HL 14: Heterostructures

Time: Monday 9:30–11:15 Location: ER 164

HL 14.1 Mon 9:30 ER 164

The initial growth stages of MBE Ge films on PrO2(111)/Si(111) support systems — •Alessandro Giussani[1], Olaf Seifarth[1], Peter Rodenbach[1], Hans-Joachim Müssig[1], Peter Zaumseil[1], Thomas Weisemöller[2], Carsten Deiter[2], Joachim Wollschläger[2], Peter Storck[3], and Thomas Schroeder[1] — [1]IHP-Microelectronics, Im Technologiepark 25, 15236 Frankfurt (Oder), Germany — [2]University of Osnabrück, Barbarastrasse 7, 49076 Osnabrück, Germany — [3]SILTRONIC AG, Hanns-Seidel-Platz 4, 81737 München, Germany

In the framework of epitaxial GeOI heterostructures on Si for CMOS applications and III-V optoelectronic materials integration on the Si platform, the MBE growth of Ge on PrO2(111)/Si(111) heterostacks was studied by means of RHEED, XPS, UPS, GI-XRD. It was shown that in the first deposition stages a GeO2-like layer forms as a result of the interaction with the PrO2 substrate, namely the diffusion of lattice oxygen from the dielectric to the growing semiconductor deposit. In consequence the PrO2(111) buffer is fully reduced to a cubic Pr2O3(111) structure. As no oxidizing species are available in the process anymore, under continuous Ge evaporation the Ge oxide layer converts to GeO, which sublimates at the deposition conditions. The uncovered cubic Pr2O3(111) surface then provides a thermodynamically stable template for the heteroepitaxial growth of elemental Ge, which occurs according to a Volmer-Weber mode and results after island coalescence in the formation of a flat, single crystalline, untwined Ge(111) film.

HL 14.2 Mon 9:45 ER 164

Growth and electrical characterization of c-BN/ZnO-heterostructures — •Marc Brötzmann, Hayo Zutz, Anne-Katrin Nix, Carsten Ronning, and Hans Hofsäss — II. Physikalisches Institut, Universität Göttingen, Germany

In this work we investigated the conduction mechanism of c-BN/ZnO-heterostuctures. For this purpose several c-BN-films with various thicknesses between 80nm and 250nm were grown on ZnO-substrates using Mass Separated Ion Beam Deposition (MSIBD). The parameters during deposition were 450eV substrate-bias and a temperature of 250-300°C. After deposition the BN-thin-films were characterized by in-situ XPS- and EELS as well as ex-situ FTIR-measurements followed by an electrical measurement of each sample. Furthermore, the structure of grown c-BN films was investigated by transmission-electron-microscope (TEM)-measurements. In addition the effect of photon-irradiation on the samples was investigated by performing several photo current measurements at various light intensities. We will discuss the effect of the layered structure of c-BN-thin-films on the conduction mechanism and the results of photo-current-measurements of the c-BN/ZnO-heterostuctures.

HL 14.3 Mon 10:00 ER 164

Anisotropic light emission of single CdSe/CdS tetrapods due to asymmetric electron localization — •Thomas Limmer[1], Christian Mauser[1], Enrico Da Como[1], Andrey Rogach[1], Dmitri V. Talapin[2], and Jochen Feldmann[1] — [1]Photonics and Optoelectronics Group, Physics Department and CeNS, Ludwig-Maximilians-Universität München, Munich, Germany — [2]Department of Chemistry, University of Chicago, Chicago, IL, USA

We have recently reported on highly luminescent CdSe/CdS tetrapod heterostructures, where wurtzite CdS arms were grown on CdSe zinc-blend nuclei [1]. Due to the peculiar energy band alignment the holes remain trapped in the CdSe core, whereas electrons in ideal tetrapods are expected to delocalize symmetrically into the four CdS arms. However, polarization dependent photoluminescence experiments on single tetrapods show asymmetric localization effects for electrons. Whereas in optical excitation nearly no polarization anisotropy is observed, high polarization degrees are present in the emission process. Calculations based on the effective mass approximation show that the electron wavefunction confinement is very sensitive to changes in the shape of the tetrapods. Breaking the symmetry by increasing the thickness of one arm gives rise to a strongly asymmetric localization of the electron and leads to high polarization degrees in emission. The related decrease in electron-hole wavefunction overlap results in a correlation between emission intensity and polarization anisotropy in agreement with our experimental findings. [1] D. V. Talapin et al., Nano Lett. 7, 2951 (2007)

HL 14.4 Mon 10:15 ER 164

Tunneling spectroscopy of a p-i-n diode interface — Sebastian Loth[1], •Martin Wenderoth[1], Karen Teichmann[1], Jan Homoth[1], Karolin Löser[1], Rainer G. Ulbrich[1], Stefan Malzer[2], and Gottfried H. Döhler[2] — [1]IV. Physikalisches Institut, Georg-August-Universität Göttingen, Germany — [2]Universität Erlangen-Nürnberg, Max-Planck-Research Group, Institute of Optics, Information, and Photonics, Germany

The performance of modern semiconductor devices is largely influenced by the spatial distribution of dopants in the device's active region on the nanoscale. Since the late 80's Scanning Tunneling Microscopy (STM) was employed to study the local properties of p-n interfaces [1]. Most studies were carried out on p-n superlattices allowing the investigation of intrinsic features accessible without applied bias across the diode.

Here, a single GaAs p-i-n diode heterostructure is investigated with Cross-Sectional STM (X-STM) in a three-terminal configuration. External source and drain contacts control the electric field across the junction. Then, the diode's active region is mapped with atomic resolution. Local I(V)-spectroscopy (STS) directly resolves the band edge alignment from p to n for different diode bias conditions. The effect of the external electric field on the spatial and spectral images of individual dopant atoms in the active layer is discussed.

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[1] P. Muralt et al., Appl. Phys. Lett. 50, 1352 (1987).

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PLD growth of ZnO resonators based on all-oxide Bragg reflectors — •Helena Hilmer, Jan Sellmann, Chris Sturm, Rüdiger Schmidt-Grund, Holger Hochmuth, Jesús Zúñiga Pérez, Gregor Zimmermann, Jörg Lenzner, Christian Czekalla, Gabriele Benndorf, Michael Lorenz, Bernd Rheinländer, Anatoli Serghei, and Marius Grundmann — Universität Leipzig, Institut für Experimentelle Physik II, Linnéstr. 5, 04103 Leipzig

High quality microcavities are crucial for reaching strong coupling of excitons and photons (exciton-polaritons) and finally to obtain a Bose-Einstein condensate of exciton-polaritons. For this, high reflective mirrors and a cavity with smooth interfaces are necessary. Furthermore, the active medium should be distinguished by a narrow linewidth of the optical emission. For this purpose, ZnO-based microcavity resonators are promising systems.

Planar resonators with ZnO as cavity material and active medium embedded between ZrO_2/Al_2O_3 Bragg reflectors have been grown on c-plane sapphire substrates by means of pulsed laser deposition. For the Bragg reflectors reflectivity values up to 99.8% at 3.3 eV and smooth interfaces ($R_a = 0.5$ nm) have been achieved. The structural and optical quality, i.e. smooth interfaces and narrow exciton linewidth, of the ZnO-layer are still a challenge. We discuss the influence of deposition rates, formation of a thin nucleation layer as well as replacing ZrO_2 by YSZ on the properties of the cavity. The optical properties were analysed by spectroscopic ellipsometry and photoluminescence. The structural properties were examined by means of AFM and XRD.

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Influence of barrier thickness on AlInN/AlN/GaN heterostructure properties — •Lars Rahimzadeh Khoshroo[1], Christof Mauder[1], Ian Booker[1], Wanjiao Zhang[1], Daniel Wamwangi[2], Herbert Horn-Solle[3], Joachim Woitok[4], Matthias Wuttig[2], Andrei Vescan[1], Michael Heuken[1,5], Holger Kalisch[1], and Rolf Jansen[1] — [1]Institut für Theoretische Elektrotechnik, RWTH Aachen, Kopernikusstr. 16, 52074 Aachen — [2]Institute of Physics (1A), RWTH Aachen, Templergraben 55, 52056 Aachen — [3]Lehrstuhl für Lasertechnik, RWTH Aachen, Steinbachstr. 15, 52074 Aachen — [4]PANalytical B.V., P.O. Box 13, 7600 AA ALMELO, The Netherlands — [5]AIXTRON AG, Kackertstr. 15-17, 52072 Aachen

We report on four AlInN/AlN/GaN heterostructures on sapphire substrates with different grown in an AIXTRON metal organic vapor phase epitaxy reactor. High resolution X-Ray diffraction showed 15%In content and X-Ray reflection (XRR) measurements allowed a reliable thickness determination. However, the sample with the thinnest AlInN barrier thickness of 3.2 nm yielded no Hall results due to an increase of sheet resistivity from 372 Ω/* immediately after epitaxy, to 972 Ω/* two weeks later. This increase weakens with increasing barrier thickness. The samples with 4.2 nm, 7.1 nm and 9.3 nm barrier thickness yielded average charge carrier densities and average mobilities (ordered by increasing thickness) of 0.89 x 1013 cm-2, 1.45 x 1013 cm-2, 1.78 x 1013 cm-2 and 1510 cm2/Vs, 1410 cm2/Vs, 1550 cm2/Vs. We assume a stronger detrimental influence on the charge carrier concentration by a changing surface potential at low barrier thicknesses.

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MOVPE Wachstum und Charakterisierung von AlInN HFET Strukturen — •Christoph Hums, Aniko Gadanecz, Armin Dadgar, Jürgen Bläsing, Thomas Hempel, Hartmut Witte, Annette Diez, Jürgen Christen und Alois Krost — Institut für Experimentelle Physik, Otto-von-Guericke-Universität Magdeburg

AlInN / GaN Heterostrukturen werden heute für unterschiedliche elektronische (HFET, Sensoren) und opto-elektronische (RCLED, VCSEL) Bauelemente eingesetzt. Dabei wird zumeist die Möglichkeit genutzt, dass AlInN bei einem Indiumanteil von 17,4% gitterangepasst auf GaN wächst und dadurch verspannungsfreie Strukturen realisiert werden können. Über die Wachstumsbedingungen und die Eigenschaften von $Al_{1-x}In_xN$ mit x > 0,18 ist dagegen wenig bekannt. Das Wachstum ist wegen der unterschiedlichen Wachstumsparameter von AlN und InN eine Herausforderung. In dieser Arbeit wird das MOVPE Wachstum von $Al_{1-x}In_xN$ in einem weiten Konzentrationsbereich (0,09 < x < 1) beschrieben und die Eigenschaften des ternären Halbleiters mit HR-XRD, AFM und FEREM Messungen untersucht. Es kann gezeigt werden, dass die Mischungslücke kleiner ist als durch theoretische Berechnungen prognostiziert. Die kritische Schichtdicke für pseudomorphes Wachstum wurde in einem Mischungsbereich von 0,09 < x < 0.34 ermittelt. Auf Grund der spontanen- und piezoelektrischen Polarisation wird für x > 0.3 an der Grenzfläche zwischen AlInN und GaN ein 2D Löchergas erwartet, welches aber mit Hall-Effekt Messungen bislang nicht nachgewiesen werden konnte. Es werden verschiedene mögliche Gründe für die Abwesenheit des 2DHG diskutiert.