HL 41: Nitrides: Preparation

Time: Tuesday 11:45–13:00 Location: POT 06

HL 41.1 Tue 11:45 POT 06

Molecular beam epitaxy and characterization of InGaN nanowires on Si (111) — •Saskia Weiszer[1], Maximilian Kolhep[1], Maria de la Mata[2], Jordi Arbiol[2], and Martin Stutzmann[1] — [1]Walter Schottky Institut and Physics Department, TUM, 85748 Garching, Germany — [2]Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and The Barcelona Institute of Science and Technology (BIST), UAB, 08193 Bellaterra, Spain

InGaN has a variable band gap that covers nearly the entire solar spectrum. Combined with Si, theoretical considerations show that an InGaN/Si solar cell could be an optimal implementation of a double-junction cell. In particular at an In content of around 50%, it is expected that a resonant tunnel junction is formed between both materials. Furthermore, the cell efficiency could be increased by growing nanowires instead of thin films to make use of the fact that nanowires act as a natural anti-reflection coating and to reduce structural defects. InGaN nanowires on Si (111) are grown via molecular beam epitaxy. Different growth series with varying III/V ratio, substrate temperature and Ga/In ratio are characterized by EDX, HRXRD and Raman scattering. EELS elemental maps of single nanowires confirm a strong fluctuation of In content within the InGaN nanowires. Despite the compositional inhomogeneity of InGaN nanowires, electrical characterization of nominally intrinsic InN nanowires grown on differently doped Si (111) substrates has been performed. With regard to device fabrication, first results of selective area growth of InN nanowires with different mask materials are discussed.

HL 41.2 Tue 12:00 POT 06

Growth Analysis of GaN Quantum Dots using Cathodoluminescence Microscopy — •Hannes Schürmann, Christoph Berger, Sebastian Metzner, Gordon Schmidt, Peter Veit, Frank Bertram, Armin Dadgar, Jürgen Bläsing, André Strittmatter, and Jürgen Christen — Institute of Experimental Physics, Otto-von-Guericke-Universitity Magdeburg, Germany

GaN quantum dots in AlN are grown by MOVPE applying a growth interruption after the deposition of a thin GaN film. The impact of this growth interruption on the formation of quantum dots is comprehensively analyzed using highly spatially and spectrally resolved cathodoluminescence (CL) microscopy. Structural properties were investigated using scanning transmission electron microscopy. The CL investigation reveals a drastic reduction of the spatial and spectral width of emission with the formation of GaN quantum dots. Time delayed CL spectra show further evidence of successful quantum dot growth.

HL 41.3 Tue 12:15 POT 06

Investigation of MBE grown AlN and InN layers under the effect of additional Ga acting as a surfactant — •Christopher Hein, Andreas Kraus, Heiko Bremers, Uwe Rossow, and Andreas Hangleiter — Institut für Angewandte Physik, Technische Universität, Braunschweig , Deutschland

Heteroepitaxial growth is always accompanied by misfit strain which, above a certain thickness, leads to relaxation and deterioation of the grown layer. In our work we investigate the surfactant effect of Ga on MBE growth of InN and AlN layers. Templates were 2.5μm thick GaN layers grown in our AIX-200 RF MOVPE on c-oriented sapphire. The 16 nm InN layers were grown at 490°C substrate temperature in a double pulsed growth scheme (10s In deposition, 15s nitridation). The AlN samples consist of a previously grown MBE GaN buffer layer, followed by a low temperature AlN interlayer and finally the AlN epilayer in Al pulsed mode. Growth temperatures were 745°C for the GaN buffer and AlN epilayer whereas the interlayer was grown at 500°C. The comparison samples had an additional Ga flux during their metal pulses. In case of InN using surfactant Ga led to a reduced RMS surface roughness from 4.4 nm down to 2.2 nm (16μm^2 area) which was accompanied by a remarkable increase of surface coalesence. An increase of structural quality for the AlN layers was observed, as indicated by (0002) and (10$\bar{1}$0) ω-FWHM reductions from 817” to 766” and 2736” down to 2160” respectively. XRD shows no incorporation of Ga into the epilayers. We will elaborate on the consequences for growth of quantum dot structures on surfaces grown under the influence of a surfactant effect.

HL 41.4 Tue 12:30 POT 06

high quality Al films grown by molecular beam epitaxy — •Bowen Sheng[1], Yixin Wang[1], Zhaoying Chen[1], Ping Wang[1], Frank Bertram[2], Jürgen Christen[2], and Xinqiang Wang[1] — [1]SKLAMMP, School of Physics, Peking University, Beijing, China — [2]IEP, Otto-von-Guericke-University Magdeburg, Magdeburg, Germany

With the development of plasmonic devices in the past decade, various plasmonic applications such as plasmonic nanolasers[1], plasmon enhanced single photon emission etc.,[2] attracted much attention. However, nanoscale plasmonic devices are extremely sensitive to the metal and interface quality. Among those three metals used frequently to generate plasmons–gold, silver, aluminum (Al), Al is the most promising metal for ultraviolet plamonics devices, due to the interband transition or absorption of gold and silver in UV regime.[3]

In this work, we demonstrate the successful growth of atomic flat single crystalline Al thin films on Si(111) substrates by molecular beam epitaxy (MBE). The growth temperature and Al flux have been modified to optimize the crystalline quality and surface morphology of Al film, and finally we get high-quality Al film with mirror-like surface. The surface morphology was measured by AFM, revealing a root-mean-square roughness of 0.395nm. The FWHM of the XRD rocking curve is 564 arcsec, which indicates the realization of high-quality Al films. Other detailed analysis will be reported as well.

[1] Lu et al.Science 2012, 337(6093), 450-453; [2] Gong et al. Proc. Nat. Ac. Sci. 2015, 112(17), 5280-5285; [3]Chou et al. Sci Rep 2016, 6.

HL 41.5 Tue 12:45 POT 06

MOVPE-growth of GaN quantum dots on deep UV AlN/AlGaN distributed Bragg reflectors — •Christoph Berger, Hannes Schürmann, Sebastian Metzner, Gordon Schmidt, Jürgen Bläsing, Armin Dadgar, Frank Bertram, Jürgen Christen, and André Strittmatter — Otto-von-Guericke-Universität Magdeburg

GaN quantum dots are potential candidates to realize single photon emitters at room temperature due to their large exciton binding energy and zero-dimensional confinement potential. We observe sharp emission lines from quantum dot states in single GaN islands. These islands are realized by growing a thin GaN layer on an AlN buffer. Applying a subsequent growth interruption allows formation of GaN islands by material desorption. For cavity enhancement of the spontaneous emission, the quantum dots are embedded in an AlN cavity on a highly reflective AlN/AlGaN DBR. Adapted to the QD emission, the DBRs are designed for the deep UV spectral region at wavelengths around 270 nm. Growing 50 pairs of $AlN/Al_{0.7}Ga_{0.3}N$ on a thin AlN buffer, crack-formation could be prevented on large wafer areas and reflectivities above 90 % are realized. Structural and optical properties of the DBRs and quantum dots are investigated by XRD, AFM, TEM and cathodoluminescence performed in a SEM and in a transmission electron microscope (STEM-CL).