CARRIER DYNAMICS IN Ga-POLAR AND N-POLAR InGaN QUANTUM WELL STRUCTURES

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InGaN plays an important role in semiconductor devices including LEDs, laser diodes, solar cells, high-power electronics owing to its beneficial properties such as a direct and tunable bandgap, high internal quantum efficiency, high carrier mobility. However, nitride semiconductor devices suffer from efficiency droop issues at elevated free carrier densities. Moreover, by increasing In content in the InGaN devices, quantum efficiency significantly drops, which limits the production of efficient InGaN-based green light devices. Due to the crystalline symmetry of nitride semiconductors, different polarity structures can be achieved. While conventional growth is in the c-direction (Ga-polar), one can achieve N-polarity by changing the growth conditions. This could be promising in altering the electronical properties of transistor devices, enhancing In incorporation for longer wavelength devices. Thus, it is important to investigate free carrier recombination pathways in the structures of both polarities. In this study, we thoroughly investigate non-equilibrium carrier dynamics in Ga-polar and N-polar quantum well structures. We do this by employing light induced transient grating and time integrated photoluminescence techniques, which provide us carrier density dependent diffusivity, carrier lifetime, and internal quantum efficiency values. We then model carrier dynamics with a modified ABC model. While N-polarity InGaN samples have not been extensively studied within the science community, our study revealed relatively high radiative bimolecular recombination rates for these samples, which is a promising indication for further advancements in nitride-based devices.