Title: Optical characterization of InGaN heterostructures for blue light emitters: Efficiency and carrier dynamics

Abstract

Radiative efficiencies and recombination dynamics in InGaN-based heterostructures and their applications as active regions in blue light emitters and particularly vertical cavities are explored. The investigations focus on understanding the mechanism of efficiency loss at high injection as well as developing designs to mitigate it, exploring nonpolar and semipolar crystal orientations to improve radiative efficiency, integration of optimized active regions with high reflectivity dielectric mirrors in vertical cavity structures, and achieving strong exciton-photon coupling regime in these microcavities for potential polariton lasing. In regard to active regions, multiple double heterostructure (DH) designs with sufficiently thick staircase electron injection (SEI) layers, which act as electron coolers to reduce the overflow of hot electrons injected into the active region, were found to be more viable to achieve high efficiencies and to mitigate the efficiency loss at high injection. Such active regions were embedded in novel vertical cavity structure designs with full dielectric distributed Bragg reflectors (DBRs) through epitaxial lateral overgrowth (ELO), eliminating the problems associated with semiconductor bottom DBRs having narrow stopbands and the cumbersome substrate removal process. Moreover, the ELO technique allowed the injection of carriers only through the high quality regions with substantially reduced threading dislocation densities compared to regular GaN templates grown on sapphire. Although it was evident that nonpolar (1-100) GaN and semipolar (11-22) GaN required further improvement of material quality, steady-state and time-resolved photoluminescence measurements supported that semipolar (1-101)-oriented GaN templates and InGaN active regions exhibited optical performance comparable to their highly optimized polar c-plane counterparts, and therefore, are promising for vertical cavities and light emitting device applications.

Short Biography:

Serdal Okur received B.Sc. and M.Sc. degrees in Physics from Ondokuz Mays University in 2005 and Izmir Institute of Technology in 2009, respectively. After graduation, he joined the faculty of the Electrical and Computer Engineering department at Virginia Commonwealth University where he obtained his Ph.D in 2014. His research centered in optoelectronics and cutting across solid state physics, electronics, materials science and photonics, which will give rise to practical applications as well as fundamental understanding. His primary research interests include high efficiency UV/visible light sources utilizing GaN, ZnO, and related materials (light emitting diodes and vertical cavity lasers on nonpolar or semipolar surfaces of GaN), ultrafast carrier dynamics in semiconductor heterostructures. He has contributed 33 scientific papers on growth, fabrication, and characterization of wide bandgap semiconductor materials and nanostructures.