Investigation of the recombination dynamics in low In-content InGaN MQWs by means of cathodoluminescence and photoluminescence excitation

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The interplay of polarisation fields, free carrier screening and localization effects in $In_xGa_{1-x}N$/GaN MQWs ($0.03<x<0.07$) is studied by combining Photoluminescence (PL) and Cathodoluminescence (CL), in an excitation density range from 10^8 to 10^{12} cm^{-2} generated e-h pairs.

After reaching the most efficient internal field screening by CL, up to recovering the nearly flat band conditions, quantum confinement effects are revealed and a high and possibly composition dependent bowing parameter is extrapolated. Steady (TI) and time-resolved (TR) PL studies performed with resonant and non-resonant UV ps-LASER excitation at different temperatures, give information on the carrier capture in the wells. The internal field and localization effects are separated, revealing the dynamical screening effect dominates in the TR spectra, while carrier localization mainly related to interface roughness affects the CW-TI experiments on thin wells. We can infer that at least for this low In content the Quantum-Confined-Stark-Effect controls the recombination dynamics in wide wells in steady state conditions. The effect of localization in potential minima and the relative weight of radiative/non-radiative recombination processes are further investigated as a function of temperature. The carrier dynamics is well reproduced in the framework of a theoretical model, self-consistently calculating electronic states and optical transition rate, which provides the time-evolution of the radiative recombination rate, as the electric field is restored after the carrier injection.