11th International Conference
on Advanced Materials

Rio de Janeiro Brazil
September 20 - 25

ICAM2009

Nanoscale Time Resolved Carrier Relaxation Phenomena in Highly Efficient Nitrides LED Structures

Frank Bertram - frank.bertram@ovgu.de - Uni-Magdeburg
Jürgen Christen

InGaN quantum wells have been studied intensively due to their potential applications for the production of efficient optoelectronic devices, such as light emitting diodes and laser diodes which can emit in the spectral region ranging from violet to green. Despite the enormous improvement in the material growth of III-V nitrides in the past years, the physical processes responsible for the bright light emission in InGaN quantum structures are not fully understood due to the strong interaction of complex alloy phase separation, high threading dislocation density and large polarizations fields. These strain-induced piezoelectric and spontaneous internal fields cause the quantum confined Stark effect (QCSE) in an InGaN quantum well. The electron and hole wave function is separated and their spatial overlap in quantum wells is reduced. Besides a red-shift of the emission energy, a reduced recombination probability as well as a pronounced increase of recombination time should be found. For a thorough understanding of the optical properties of an InGaN quantum well in highly efficient nitrides LED structures it is essential to use a spatially, spectrally and time-resolved optical technique.

The most common strategy to overcome the QCSE-problem is to avoid or minimize the polarization fields by growing the heterostructures in other directions, e.g. perpendicular to the GaN c axis (i.e. in the non-polar direction) by using a- or m-plane nitrides. Another approach is to reduce the fields growing in semi-polar directions. However, epitaxial growth on such planes is by far less developed than the growth on the commonly used c-plane. Morphological defects like dislocations and – in particular in non-c-axis grown material – stacking faults and spontaneous and piezoelectric polarization fields are the major problems in group-III-nitrides. In ternary and quaternary alloys as well as in their heterostructures nanoscale fluctuations of stoichiometry and/or interfaces have strong impact on the radiative recombination in light emitters. We correlate the structural, electronic and optical properties of non- and semipolar epitaxial nitride structures on a micro- and nanoscale with the crystalline real structure using highly spatially, spectrally and time resolved cathodoluminescence microscopy. The complex interaction of relaxation, recombination (radiative + non-radiative), and transport in energy, space and time of the excited carriers will be discussed.