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Radiative Recombination Rates in Narrow AlGaN Quantum Wells SERGEY RUDIN, GREG RUPPER, GREGORY GARRETT, CHELSEA HAUGHN, U.S. Army Research Laboratory — Polar $Al_xGa_{1-x}N$ narrow quantum wells are important elements of deep-ultraviolet light emitting devices, and electron-hole radiative recombination rates are important characteristics of these nanostructures. We evaluated these rates for a set of AlGaN/AlN wells with 60% Al concentration, with well widths from 0.6 nm to 2 nm, and n-doped barriers. We obtained the dependence on carrier density, lattice temperature from 10 K to 300 K, and well width and compared our theoretical results with the experimentally determined radiative rates. The polarization fields and density dependent screening of the polarization fields were included in the model. We employ a Green's function formalism with self-energies evaluated in the self-consistent T-matrix approximation, for a two-band model, with the bands determined in the $\mathbf{k}\bullet\mathbf{p}$ approximation. This formalism models the Coulomb correlations sufficiently to include the effect of excitons. The results are applicable in a wide range from low densities of carriers, through the Mott transition, up to relatively high densities, over a wide range of temperatures. The recombination coefficient was obtained from the integrated photo-luminescence. We then model density decay by $\partial n_h/\partial t = An_h + n_e n_h B(n_e, n_h)$, where An_h is the non-radiative decay rate and $n_e n_h B(n_e, n_h)$ is the radiative recombination rate from our model. The photo-luminescence decay is compared to experimental results obtained using time-resolved photoluminescence.

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