HL 96: Poster III C (III-V Semiconductors incl. Nitrides)

Presenters are kindly requested to be near their poster for at least one hour in the time between 16:00-18:00 or to leave a note about their availability for discussions.

Time: Thursday 14:00–20:00 Location: Poster B

HL 96.1 Thu 14:00 Poster B

Use of In-Plane-Gate transistors for sensing of dielectrics — •Benjamin Gerd Feldern, Arne Ludwig, and Andreas Dirk Wieck — Angewandte Festkörperphysik, Ruhr Universität Bochum, Germany

The Idea of this work is to examine the ability of In-Plane Gate field effect transistors (IPG-FET)[1] based on GaAs/$Al_xGa_{1-x}As$ to sense dielectrics and to determine the dielectric function from the measurements. The work is motivated by the observation that organic IPG-FETs were shown to be able of sensing different organic molecules[2]. The change of the transconductance on presence of dielectrics is supposed from the shielding of the electric field between gate and source contact. This is assumed from polarization of the molecules due to the electric field. Additionally, an ac-gate-source field might be able to excite resonant modes of the molecule, thus leading to additional polarization. The measurements shown address the question of effect of an ac-gate voltage in the kHz region.

[1] J. Nieder, A D. Wieck, P. Grambow, H. Lage, D. Heitmann, K. v. Klitzing, and K. Ploog, "One-dimensional lateral field-effect transistor with trench gate-channel insulation", Appl. Phys. Lett . **57**, 2695 (1990). [2] J. Kettle, S. Whitelegg, A.M. Song, D.C. Wedge, L. Kotacka, V. Kolarik, M.B. Madec, S.G. Yeates, and M.L. Turner; Nanotechnology **21** 075301 (2010).

HL 96.2 Thu 14:00 Poster B

Fabrication of nanopattern arrays of gold dots for nanowire arrays on GaP substrates by electron-beam lithography — •Emad H. Hussein[1,2], Vanesa Hortelano[1], M. P. Semtsiv[1], and W. T. Masselink[1] — [1]Institut für Physik, Humboldt Universtät zu Berlin, Newtonstrasse 15, 12489 Berlin, Germany — [2]Department of Physics, college of Science, Al-Mustansiriyah University, Iraq

Fabrication of high-density and uniformly distributed gold dots on GaP (100) substrates using electron-beam lithography (EBL) was carried out. A positive EBL resist of PMMA (polymethyl methacrylate -600k) with a nominal thickness about 300 nm was spun onto the substrate and immediately baked on a hotplate at 160 $^{\circ}C$ for 3 min. The pattern on the PMMA resist was written using a Raith nanolithography system connected to a JEOL JSM- 6360 scanning electron-microscopy. Arrays of 100 × 100 μm^2 including holes patterns have been printed on the resist. We optimized the electron beam acceleration voltage to less than 15 kV and exposure doses between 150 and 220 $\mu c/cm^2$ that are needed to generate a high-contrast pattern. A gold layer with thickness of 35 nm was evaporated onto the produced pattern and lifted off. The resulting nanopattern of gold dots with diameter about 130 nm and density of 3 × 10^7 cm^{-2} has been fabricated on the substrates. These patterns are used either to directly etch nano-columns in the GaP substrate or as etch masks for initiating organized arrays of GaP nanowires grown by gas-source molecular-beam epitaxy. Results of the pattering and of resulting nanowires will be discussed.

HL 96.3 Thu 14:00 Poster B

Rabi Oscillations of Photon Echo in (In,Ga)As Quantum Dots — •Matthias Salewski[1], Lukas Langer[1], Sergey V. Poltavtsev[1,2], Irina A. Yugova[1,2], Dimitri R. Yakovlev[1,3], Christian Schneider[4], Martin Kamp[4], Ilya A. Akimov[1,3], and Manfred Bayer[1,3] — [1]Experimentelle Physik 2, Technische Universität Dortmund, 44221 Dortmund, Germany — [2]Spin Optics Laboratory, St. Petersburg State University, 198504 St. Petersburg, Russia — [3]A.F. Ioffe Physical-Technical Institute, 194021 St. Petersburg, Russia — [4]Technische Physik, Universität Würzburg, 97074 Würzburg, Germany

We perform four-wave-mixing spectroscopy on an ensemble of inhomogeneously broadened (In,Ga)As quantum dots which are embedded into a cavity with low quality factor Q∼200. Enhancement of light-matter interaction in studied structures allows us to observe strong photon echo (PE) signals.

In our experiments we studied the dependence of the PE amplitude on the pulse area of ps-laser pulses for different polarization configurations. The oscillatory behavior of the PE amplitude as function of the first and second pulse areas is attributed to Rabi oscillations. We observe different envelopes for oscillations in various polarization configurations which is explained due to different contributions of exciton and trion sub-ensembles.

HL 96.4 Thu 14:00 Poster B

Optical properties of Bi-containing nanostructures on GaAs — •Julian Veletas, Nils Rosemann, Lukas Nattermann, Kerstin Volz, and Sangam Chatterjee — Faculty of Physics and Materials Sciences Center, Philipps-Universität Marburg, Renthof 5, D-35032 Marburg, Germany

Incorporating bismuth (Bi) into well studied GaAs-based devices leads to a promising way of tuning the band gap to telecom wavelength. Because of the large covalent radius of Bi the incorporation into the GaAs lattice is hindered and it tends to form nanoscaled structures at the substrate surface. Due to their metallic character these structures show interesting properties e.g., strong plasmonic effects. To investigate those nanostructures, we studied a series of Bi-containing nanostructures grown on GaAs substrates using photo modulated reflection spectroscopy.

HL 96.5 Thu 14:00 Poster B

Increase of efficiency of photoelectric transformers of solar concentrated energy on the basis of III-V semiconductor compounds — •Ia Trapaidze[1], Rafael Chikovani[1], Gela Goderdzishvili[1], Temur Khachidze[1], and Lia Trapaidze[2] — [1]Dep. of Physics, Georgian Technical University, 77 Kostava, 0175 Tbilisi, Georgia — [2]Dep. of Physics, Tbilisi State University, 3 Chavchavadze Ave., 0179 Tbilisi, Georgia

Georgia, as the Southern country is rich of solar energy. It is located in the Sun's belt. Using of solar energy for receiving the electrical and thermal energies is very important for Georgia. To increase the efficiency of using of solar element there are used the concentrators of optical radiation. They provide with concentration of incident beam energy on a wide area (on the surface of a concentrator) on relatively small area of a semiconductor crystal, which increases the power of electronic energy generated (labored out) by the photocell. And this means the increase of efficiency of using of the solar cells.

For the purpose to make more effective the removal of heat from the photocells, we consider it expedient to develop a new system for using to heat relieved from the photocell for heating the water.

HL 96.6 Thu 14:00 Poster B

Optical properties of GaN and InGaN/GaN microrods — •Christian Tessarek[1], George Sarau[1], Martin Heilmann[1], Robert Röder[2], Carsten Ronning[2], and Silke Christiansen[1,3] — [1]Max-Planck-Institut für die Physik des Lichts, Erlangen — [2]Institut für Festkörperphysik, Friedrich-Schiller-Universität Jena — [3]Helmholtz Zentrum Berlin für Materialien und Energie

Self-assembled GaN microrods on sapphire substrates have been grown by metal-organic vapor phase epitaxy. The smooth and straight sidewall facets and the regular hexagonal shape of the rods facilitate the use as microresonators. Respective whispering gallery modes (WGMs) can be observed in cathodo- (CL) and photoluminescence (PL) investigations [1].

A route towards an improvement of the optical activity in the GaN near band edge emission range will be discussed. Excitation density dependent PL investigations will show lasing activity in these microrods between 365 and 380 nm [2].

Finally, optical properties of GaN microrods covered with InGaN quantum wells (QWs) will be presented. An emission wavelength gradient along the microrod can be observed in spatially resolved CL measurements. The InGaN emission in the range between 400 and 500 nm is in superposition with WGMs having quality factors up to 1200.

[1] C. Tessarek et al., Opt. Express **21**, 2733 (2013).
[2] C. Tessarek et al., ACS Photonics **1**, 990 (2014).

HL 96.7 Thu 14:00 Poster B

Oxygen and hydrogen profiles and electrical properties of unintentionally doped n-GaN grown by HVPE — •Valentin Garbe[1,2], Barbara Abendroth[1], Hartmut Stöcker[1], Arkadi Gavrilov[2], Doron Cohen-Elias[2], Shlomo Mehari[2], Dan Ritter[2], and Dirk C. Meyer[1] — [1]Institute for Experimental Physics, TU Bergakademie Freiberg, Leipziger Str. 23, 09599 Freiberg, Germany — [2]Department of Electrical Engineering, Technion, Israel Institute of Technology, Haifa 32000, Israel

During hydride vapor phase epitaxy (HVPE) growth of GaN, oxygen and hydrogen are easily incorporated. Oxygen is an n-type dopant, while hydrogen may passivate some of the donors. In this work, we attempt to characterize commercially available 5 μm thick HVPE grown (0001) GaN (deposited on sapphire), which is unintentionally n-doped. On the basis of secondary ion mass spectrometry profiles provided by the manufacturer Kyma Inc., electrical (capacitance–voltage, Hall), structural (high resolution X-ray diffraction) and optical (polarized infrared spectroscopy) methods were utilized to derive a GaN layer model of the wafer, including doping profile and mobility. The model contains two different layers, a smooth GaN surface layer which exhibits lower carrier concentration but higher mobility, while a bottom layer shows higher background carrier concentration and lower mobility, because of high impurity incorporation. Oxygen seems to be the donor, substitutionally filling the positions of nitrogen vacancies, leading to the overall n-doping. Surprisingly, the effect of hydrogen passivation seems to play no role here.

HL 96.8 Thu 14:00 Poster B

Optical investigations on the effect of hydrogen on the internal quantum efficiency of GaInN LED structures — •Silke Wolter, Fedor Alexej Ketzer, Heiko Bremers, Torsten Langer, Uwe Rossow, and Andreas Hangleiter — Institut für Angewandte Physik, Technische Universität Braunschweig

GaInN based light emitting diodes being grown via low pressure MOVPE are investigated regarding the impact of hydrogen from the buffer layer on the active zone. So far hydrogen is used as carrier gas during the growth of the buffer layer. Therefore it is present in the reactor as also in the structure and may influence recombination of carriers and the efficiency of the LED in several ways. Hydrogen is known to influence incorporation as well as electrical activity of defects in GaN.

We compare structures having different surroundings of the quantum well with additional use of hydrogen and silane fluxes during the growth for raising the hydrogen content within the n-GaN buffer layer. The comparison is based on excitation power and temperature dependent photoluminescence (PL) spectroscopy. From the data we determine the internal quantum efficiency and compare it with time-resolved PL measurements to understand the influence of hydrogen on radiative and nonradiative recombination. Our results show that the growth of the layers close to the quantum well highly affects the efficiency of the LED. While low temperature PL shows high intensity, room temperature efficiency is decreased which may be attributed to a change in the density of background carriers.

HL 96.9 Thu 14:00 Poster B

In-situ UHV cathodoluminescence of MQW samples grown by MBE and MOVPE — •Kim Sandra Degener, Christopher Hein, Andreas Kraus, Heiko Bremers, Uwe Rossow, and Andreas Hangleiter — Institute of Applied Physics, TU Braunschweig, Germany

A special point of interest concerning the characterization of group-III-nitride heterostructures are their luminescence properties. Therefore in situ techniques are desired to analyze the optical quality and structure of group-III-nitride quantum films, in particular piezoelectric characteristics of samples without accumulated surface charge. Our experimental setup consists of a RIBER 32P MBE machine equipped with a STAIB instruments RHEED gun which we use as the excitation source for cathodoluminescence studies. The luminescence of the samples is then collected by an optical fibre cable positioned outside the chamber, sent into a Spex double spectrometer and measured by a photodiode. We compare the luminescence properties of MBE and MOVPE grown samples. MBE grown samples enable us to measure the luminescence properties of samples which have never been exposed to air. During air exposure an adsorption or oxide layer develops on the samples. The influence of such a layer on optical properties can be investigated by removing it in UHV conditions via heating combined with in-situ CL measurements.

HL 96.10 Thu 14:00 Poster B

Effects of rapid thermal annealing on the disorder and composition of Ga(N,As,P) quantum wells on silicon for laser application — •Sebastian Gies, Sarah Karrenberg, Martin Zimprich, Tatjana Wegele, Andreas Beyer, Wolfgang Stolz, Kerstin Volz, and Wolfram Heimbrodt — Faculty of Physics and Material Science Center, Philipps University Marburg, D-35032 Marburg, Germany

Realizing suitable light sources for optical data transmission on silicon is one of the major goals of optoelectronic integration nowadays. The quaternary Ga(N,As,P) is a promising candidate for this. Here, we present an analysis of the annealing effects on Ga(N,As,P) quantum wells (QWs) on silicon using PL, PL excitation and raman spectroscopy as well as transmission electron microscopy (TEM). The growth was performed using metal-organic vapor-phase epitaxy. After growth the samples underwent rapid thermal annealing for ten seconds at annealing temperatures between 800 °C and 1000 °C. Combining PL and raman spectroscopy an As-P-exchange could be revealed. Furthermore, we could quantify this exchange by conjunction of PLE experiments and QW calculations to be 5-10% at highest annealing temperatures. To further analyze the interplay of removing defects by annealing and creating new ones by As-P-exchange we studied the disorder of the Ga(N,As,P) QW. A two scaled disorder common for these materials was found. The behavior of the disorder was compared with the QWs morphology obtained by TEM measurements.

HL 96.11 Thu 14:00 Poster B

Type-II Excitons in (Ga,In)As/Ga(N,As)-quantum wells on GaAs — •Carsten Kruska, Sebastian Gies, Philip Hens, Wolfgang Stolz, Kerstin Volz, and Wolfram Heimbrodt — Faculty of Physics and Material Science Center, Philipps University Marburg, D-35032 Marburg, Germany

Quantum Well (QW) structures are used in many semiconductor devices. These systems inevitably contain interfaces, that influence the charge carriers. Since the recombination of type-II excitons takes place across the interface their properties are influenced by the interface, making type-II excitons an excellent probe to study internal interfaces. Here, we present an analysis of the recombination of spacially indirect (type-II) excitons in (Ga,In)As/Ga(N,As)-MQWs on GaAs.

The MQW structures under investigation were grown epitaxially using metal-organic vapor-phase epitaxy and consist of a (Ga,In)As-QW and a Ga(N,As)-QW separated by a GaAs interlayer of varying thickness. By adjusting the N-content the type-I or type-II behavior is achieved. The type-II transition between the electron in the Ga(N,As)-QW and the heavy hole in the (Ga,In)As-QW was observed and investigated depending on the interlayer thickness. Conjuction of experiment and QW-calculation using the transfer matrix method reveal the hetero-offset between the conduction bands of Ga(N,As) and GaAs to be 600 meV. For the heavy hole band within the errorbars no offset was found. Furthermore, time resolved measurements were performed to reveal the recombination dynamics of the type-II transitions and their interplay with the interface.

HL 96.12 Thu 14:00 Poster B

Study of Optical Emission Properties of InGaN Quantum Wells on Semipolar (20-21) and (20-2-1) orientations — •Nikolay Ledentsov Jr.[1], Ingrid Koslow[1], Christian Mounir[3], Tim Wernicke[1], Tore Niermann[1], Ulrich T. Schwarz[3], Markus Weyers[2], and Michael Kneissl[1,2] — [1]TU Berlin, Hardenbergstr. 36, 10623 Berlin, Germany — [2]Ferdinand-Braun-Institut, Gustav-Kirchhoff-Str. 4, 12489 Berlin, Germany — [3]Universität Freiburg, Georges-Köhler-Allee 106, 79110 Freiburg, Germany

Semipolar quantum wells (QW) exhibit polarized surface emission in contrast to polar QWs grown on the (0001) plane. This is caused by anisotropic and shear strain, leading to the mixing of the A,B and C valence bands. In this work we investigate the optical polarization of $In_{0.16}Ga_{0.84}N$ and $In_{0.25}Ga_{0.75}N$ 3.5nm single QWs grown on bulk GaN substrates with (20-21) and (20-2-1) orientation. Polarization resolved temperature- and excitation-dependent photo- (PL) and electro- (EL) luminescence measurements were performed on these samples. On (20-2-1) QWs we observe polarization ratios of 0.8-0.9 and band distances (ΔE) of 20-30meV at room temperature. These values agree with $k \cdot p$ simulations and literature. We found a strong dependency of ΔE on excitation power in PL measurement which could explain discrepancies between EL and PL measured ΔE values in the literature. (20-21) QWs exhibit low polarization ratios and do not correspond

with $k \cdot p$ simulations, a trend observed by many groups. This discrepancy is addressed by TEM measurements and their interpretation in connection with the PL results.

HL 96.13 Thu 14:00 Poster B

Spectroscopic characterization of Lanthanide-doped AlN and AlInN — •Sebastian Bauer[1], Miao Yang[2], Niklas Bayrle[1], Murat Yildirim[1], Matthias Hocker[1], Horst P. Strunk[2], and Klaus Thonke[1] — [1]Institute of Quantum Matter / Semiconductor Physics Group, University of Ulm, 89081 Ulm, Germany — [2]Institute of Materials Science, Chair of Materials Physics, University of Stuttgart, 70569 Stuttgart, Germany

Radiative electron transitions in the $4f$ shell of rare earth ions are of great interest for applications in optoelectronics as temperature-stable emitters of sharp spectral lines. Due to the wide band gap of the host semiconductor AlN, a wide range of the rare earth internal transitions is accessible.

We investigate polycrystalline rare earth doped AlN and AlInN layers with grain sizes in the nanometre regime. They were deposited by magnetron co-sputtering on Si(100) substrates, and doped with Praseodymium, Neodymium, Samarium, Terbium, and Thulium. The emission features recorded in temperature dependent photoluminescence using above or below bandgap excitation are assigned to their corresponding $4f$ states split by the hexagonal crystal field. Despite the polycrystalline nature of the samples, line widths below 0.5 nm were observed in the spectra. Furthermore, the influence of indium as a constituent in the host crystal, and of different annealing processes applied after deposition is discussed.

HL 96.14 Thu 14:00 Poster B

Combined and spatially correlated measurements by SEM-CL and EBIC on semiconductor microstructures — •Manuel Knab[1], Matthias Hocker[1], Ingo Tischer[1], Pascal Maier[1], Junjun Wang[2], Ferdinand Scholz[2], and Klaus Thonke[1] — [1]Institute of Quantum Matter/Semiconductor Physics Group, University of Ulm — [2]Institute of Opotoelectronics, University of Ulm

Among the crucial aspects for the successful realization of semiconductor-based light emitting diodes is the quality of both the pn-junction and the quantum well. The cathodoluminescence (CL) measurement technique provides important information about the radiative recombination in the semiconductor structure, especially in the quantum well. With the electron beam induced current (EBIC) setup we are able to gain access to the pn-junction quality. Both measurement techniques are applied in a scanning electron microscope yielding high spatial resolution. The investigations were performed on the identical spot of semipolar InGaN/GaN microstructures. The results show both correlation and anti-correlation of the respective signal intensities. These are discussed regarding the crystal quality, the quality of the pn-junction and of the quantum well. In conclusion we can provide a powerful tool for the analysis of the light emitting diode structures by the combination of CL and EBIC.

HL 96.15 Thu 14:00 Poster B

GaN quantum dot ensembles for capacitance-voltage measurements — •Carlo A. Sgroi, Arne Ludwig, and Andreas D. Wieck — Lehrstuhl für Angewandte Festkörperphysik, Ruhr-Universität Bochum, D-44780 Bochum, Germany

GaN and its alloys have excellent properties regarding thermal stability at ambient conditions, high thermal conductivity and wide bandgap energies, thus making it an ideal candidate for high power and high temperature microelectronic devices.

The aim of this study is to design a heterostructure by MBE growth for measuring self-assembled GaN QDs on $Al_xGa_{1-x}N$ by capacitance-voltage (C-V) spectroscopy. Whereas InAs - QDs on GaAs cease to exhibit their quantum character above a temperature of about T = 20 K, the higher bandgap of GaN will lead to a substantial higher working temperature of GaN - QDs.

$GaN/Al_xGa_{1-x}N$ heterostructure layers in the wurzite structure have deformed band structures due to polarization effects induced by doping and strain which complicates the prediction about the band structure and electrical properties.

Band structure simulations were run to calculate a decent tunneling barrier for C-V measurements capitalizing on the polarization effect and the quantum dot conduction band minimum close to the Fermi energy. Therefore, different Al-contents in the adjacent heterostructure layers are required. To establish a lower polarization effect and the demanded band structure, the Al-content is graded linearly. C-V measurements will be presented for different configurations.

HL 96.16 Thu 14:00 Poster B

Achieving step flow AlN growth by MOVPE — •Konrad Bellmann, Tim Wernicke, Markus Pristovsek, Frank Mehnke, Christian Kuhn, and Michael Kneissl — Technische Universität Berlin, Institute of Solid State Physics, Secretariat EW6-1, Hardenbergstrasse 36, 10623 Berlin, Germany

Wide bandgap devices based on nitride materials like UVC-LEDs and GaN QDs rely on smooth AlN base layers. Depending on the growth conditions the surface morphologies of AlN layers can vary between step bunches, step flow or spiral hillocks. The V/III ratio during growth has an important impact on the surface reconstruction resulting in a change in surface energy. This work will present a systematic study of AlN growth by metal organic vapor phase epitaxy(MOVPE). The growth of AlN at 1080 °C is investigated for different V/III ratios from 15 to 250. Depending on the V/III ratio a clear transition in surface morphology can be observed. For high V/III ratios AlN growth exhibits spiral growth. At low V/III ratio smooth surfaces with step flow growth are obtained. The data is interpreted with a kinetic model considering the balance between terraces width and diffusion length.

HL 96.17 Thu 14:00 Poster B

Experimental verification of electron scattering simulations for depth-resolved cathodoluminescnece — •Matthias Hocker[1], Pascal Maier[1], Ingo Tischer[1], Oliver Rettig[1], Robert A.R. Leute[2], Kamran Forghani[2], Ferdinand Scholz[2], and Klaus Thonke[1] — [1]Institute of Quantum Matter, Semiconductor Physics Group, University of Ulm, Ulm, Germany — [2]Institute of Optoelectronics, University of Ulm, Ulm, Germany

Scanning electron microscope cathodoluminescence (SEM-CL) has a high lateral resolution. However, the depth of the origin of the luminescence signal cannot be determined directly. By varying the primary electron (PE) energy and comparing the measurement results with Monte Carlo simulations of the PE scattering process inside the semiconductor material, depth-resolved SEM-CL measurements are possible. We applied this investigation method to different nitride semiconductor layer systems. In order to verify the validity of the simulation model, cross sectional SEM-CL measurements were perfomed as well.

HL 96.18 Thu 14:00 Poster B

Photoluminescence of Si-doped $Al_xGa_{1-x}N$ with aluminum mole fractions beyond 80% — •Dimitri Henning, Christoph Reich, Frank Mehnke, Tim Wernicke, Christian Kuhn, Harald Pingel, and Michael Kneissl — Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, 10623 Berlin, Germany

For the realization of deep ultraviolet light emitting diodes, highly conductive n-doped layers are needed. In this study we investigate the photoluminescence of Si-doped doped n-$Al_xGa_{1-x}N$ ($0.8<x<1$) layers grown by metal organic vapor phase epitaxy on epitaxially laterally overgrown AlN/sapphire templates. We found the resistivity is highly dependent on the SiH_4/III ratio leading to a narrow growth window. Si-doped n-$Al_xGa_{1-x}N$ layers with resistivites as low as 0.026 Ω cm have been realized. The n-AlGaN layers were excited by an ArF-excimer laser (193 nm) in a range between 5 K-300 K. Low temperature PL spectra show near band gap emission as well as different defect bands depending on the SiH_4/III ratio. Three major defect luminescence bands were identified as impurity transitions using assignments from literature as $(V_{III}\text{-complex})^{1-}$, $(V_{III}\text{-complex})^{2-}$, $(V_{III})^{3-}$ (listed high to low energy position). For SiH_4/III ratio below the optimum condition the emission related to the $(V_{III}\text{-complex})^{1-}$ appears to be the strongest defect luminescence band. At the optimum condition intensity of all defect luminescence bands reaches a minimum in comparison to the band edge luminescence. A higher SiH_4/III ratio leads to a strong increase of $(V_{III})^{3-}$ related defect luminescence.

HL 96.19 Thu 14:00 Poster B

Non-Classical Light Emission From GaN Quantum Wires — S. Kalinowski[1], G. Callsen[1], J. Teubert[2], J. Arbiol[3], P. Becker[2], G. Hönig[1], D. Bostanjoglo[1], •A. Bokov[1], A. Schliwa[1], M. Eickhoff[2], and A. Hoffmann[1] — [1]Technische Universität Berlin, Institut für Festkörperphysik,10623 Berlin, Germany — [2]Justus Liebig-Universität Gießen, I. Physikalisches Institut, 35392 Gießen, Germany — [3]ICREA and ICMAB-CSIC, Campus de la UAB, 08193 Bellaterra, Spain

Studying quantum effects in nitride-based nanowires with diameters scaling down to a few hundred nanometers is hindered by their still mostly bulk-like properties. A drastic diameter reduction towards the domain of the so-called quantum wires (QWRs) facilitates true one- dimensionality of the structures exhibiting confinement in two directions, while the third direction can straightforwardly be tailored. If the QWR length is sufficiently reduced one can approach the transitional regime between one- and zero-dimensional structures with drastic effects on the observed emission line characteristics and photon statistics.

Our results summarize the particular optical properties of novel GaN QWRs with special regard on the photon statistics. By tuning the QWR length as most vital parameter we can tune the emission characteristics yielding a natural transition between the optical properties of one- to zero-dimensional structures with strong perspectives for future photonic applications.

HL 96.20 Thu 14:00 Poster B

External Pressure on GaN/GaInN Quantum Wells: Influence of Strain on Internal Fields — •Hendrik Kuhn[1], Torsten Langer[2], Jens Hübner[1], Andreas Hangleiter[2], and Michael Oestreich[1] — [1]Leibniz Universität Hannover, Institut für Festkörperphysik, Abteilung Nanostrukturen, Appelstrasse 2, D-30167 Hannover, Germany — [2]Technische Universität Braunschweig, Institut für Angewandte Physik, Mendelssohnstrasse 2, D-38106 Braunschweig, Germany

Group III nitride based heterostructures are of strong interest since their versatile tunability in emission energy that is especially interesting for optical devices e.g. the blue LED [1]. However, as a piezoelectric material they contain an internal electric field that results in a small overlap of the wavefunctions of electron and hole and is the reason for a reduced quantum efficency. We examine GaN/InGaN quantum wells (QW) and apply external stress in order to vary the internal piezoelectric fields and thereby influence the optical properties of the QWs [2,3]. We measure time resolved photoluminescence and perform pump probe experiements on single and multiple GaN/InGaN QW under varied strain that is applied uniaxial and along the growth direction with a pressure cell. Additionally we measure the spin dynamics via Kerr rotation to gain information on the internal electric fields since the spin dephasing rate is directly related to the field via Rashba effect.

[1] Y. Nanishi, Nat. Photonics (2014). [2] S.L. Chuang and C.S. Chang, Semicond. Sci. Technol. 12, (1997). [3] A. Hangleiter et al., Phys. Status Solidi 216, (1999).

HL 96.21 Thu 14:00 Poster B

Optimization of Ohmic contacts of GaN HEMTs with AlN spacer — •Teresa Baur[1,2], Sebastian Mansfeld[2], Helmut Jung[2], Manfred Madel[2], Hervé Blanck[2], Jan Grünenpütt[2], Bernd Schauwecker[2], and Klaus Thonke[1] — [1]Institute of Quantum Matter / Semiconductor Physics Group, Ulm University, 89081 Ulm, Germany — [2]United Monolithic Semiconductors GmbH, 89081 Ulm, Germany

As a promising candidate for future microwave and millimeter-wave power devices, AlGaN/GaN high-electron mobility transistors (HEMTs) have attracted much research interest. In order to realize the full potential of AlGaN/GaN HEMTs as high-power, high-frequency, and high-temperature devices Ohmic contacts with low specific resistance are essential. The electron mobility in the two-dimensional electron gas (2DEG) can be increased by inserting a thin Aluminum Nitride spacer at the AlGaN-GaN interface, which reduces alloy scattering. This AlN spacer lowers the sheet resistance, but also typically leads to undesirable higher ohmic contact resistance.

A possible way to circumvent this disadvantage is to reduce the distance between the contact and the 2DEG by creating a recess prior to the metallization step. Electrical data extracted from the Transmission Line Measurement (TLM) confirm this theory.

In order to better understand the physical conduction mechanisms at the metal/semiconductor interface, temperature-dependent $I(V)$ measurements were undertaken for different sample configurations.

HL 96.22 Thu 14:00 Poster B

Strain and surface morphology in AlGaN-based UV-C laser heterostructures — •F. Krueger[1], C. Kuhn[1], F. Mehnke[1], M. Martens[1], P. Schneider[1], V. Kueller[2], J. Park[3], A. Knauer[2], J. Rass[1,2], T. Wernicke[1], M. Weyers[2], M. Lehmann[3], and M. Kneissl[1,2] — [1]Technische Universität Berlin, Institut für Festkörperphysik, Germany — [2]Ferdinand-Braun-Institut, Leibniz-Institut für Höchstfrequenztechnik, Berlin, Germany — [3]Technische Universität Berlin, Institut für Optik und Atomare Physik, Germany

UV laser diodes would be superior to conventional UV lasers in cost, size and robustness. However the realization of UV lasers has proven to be challeging due to insufficient n- and p-type doping as well as high dislocation densities in AlGaN/ sapphire heterostructures. In this work optically pumped AlGaN MQW lasers grown on defect reduced AlN/sapphire templates with lasing wavelengths between 250 nm and 280 nm are investigated. The surface morphology is strongly dependent on the growth conditions and exhibits step bunches, hillocks and V-pits. It was found, that the V-pit density correlates with the strain state of the QWs. By increasing the aluminum content in the QWs less strain is induced which leads to a reduced V-pit density and therefore less non-radiative recombination centers and mode losses. Additionally, the optimized QWs were embedded into a p-n-junction for current injection. For the p-side we investigated AlGaN:Mg cladding layers with an average aluminum content between 34%-81%. All heterostructures show electro-luminescence near 270 nm and increasing operation voltage with increasing aluminum content in the AlGaN cladding.

HL 96.23 Thu 14:00 Poster B

C-doped GaN buffer layers with CBr_4, C_3H_8 and Fe-doped GaN for breakdown voltage enhancement of HEMTs — •Andreas Lesnik, Jonas Hennig, Armin Dadgar, Jürgen Bläsing, Hartmut Witte, and Andrè Strittmatter — Institut für Experimentelle Physik / Abteilung Halbleiterepitaxie, Otto-von-Guericke-Universität Magdeburg

We investigated C-doped and Fe-doped GaN buffer layers grown on Si (111) substrates using metalorganic vapour-phase epitaxy (MOVPE). For the intentional C-doping a high purity 10% propane in hydrogen mixture and carbon tetrabromide (CBr_4) were used as precursors. For Fe-doping ferrocene was used as iron source. Secondary ion mass spectroscopy measurements were performed to quantify the incorporation behaviour of carbon and iron. X-ray diffraction and atomic force microscopy (AFM) were used to characterize the structural quality of the buffer layers. The horizontal and vertical buffer breakdown voltage in dependence of carbon and iron incorporation was investigated.