Abstract of Presentation

Presentation Title:

Growth issues and optical properties of nonpolar (Al,In,Ga)N films and quantum wells

Abstract :

Wurtzite (Al,In,Ga)N devices have cut open the new age of semiconductor optoelectronics. For example, blue LEDs, purple LDs, and high-power, high-frequency transistors have been realized. One of the drawbacks of conventional *c*-plane heterostructures is that immobile sheet charges are formed at the heterointerfaces due to spontaneous and piezoelectric polarization discontinuity along the polar c-axis, which induce the quantum-confined Stark effects (QCSEs) in quantum well (QW) structures. Therefore, the oscillator strength of electron-hole pairs in *c*-plane QWs, especially lattice-mismatched $In_xGa_{1-x}N$ of high *x*, suffers detrimental lowering. To overcome this problem, the use of nonpolar planes is attractive, because the *c*-axis is parallel to the interfaces and QWs fabricated on nonpolar planes are free from the QCSE.

However, as long as heteroepitaxial substrates were used, *a*-plane and *m*-plane GaN contained high density basal stacking faults (SFs) and threading dislocations (TDs) as high as 10^5 cm^{-1} and 10^{10} cm^{-2}, respectively. Those defective nonpolar QW LEDs generally exhibited low output power. A variety of lateral epitaxial overgrowth (LEO) techniques have been used to reduce the TD density. However, the basal plane SFs seldom vanish even in thick films or in windows and N-polar wings of nonpolar GaN prepared by LEO. Recently, good performance *m*-plane LEDs and LDs have been demonstrated using the low TD / SF density freestanding (FS) GaN substrates that were sliced from approximately 1-cm-thick *c*-plane FS-GaN.

In this presentation, overview of the superiority and issues of nonpolar (Al,In,Ga)N film growths and devices will be introduced. Structural and optical properties of GaN, InGaN, AlGaN and QW structures will be shown, including the results of high-resolution x-ray analyses, steady-state and time-resolved PL measurements, spatially-resolved CL measurements, and gain measurements on those grown by MOVPE or NH_3-MBE. Reasonably high equivalent internal quantum efficiency and short radiative lifetime for the near-band-edge emission are demonstrated for *m*-plane InGaN.