# DS 8: Semiconductor Nanophotonics: Materials, Models, Devices - GaN based Photonics I: Polaritzation Fields

Time: Monday 14:00–15:45 Location: H 2032

**Invited Talk** DS 8.1 Mon 14:00 H 2032

**High Efficiency Nonpolar InGaN/GaN based Blue Light Emitting Diodes and Laser Diodes** — •Steven P. DenBaars, Mathew C. Schmidt, Robert Farrell, Daniel Fezzell, Stacia Keller, James S. Speck, and Shuji Nakamura — Electrical and Computer Engineering and Materials Departments,University of California, Santa Barbara, California 93106, USA.

We report on the recent advances in the performance of nonpolar InGaN/GaN based blue light-emitting diodes (LEDs) grown on nonpolar a-plane and m-plane GaN. Significant improvement in the outputpower has been achieved by optimizing the growth conditions of the active region. Growth of nonpolar III-nitride based materials have attracted great attention in the recent years because of *polarization-free* heterostructures and the potential of improving the performance of (Al, Ga, In) N-based optoelectronic devices. However the poor structural quality of the planar a-plane and m-plane GaN templates limits the performance of the LEDs grown on them. In this work, we have studied thecontinuous wave (cw) and pulsed current performance of nonpolar InGaN/GaN LEDs and laser diodes grown on reduced defect bulk GaN.

High power and high efficiency nonpolar m-plane nitride light emitting diodes (LEDs) have been fabricated on low extended defect bulk m-plane GaN substrates. The LEDs were grown by metal organic chemical vapor deposition (MOCVD) using conditions similar to that of c-plane device growth. The output power and external quantum efficiency (EQE) of the packaged 300 - 300 $mm^2$ was 23.7 mW and 38.9%, respectively, at 20 mA. The peak wavelength was 407 nm and $<$ 1 nm redshift was observed with change in drive current from 1* 20 mA. The EQE shows a minimal drop off at higher currents.

Recently we have employed these nonpolar (m-plane) InGaN/GaN quantum structures into laser diodes without any Al-containing waveguide cladding layers. These devices utilize thick InGaN quantum wells to generate transverse optical mode confinement and can be grown and fabricated in a manner analogous to InGaN/GaN light emitting diodes. Pulsed and CW lasing operation was demonstrated,with threshold current densities of 3.7 $kA/cm^2$ and 4.3 $kA/cm^2$, respectively.

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**Invited Talk** DS 8.2 Mon 14:45 H 2032

**Polarization induced effects in GaN-based devices** — •Oliver Ambacher — Fraunhofer Institute for Applied Solid State Physics, Tullastr. 72, D-79108 Freiburg, Germany

The macroscopic non-linear pyroelectric polarization of wurtzite AlGaN, InGaN and AlInN ternary compounds dramatically affects the optical and electrical properties of multilayered Al(In)GaN/GaN hetero-, nanostructures and devices, due to the huge built-in electrostatic fields and bound interface charges caused by gradients in polarization at surfaces and heterointerfaces. In the presentation we review the theoretical and experimental results of the elastic and pyroelectric properties of binary and ternary group-III-nitrides with wurtzite crystal structure. We develop an improved method to calculate the piezoelectric and spontaneous polarization taking non-linearities due to alloying and/or high internal strain into account. Polarization induced interface charges and sheet carrier concentrations of 2DEGs are predicted for pseudomorphic InGaN/GaN, AlGaN/GaN and AlInN/GaN quantum well and heterostructures on the basis of the improved theory and compared with experimental results achieved by a combination of elastic recoil detection, high resolution X-ray diffraction, X-ray standing wave, photoluminescence, C-V profiling, and Hall effect measurements. Based on the improved model of polarization induced surface and interface charges a review of novel sensors based on AlGaN/GaN-heterostructures is provided, enabling a detailed understanding of the detection mechanisms and new functionalities of these interesting devices.

**Invited Talk** DS 8.3 Mon 15:15 H 2032

**The optoelectronic chameleon - GaN-based light emitters from the UV to green** — •Michael Kneissl — Institut für Festkörperphysik, Technische Universität Berlin, Hardenbergstr. 36, D-10123 Berlin, Germany

Group III-nitrides have evolved into one of the most versatile and important semiconductor materials for optoelectronic devices. GaN-based blue, green and white light emitting diodes have already entered many parts of everyday life and violet lasers are expected to be following soon. However, considering the extraordinary electronic properties and the wide spectral range that is accessible through nitride materials, it appears that it we have just touched the tip of the iceberg. We will discuss some of the new fields of research for InAlGaN materials and devices and review progress in the development of near and deep ultraviolet light emitting diodes, as well as growth and optical properties of InN and indium rich InGaN alloys for emitter in the blue-green spectral range and beyond.