DF 27: Metamorphic structures: Bringing together incompatible materials II (Joint Focus Session with HL and DS)

Continuation of the morning session 'Metamorphic structures: Bringing together incompatible materials I'

Organizers: Ferdinand Scholz, Universität Ulm, and Andreas Hangleiter, TU Braunschweig.

Time: Thursday 15:00–16:30 Location: POT 251

Topical Talk DF 27.1 Thu 15:00 POT 251

Integration of cubic III/V semiconductors on silicon (001) — •Kerstin Volz — Philipps-Universität Marburg, Fachbereich Physik & Wissenschaftliches Zentrum für Materialwissenschaften

GaP layers on Si(001) can serve as pseudo-substrates for a variety of novel optoelectronic devices, like integrated lasers, solar cells and n-channel layers. The quality of the GaP nucleation layer is a crucial parameter for the performance of such a device. This presentation will summarize our current understanding of III/V heteroepitaxy on Si substrates and give several examples of successful integration of multinary III/V semiconductors on GaP/Si(001) virtual substrates.

DF 27.2 Thu 15:30 POT 251

Optical and structural characterization of an InGaN SQW embedded between quaternary InAlGaN barriers of varying In-concentration — •Christopher Karbaum[1], Frank Bertram[1], Marcus Müller[1], Peter Veit[1], Jürgen Christen[1], Jürgen Bläsing[1], Alois Krost[1], Martin Feneberg[1], Rüdiger Goldhahn[1], Jan Wagner[2], Michael Jetter[2], and Peter Michler[2] — [1]Institute of Experimental Physics, OvGUniversity Magdeburg, Germany — [2]IHFG, University Stuttgart, Germany

The change of the optical and structural properties of an InGaN SQW within InAlGaN barriers have been investigated using time resolved SEM-CL and STEM-CL spectroscopy at liquid helium temperature, PL, and HRXRD. The set of samples was grown on an optimized 1 μm thick GaN:Si buffer ontop of a c-oriented sapphire substrate. Subsequently, an InGaN SQW was embedded between InAlGaN barrier layers. The In gas flow during the pulsed MOVPE growth of these barriers was varied from 3 sccm up to 50 sccm. PL-spectra are dominated by the bound exciton emission of GaN (355 nm), a DAP at about 380 nm, the broad emission band from the InGaN SQW between 450 nm and 500 nm and the quaternary InAlGaN barrier emission. The fundamental idea behind the variation of the In-flux during growth is to achieve polarization matched conditions to decrease the QCSE of the InGaN SQW emission. For higher In-fluxes the InGaN emission undergoes a blueshift (150 meV) accompanied by a decrease of initial lifetime from 18 ns down to 5 ns. The temperature dependence of the luminescence and the recombination kinetics will be discussed.

DF 27.3 Thu 15:45 POT 251

Characterization of strained GaN on nanometer scale by IR near field microscopy — •Fabian Gaussmann[1], Stefanie Bensmann[1], Jochen Wüppen[1], and Thomas Taubner[1,2] — [1]Fraunhofer-Institut für Lasertechnik ILT, Aachen — [2]1. Physikalisches Institut 1A, RWTH Aachen Universität

Near-field microscopy combines the high spatial resolution of an atomic force microscopy with the depth of information that comes with spectroscopical analysis techniques. By using laser light in the mid IR range this technique is amongst others sensitive to the structure of polar materials like SiC or GaN. Regardless of the wavelength of the input laser light, the spatial resolution of these analyses is typical only a few tens of nanometer. This talk is focused on the characterization of strained gallium nitride systems. For near field analyses of GaN, laser light in the spectral range of 12 μm to 16 μm is required. This range, combined with a sufficient power density, is first covered by a novel developed tunable broadband laser system at the Fraunhofer ILT. While the two dimensional visualization of local stress fields using monochromatic laser systems is a common technique for near field analyses, we will present a method to transfer this capability to broadband laser systems. By recording single near field spectra, the optical properties and subsequent information for example about the strain, doping concentration or electron mobility can be achieved. Applied to cross-sections of layered systems, this technique gives a unique insight to the relaxation of crystal strain along the layer structure.

DF 27.4 Thu 16:00 POT 251

Measurement of strain in the InGaN/GaN heterogeneous nanostructures — •Tomaš Stankevič[1], Simas Mickevičius[1], Mikkel Schou Nielsen[1], Robert Feidenhans'l[1], Olga Kryliouk[2], Rafal Ciechonski[2], Giuliano Vescovi[2], Zhaoxia Bi[3], and Anders Mikkelsen[3] — [1]University of Copenhagen, Niels Bohr Institute, Copenhagen, Denmark — [2]GLO AB, Lund, Sweden — [3]Lund University, Nanometer Structure Consortium, Lund, Sweden

Growth and electrical properties of the core-shell nanostructures are often infulenced by the lattice mismatch induced strain. In contrast to planar films nanostructures contain multiple facets that act as independent substrates for the shell growth. In this study we present experimental results obtained by X-ray diffraction showing that the InGaN shells grown on the GaN cores are strained along each of the facets independently. Reciprocal space maps (RSMs) reveal multiple Bragg peaks corresponding to different parts of the shell strained along individual facet planes. Strained lattice constants were found from the peak positions. Vegard's law and Hooke's law for an anisotropic medium were applied in order to find the composition and strain in the InGaN shell. Simple atomistic kinematic simulations of the RSMs showed good agreement with the experimental data. We conclude that 8 nm the InGaN shells of up to 27% indium composition were nearly fully strained bixially along each of the $10\bar{1}0$ facets of the nanowires and the $10\bar{1}1$ facets of the nanopyramids.

DF 27.5 Thu 16:15 POT 251

Direct correlation of optical and structural properties of InGaN/GaN core-shell microrods by STEM-Cathodoluminescence — •Benjamin Max[1], Marcus Müller[1], Gordon Schmidt[1], Anja Dempewolf[1], Thomas Hempel[1], Peter Veit[1], Frank Bertram[1], Jürgen Christen[1], Martin Mandl[2], Tilman Schimpke[2], and Martin Strassburg[2] — [1]Institute of Experimental Physics, Otto-von-Guericke-University Magdeburg, Germany — [2]OSRAM Opto Semiconductors GmbH, Regensburg, Germany

We present a direct nano-scale correlation of the optical properties with the crystalline real structure of InGaN/GaN core-shell microrods using highly spatially resolved cathodoluminescence spectroscopy (CL). The characterized three microrod samples were grown by MOVPE on c-plane GaN/sapphire template via selective area growth using a SiO_2 mask: a GaN microrod reference structure without shell, a sample with InGaN single quantum well (SQW), and finally a complete core-shell LED structure were investigated. In all samples the GaN NBE emission originates exclusively from the compressively strained GaN template with an emission line at 356 nm. Spatially resolved CL mappings of the undoped sample and the LED structure exhibit luminescence from the InGaN SQW on the non-polar facet at about 400 nm. In contrast, on the semi-polar facet at the tip of the microrod the InGaN SQW luminescence is shifted to longer wavelengths. Additionally, the final core-shell LED structure shows DAP recombination at 380 nm, superimposing the InGaN SQW emission at the non-polar facets.