control and manipulate charge and spin excitations in semiconductor quantum structures. Here, we analyze the influence of the dynamic electric field induced by a SAW on the optical emission of single semiconductor nanowires. The investigated NWs consist of a GaAs core and an AlGaAs shell containing a single 5nm wide radial GaAs quantum well (QW). The optical emission is studied by conventional, low-temperature micro-photoluminescence (μ-PL) spectroscopy in combination with a stroboscopic excitation. For both, the GaAs core and the radial QW, at high SAW power, we observe clear signatures of acousto-electric exciton dissociation and conveyance of electrons and holes. However, in an intermediate range of SAW amplitudes, we observe fingerprints of quantum dot (QD)-like emission centers within the narrow QW. These QD manifest themselves by several sharp spectral lines which exhibit dynamic spectral shifts. Moreover, we observe intensity oscillations being connected to the local acoustic phase, which was previously observed by embedded, planar QD structures.

HL 94.6 Fri 10:45 H13

Band structure and photoluminescence on silicon nanocrystals — •Prokop Hapala and Pavel Jelinek — Institute of Physics , Academy of Sciences of the Czech Republic, Cukrovarnická 10, Prague, 16253, Czech Republic

Since the first observation of photoluminescence in silicon nanocrystals (SiNCs) there is a debate whether the band structure theory is appropriate to make any statements about this kind of systems. While translational symmetry - the fundamental assumption of Bloch theorem - is violated, the only rigorous treatment would be considering SiNC as a molecule with molecular orbitals (MOs) instead of bands. On the other hand, in literature it is common practice to use band structure arguments, such as "(in-)direct band gap" to rationalize optical properties of NCs. We analyze band structure of up to 3nm SiNCs using Fourier transform of MOs obtained from DFT calculations. By this method we can rationalize effects of surface passivation (-OH, -CHO, -H, -CH3) and size (1.5-3nm) on optical properties of SiNCs.