HL 41.1 Towards III-V semiconductor nanowire field effect transistors: Atomic layer deposition of Al nanowires
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NF nanowires — The InAs nanowires are grown by a vapour-solid mechanism in a molecular beam epitaxy system. The Al2O3 is deposited ex-situ in the ALD machine. Trimethylaluminum and ozone are used as precursors. In advance, deposition experiments on silicon substrates were performed to optimise the Al2O3 layer using XRR, ellipsometry and CV measurements for characterisation. High resolution transmission electron microscopy investigations on nanowires covered with Al2O3 show the high uniformity of the deposition process even for high nanowire density. Further, in-situ techniques for characterising single nanowires with source, drain and gate contacts using only one metallisation step. Preliminary DC measurement results on processed devices are presented and discussed.

HL 41.2 Different Approaches for Uncovering InAs/AlAs Quantum Dots — Evgeniya Shekemet, Raúl D. Rodríguez, Torsten Jagemann, Wolfgang Grünenthal, Dorenen Dentell, Alexander Török, Alexander Milechin, and Dietrich R. T. Zahn
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The versatile capability of tuning energy band-gap by changing size, and composition makes quantum dot (QD) materials of significant technological impact. In this work, towards the study of electronic, structural and vibrational properties of a single QD, we performed experimental investigations of InAs/AlAs QD in AlAs (InAs) matrix prepared by molecular beam epitaxy on GaAs substrates. We report on the systematic investigation of different surface preparation methods including crystal cleavage, ion milling, and mechanical polishing and their effect on the QD superlattice topology. We found that the less invasive sample processing method, namely crystal cleavage, preserves the desired surface structure but fails for the structures with growth defects. In this case the most optimal QD surface is achieved by ion milling at low temperature and low ion energy, what is revealed by atomic force microscopy. The structural defects introduced by preparation on QD superlattices, as well as degradation over time were investigated using Raman spectroscopy.

HL 41.3 MOVPE growth of InGaAs quantum dots on GaP for nanomemory cells — Gernot Stracke, Bertram Jaeger, Tobias Nowozin, Leo Bonato, Stephan Fiechter, Marco Schowalter, Andreas Rosenauer, and Detlev Hommel
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InGaAs quantum dots (QDs) are realized on GaP(001) substrates by metalorganic vapor phase epitaxy. A prospective application of such QDs is the fabrication of nanomemory cells. These QD memory cells promise to combine the fast write and erase times of a DRAM with the non-volatility of a Flash memory. By replacing GaAs with GaP as matrix material, an extension of the storage time of InAs QDs at room temperature from 0.5 ns to 1 s can be expected. Additionally, GaP offers the potential of integration with Si, since GaP and Si have almost the same lattice constant. The growth of coherent InGaAs QDs on GaP is found to depend critically on the deposition of a thin layer of GaAs prior to QD growth. On a bare GaP substrate the growth proceeds purely two-dimensional even for high indium concentrations of up to 83%. In contrast, Strantski-Krastanow growth of InGaAs QDs is observed already for indium concentrations as low as 25% when the surface of the GaP substrate is covered by 3 monolayers (ML) of GaAs. In0.25Ga0.75As/3 ML GaAs/GaP QDs exhibit luminescence around 1.9 eV. The storage time of holes in In0.25Ga0.75As/3 ML GaAs/GaP QDs is estimated to 3 μs at room temperature.

HL 41.4 High density (Ga,In)As/GaP self-assembled quantum dots — Matthias Heidemann, Sven Höfling, and Martin Kamp
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The large lattice mismatch between usual III/V materials and Si is one of the most important issues considering defect-free nucleation of layer structures for monolithic integration with Si CMOS technology. Among the III/V materials, GaP offers the lowest lattice mismatch to Si with only 0.37% at 300K and the incorporation of 2% nitrogen results in a perfect lattice match to Si. Since GaP has an indirect bandgap, a direct bandgap III/V material epitaxially grown on GaP is required and various materials and nanostructures have been proposed. Dilute Nitride Materials are used to enhance the direct bandgap character in GaAsPN/GaP and GaInPN/GaP quantum wells. By using quantum dots (QDs) the growth of larger lattice-mismatched nanostructures is possible, resulting in a direct bandgap without the incorporation of nitrogen.

In this work self-assembled InGaAs QDs embedded in GaP have been grown using molecular beam epitaxy. Based on these QDs, light emitting diodes and laser structures were fabricated and characterized. The latest results show QDs with a high density of 8.2×10^{10} cm^{-2} and photo-/electroluminescence signal up to room temperature.

HL 41.5 Whispering gallery modes in zinc-blende AlN microdisks embedded with cubic GaN quantum dots — Matthias Böger, Marcel Ruth, Stefan Declair, Cedrik Meier, Jens Förstner, and Donat Josef An
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Optical microcavities, like semiconductor microdisks offer applications in quantum information technology as well as low threshold lasing devices. Microdisks support strong confined whispering gallery modes (WGM). In the case of group III-nitrides only microdisks of wurtzite AlN/InN/GaN have been fabricated up to now. However, piezoelectric and spontaneous polarization fields in the polar (0001) c-direction of hexagonal GaN induce a Quantum Confined Stark Effect. These built-in electric fields influence the behavior of quantum confinement devices containing quantum dots (QDs). The recombination probability of electrons and holes is reduced due to a spatial separation of electron and hole wave functions and limits the performance of photonic devices. Therefore, the fabrication of real non-polar metastable cubic GaN (c-GaN) and AlN (c-AIN) in (001) growth direction is very interesting for future applications. To improve the light extraction efficiency QDs can be integrated into microdisks. This work reports on the growth of c-AIN layers and c-GaN QDs on 3C-SiC substrate by means of molecular beam epitaxy. The freestanding microdisk located on a 3C-SiC pedestal were fabricated by reactive ion etching. Morphological investigations were realized by scanning electron microscopy. WGMs were observed in low temperature micro-photoluminescence measurements.

HL 41.6 Confinement enhancement in InGaAs quantum dots by AlGaN barriers — Carsten Lauchs, Tim Aschenbrenner, Stephan Fiechter, Marco Schowalter, Andreas Rosenauer, and Detlev Hommel
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InGaAs quantum dots (QDs) are of great interest to realize single photon emitters for quantum cryptography. Single photon emission (SPE) up to 50 K was achieved utilizing spinodal phase decomposition for QD formation [S. Kremling, APL 100, 061115 (2012)]. One approach reaching SPE at 300 K is the implementation of a barrier which improves the confinement of charge carriers and thus the temperature
stability. Using InGaN as active layer, AlGaN is a promising barrier material because of its higher bandgap. Several sample series were grown by MOVPE with respect to diverse growth parameters e.g. growth temperature of the AlGaN barrier, barrier thickness and aluminum concentration of the barrier. For structural analysis by SEM samples without a GaN capping layer were used, whereby μ-PL investigations were made with capped samples. Based on SEM data the surface structures of the uncapped samples are divided in two phases with different indium concentration. The indium-rich phase consists mostly of islands and the indium-low is a meander-like structure which are QDs. On the basis of TEM data the quality of the AlGaN barrier in dependence of the aluminum concentration will be evaluated. Furthermore the capping of InGaN QDs with GaN or AlGaN and its problems will be discussed.