HL 61: GaN: Preparation and Characterization II (mainly structural)

Time: Wednesday 15:00–16:15 Location: EW 202

HL 61.1 Wed 15:00 EW 202

Effect of the growth conditions on the early stages of pyramidal semipolar template growth — •Jan Wagner, Clemens Waechter, Julian Mack, Michael Jetter, and Peter Michler — Institut für Halbleiteroptik und Funktionelle Grenzflächen and Research Center SCoPE, Universität Stuttgart, Allmandring 3, 70569 Stuttgart, Germany

The nitride material system is in the focus of many research studies for several years now because of the large tunability of the emission energy over the visible range. A challenge that occurs is the huge influence of the Quantum Confined Stark Effect (QCSE) which reduces the emission efficiency dramatically. One approach to manage this problem is the use of native non- or semi-polar substrates which are still quite expensive. A promising alternative for those substrates is the use of semipolar surfaces grown by epitaxial lateral overgrowth (ELO). The growth of active layers on the facets of GaN pyramids re- duces the QCSE and therefore enhances the emission efficiency. Since the pyramid facets serve as growth template for the active region, their crystalline quality directly affects the emission efficiency. This contribution therefore deals with the early growth stages of the GaN pyramids grown at different growth times and growth conditions. The structural investigation reveal the internal defects and gives an insight on the material quality in the pyramids and their facets.

HL 61.2 Wed 15:15 EW 202

Epitaxy and characterization of $Al_{1-x}In_xN$ grown by low pressure MOVPE on various substrates — •Ernst Ronald Buss, Uwe Rossow, Heiko Bremers, and Andreas Hangleiter — Institut für Angewandte Physik, TU Braunschweig

Due to the advantages of $Al_{1-x}In_xN$ compared to $Al_xGa_{1-x}N$ regarding lattice mismatch and contrast in refractive index to GaN it is a very promising material for claddings in GaN based laser structures. To minimize optical losses the $Al_{1-x}In_xN$ layers have to be quite thick, of high crystalline quality and very smooth.

Lattice matched $Al_{1-x}In_xN$ grown by low pressure MOVPE exhibits a typical surface morphology for small layer thicknesses consisting of small features of about 100 nm in diameter, some of which are decorated with a pit inside. To investigate the influence of parameters like the strain state of the $Al_{1-x}In_xN$, the defect density of the substrate, the material of the underlying layer, or the presence of $(1\bar{1}01)$ facets on surface morphology we performed growth experiments of single layer samples and multi layer structures on various substrates and templates. It turned out that the surface of $Al_{1-x}In_xN$ gets more fine-grained with increasing layer thickness. Varying the material of the underlying layer we were able to initiate the fine-grained morphology for thinner layers. For very large layer thicknesses, as well as for stacked sample structures of $Al_{1-x}In_xN$ and GaN with a large total film thickness of $Al_{1-x}In_xN$ we can observe a splitting in the composition independent of the properties of the underlying material. Hence, the origin of this splitting must be an instability during growth.

HL 61.3 Wed 15:30 EW 202

InGaN(0001) surface reconstructions — •C. Friedrich[1], A. Biermann[1], N. Esser[1,2], M. Kneissl[1], and P. Vogt[1] — [1]TU Berlin, Inst. f. Festkörperphysik EW6-1, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Leibniz-Inst. für Analytische Wissenschaften - ISAS e.V., Albert-Einstein Str. 9, 12489 Berlin, Germany

Surfaces of the InGaN alloy system are hardly understood in terms of their atomic structure. In order to reveal the principal mechanisms for the formation of surface reconstructions the preparation of such surfaces for measurements in ultra high vacuum (UHV) is crucial. The preparation and surface structure of high quality group-III-polar (0001) InGaN layers grown by metal-organic vapor phase epitaxy have been investigated. We show that different InGaN surface reconstructions such as (1×1), (1+1/6), (2×2) and $(\sqrt{3}\times\sqrt{3})R30°$ can be obtained by annealing at various temperatures under ultra high vacuum and nitrogen-rich conditions as observed by low energy electron diffraction. Depending on the annealing temperature and nitrogen supply these surfaces exhibit significant differences in stoichiometry and morphology as determined by Auger electron spectroscopy and atomic force microscopy measurements. We show that the (2×2) and $(\sqrt{3}\times\sqrt{3})R30°$ are explained by indium-adatoms and a related In depletion in the first group-III layer underneath whereas the (1+1/6) exhibits a discommensurate overlayer of group-III-atoms. Strain-relaxation is suggested to explain this structure formation.

HL 61.4 Wed 15:45 EW 202

Determination of piezoelectric fields in GaN/InGaN/GaN quantum wells by DPC — •Josef Zweck[1], Matthias Lohr[1], Michael Jetter[2], Clemens Wächter[2], Thomas Wunderer[3], and Ferdinand Scholz[3] — [1]Physics Faculty, University of Regensburg, FRG — [2]Institute for semiconductor optics and functional interfaces, Stuttgart University, FRG — [3]Institute for optoelectronics, Ulm University, FRG

Differential phase contrast microscopy senses the local electric field by measuring the deflection of the probe beam after passing through a specimen area carrying an electric field.

An application of the technique to measure piezoelectric polarization fields inside multi-layered structures such as quantum wells is demonstrated. For this purpose, piezoelectric fields within noncentrosymmetric crystal structures, based on GaN/InGaN/GaN quantum wells, are investigated. It can be shown that the technique is sensitive to these fields and yields detailed and quantitative information about the field distribution. The specific information and experimental limitations will be discussed in detail and first measurements are shown.

The main advantages turn out to be high sensitivity for electric fields, combined with a very high resolution in the nanometer regime, which is only limited by the STEM probe size. Another advantage is the large achievable field of view.

HL 61.5 Wed 16:00 EW 202

Investigation of the influence of InGaN underlying layers on the optical properties of InGaN quantum well structures — •Mathias Müller[1], Anja Dempewolf[1], Frank Bertram[1], Thomas Hempel[1], Antje Rohrbeck[1], Jürgen Christen[1], Alois Krost[1], Wang Lai[2], Wang Jiaxing[2], Wang Lei[2], and Luo Yi[2] — [1]Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, Germany — [2]Department of Electronic Engineering,Tsinghua University, Beijing, China

The optical properties of InGaN/InGaN multiple quantum wells (MQWs) with InGaN underlying layers (UL) on sapphire substrates have been comprehensively investigated by highly spatially and spectrally resolved cathodoluminescence microscopy (CL) at He temperature and by temperature dependent photoluminescence spectroscopy (PL). The Indium content of the UL was systematically varied from 1% to 4% between the samples. SEM and AFM measurements were used to examine the sample morphology. The evaluation of the temerature dependent PL measurements shows a rising activation energy of nonradiative centers with increasing In content. CL investigations of the sample surface show elongated structures in the integral intensity images and peak wavelength images, which becomes more spot-like with rising In content. The peak energy of the MQW luminescence shows a blueshift with rising In content which may be caused by a possible reduction of the quantum confined Stark effect (QCSE). At the same time the FWHM of the MQW emission is reduced from 27 meV to about 18 meV when introducing ULs.