HL 43 GaN: Präparation und Charakterisierung II

Zeit: Montag 15:00–16:45 Raum: TU P164

HL 43.1 Mo 15:00 TU P164

Segregation von Dotieratomen in GaN — •M. Siebert, Th. Schmidt, J. I. Flege, S. Gangopadhyay, A. Pretorius, S. Einfeldt, S. Figge, D. Hommel und J. Falta — Institut für Festkörperphysik, Universität Bremen, Postfach 330 440, 28 334 Bremen

Im blauen Spektralbereich sind GaN-basierte Heterostrukturen von großer Bedeutung für die Anwendung in Laserdioden (LD) und Leuchtdioden (LED). In diesem Zusammenhang ist ein genaues Verständnis des Einbaus von Mg und Si, die als Dotieratome für p- bzw. n-Dotierung verwendet werden, notwendig. So wurde beobachtet, dass Mg-Dotieratome nicht homogen im GaN-Film verteilt sind, sondern in Abhängigkeit von der Dotierkonzentration unterschiedlich starke Tendenz zur Segregation zeigen. Zur genaueren Charakterisierung des Segregationsverhaltens wurden Experimente mit Photolelektronenspektroskopie (XPS) und Spektromikroskopie (ESCA-Mikroskopie) bei verschiedenen Dotierkonzentrationen durchgeführt. Dabei wurde festgestellt, dass Mg auch bei niedrigen Dotierkonzentrationen deutlich unterhalb der Schwellwertbedingung für die Bildung von Inversionsdomänengrenzen Segregation zeigt. Desweiteren konnte anhand von Spektromikroskopieexperimenten zum ersten Mal gezeigt werden, dass auch Si segregiert und sich dabei an facettierten Oberflächenrissen entlang der Kristallsymmetrieachsen anlagert.

HL 43.2 Mo 15:15 TU P164

Optical and magnetic properties of rare earth implanted AlN — •Gregor Öhl[1], U. Vetter[1,2], and H. Hofsäss[1] — [1]Georg-August-Universität, II. Physikalisches Institut, Friedrich-Hund-Platz 1, 37077 Göttingen — [2]Philipps-Universität, AG Oberflächenphysik, Renthof 5, 35032 Marburg

Rare earths (RE) in AlN already have been studied extensively. Nevertheless, as shown in recent studies e.g. on the system AlN:Gd [U. Vetter, Appl. Phys. Lett. 83,11 and Gruber, Vetter et al., Phys. Rev. B 69], where single systems with moderate Lanthanide doses implanted were investigated - RE in AlN show very promising features, e.g. for the use as electroluminescent emitters.

In this study we investigated single (at high doses) and double systems of RE in AlN thin films grown on SiC. The RE were implanted at different energies and fluences giving a square implantation profile. The implantation process was optimised, as was the post-implantation annealing procedure. RBS analysis was performed to monitor the annealing behaviour of the implantation profile, while possible clustering of the metal ions was monitored by XRD measurements. Optical properties were investigated by means of temperature dependent time-resolved cathodoluminescence studies, life-time and energy-transfer studies were performed on selected radiative intra-4f electron transitions of the implanted lanthanide ions. In addition, magnetic properties of the RE implanted AlN will be discussed.

HL 43.3 Mo 15:30 TU P164

MOCVD-grown GaMnN epilayers and nanostructures — •M. Strassburg[1,2], M.H. Kane[2,3], A. Asghar[2], Ch. Hums[1,4], J. Senawiratne[1], M. Alevli[1], N. Dietz[1], C.J. Summers[3], I.T. Ferguson[2], U. Haboeck[4], A. Hoffmann[4], D. Azamat[4], and W. Gehlhoff[4] — [1]Georgia State University, Department of Physics and Astronomy, Atlanta, GA 30302 — [2]Georgia Institute of Technology, Electrical and Computer Engineering, Atlanta, GA 30332 — [3]Georgia Institute of Technology, Materials Science and Engineering, Atlanta, GA 30332 — [4]Technische Universität Berlin, Institut für Festkörperphysik, D - 10623 Berlin

High-quality GaMnN epilayers and nanostructures providing room temperature (RT) ferromagnetism were achieved. The incorporation of up to 2-5 % of Mn was enabled without significant drop in the crystalline quality taking advantage of MOCVD growth. Structural quality and absence of second phases were confirmed by high-resolution XRD, AFM and Raman spectroscopy. Local coordination and environment, and the valence state of the magnetic dopants were identified by electron paramagnetic resonance (EPR). Direct correlation of the Mn induced midgap-band with the magnetization was observed. Using co-doping (Si, Mg), the RT magnetization were explored in MOCVD-grown n- and p-type GaMnN epilayers. Strong Fermi level dependence of the magnetization was observed until the complete loss of ferromagnetic behavior for Silicon concentrations of 10^{20} cm^{-3}. Hence, phase segregation or ferromagnetic clusters were ruled out to cause the observed ferromagnetism.

HL 43.4 Mo 15:45 TU P164

Selection rules for optical transitions of wurtzite InN — •P. Schley[1], R. Goldhahn[1], G. Gobsch[1], V. Cimalla[1], O. Ambacher[1], C. Cobet[2], N. Esser[2], J. Furthmüller[3], F. Bechstedt[3], H. Lu[4], and W.J. Schaff[4] — [1]Institut f. Physik, TU Ilmenau — [2]ISAS Berlin — [3]FSU Jena — [4]Cornell University Ithaca

Although it is now commonly accepted that the band gap of InN is lower than the long time used value of 1.9 eV, the large deviation between recently reported data (from 0.64 to 1.4 eV) requires clarification. One of the intrinsic properties of all nitrides is that the optical response at the band gap is strongly polarisation dependent due to the splitting of the valence bands at the Γ-point of the Brillouin zone, i.e. the absorption edge of the extraordinary dielectric function (DF) is shifted with respect to the ordinary one. We observed such a behaviour in the energy range below 1 eV. The DFs were determined by spectroscopic ellipsometry investigating a-plane InN films grown by MBE on r-plane sapphire substrates. From the energetic splitting the crystal field energy is determined with ∼30 meV taking into account the calculated spin-orbit energy of 12 meV (M. Cardona, Sol. Stat. Commun **116** (2000) 421). Knowing these energies we discuss the orientation dependence of oscillator strengths for the corresponding transitions. All results provide further evidence that InN has a band gap of about 0.65 eV at room temperature.

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MD-simulations of high pressure synthesis of single crystalline GaN — •Karsten Albe und Paul Erhart — TU Darmstadt, Insitut für Materialwissenschaft, Petersenstr. 23, D-64287 Darmstadt

Bulk synthesis of gallium nitride from nitrogen and liquid gallium at high-pressures is a promising way to produce defect free crystallites that can be used as seeds for MBE growth. We have performed atomic scale molecular-dynamics simulations in order to study the basic mechanisms of solid phase formation using a newly develeped bond-order potential that realistically describes the nitrogen gas phase, pure gallium as well as various solid structures of GaN. By varying the gas pressure we investigate the process of nitrogen saturation of the gallium melt and the corresponding conditions for GaN crystallization. Moreover, we elucidate the basic mechanisms for dissociation of N_2 dimers at the liquid-gas interface.

HL 43.6 Mo 16:15 TU P164

Determination of the 2DEG density of an AlGaN/GaN HEMT by electroreflectance spectroscopy — •A.T. Winzer[1], R. Goldhahn[1], G. Gobsch[1], A. Link[2], M. Eickhoff[2], U. Rossow[3], D. Fuhrmann[3], and A. Hangleiter[3] — [1]Inst. f. Physik, TU Ilmenau, PF 100565, D-98684 Ilmenau — [2]Walter Schottky Institut, TU München, Am Coulombwall 3, D-85748 Garching — [3]Inst. f. Techn. Physik, TU Braunschweig, Mendelssohnstraße 2, D-38106 Braunschweig

A method for determination of the 2DEG density of an $Al_xGa_{1-x}N$/GaN high electron mobility transistor (HEMT) will be presented. The technique is based on electroreflectance spectroscopy, i.e. on the analysis of the Franz-Keldysh oscillations and the determination of the electric field strength in the AlGaN layer. Another result of the method is the polarization discontinuity between AlGaN and GaN which represents the polarization charge bound at the AlGaN/GaN interface. This property is of fundamental interest for the design of HEMTs.

We have investigated a transistor structure with 23% Al-content in the barrier. Using a Schottky gate contact the 2DEG density was adjusted between 0 and 10^{13} cm^{-2}. Magnetotransport measurements confirm the precision of our method. Furthermore, our findings indicate a 22% lower polarization discontinuity than theory predicts, taking into account the spontaneous and the piezoelectric contribution [Ambacher *et al.*, J. Phys.: Condens. Matter **14**, 3399 (2002)]. The results are discussed in terms of a simple plate capacitor model and by self consistent conduction band calculations.

HL 43.7 Mo 16:30 TU P164

Characterization of epitaxially laterally overgrown GaN structures by micrometer-resolved X-ray Rocking Curve Imaging — •Daniel Lübbert[1,2], Tilo Baumbach[1], Petr Mikulik[3], Petra Pernot[1,4], Lukas Helfen[1,4], Stacia Keller[5], and Steven DenBaars[5] — [1]Institut für Synchrotronstrahlung, FZK, D-Karlsruhe — [2]Humboldt-Universität, D-Berlin — [3]Masaryk University, CZ-Brno — [4]ESRF, F-Grenoble — [5]University of California, Santa Barbara, USA

Epitaxial lateral overgrowth (ELO) of GaN works by growing a nucleation layer on a substrate and covering by a mask with laterally periodic openings. Upon subsequent regrowth of GaN, dislocations from the wetting layer can propagate vertically through these mask windows, but not usually into the lateral GaN wings growing on both sides of the windows. The GaN lattice quality in ELO wings is therefore expected to be superior.

We have performed experimental investigations of the *local* lattice quality in ELO structures using a technique of spatially resolved X-ray diffraction named *Rocking Curve Imaging*. It allows to monitor the crystal lattice quality and ELO wing tilt in individual periods of the laterally periodic structure, with spatial resolution down to one micrometer. Results show a highly inhomogeneous lattice tilt distribution across the sample surface. The progressive bending of laterally overgrown areas can be analyzed, showing both concave and convex curvature of ELO wings, depending on growth conditions. Samples grown on different substrates (SiC vs. sapphire) and by different growth sequences (1S- and 2S-ELO) will be compared in view of their crystalline perfection.