Recovering rectangular band profile in polar InGaN-based heterostructures utilizing junction field

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III-nitride heterostructures are most commonly obtained along polar and semipolar directions. As a consequence built-in polarization, both spontaneous and piezoelectric, has to be taken into account when simulating and designing nitride devices.

We studied single InGaN quantum well (QW) heterostructures closely surrounded by p- and n-type layers with different doping levels. Band profiles of two exemplary structures simulated using 1D DDCC simulation software developed by Yuh-Renn Wu et. al [1] are shown in Fig 1.

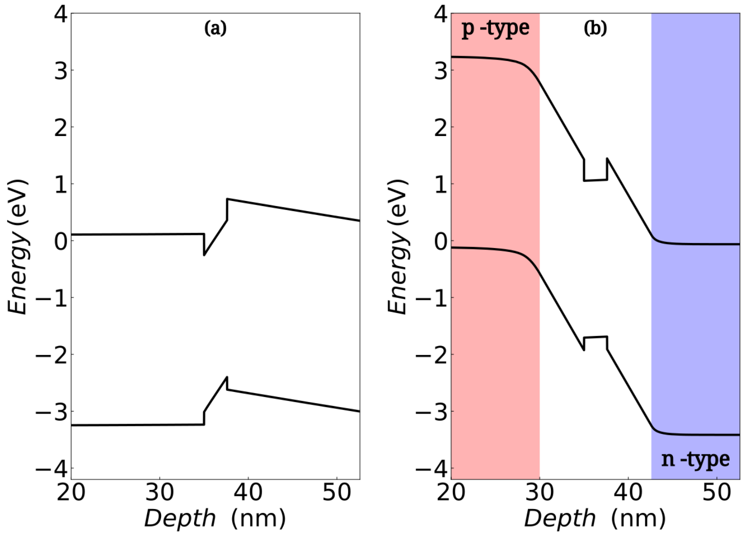

Figure 1: Conduction and valance band profile for $In_{0.17}Ga_{0.83}N/In_{0.03}Ga_{0.97}N$ QW surrounded by (a) no intentional doping and (b) $N_A = 6 \cdot 10^{19}$ atoms/cm^3, $N_D = 3 \cdot 10^{20}$ atoms/cm^3 .

We used plasma-assisted molecular beam epitaxy to obtain very sharp doping profile to investigate optical transitions in Ga-polar QWs with varied total electric field. Change in doping concentrations within the cladding layers affect the depletion width what results in different value of the total electric field in the QW (FQW) (see Fig 1.). By reaching doping concentrations above 10^{20} atoms/cm^3 we were able to obtain p-n junction field high enough to completely abolish built-in electric field and recover rectangular-like band profile typical to nonpolar heterostructures (Fig 1(b)).

We analyzed influence FQW on the photoluminescence (PL) spectra as a function of pumping power. As expected from simulations, for different doping levels we obtained substantially different shift of the emission peak. For structure without p-n junction we observed 9 nm shift, while for the highest used doping level the emission wavelength was independent of pumping power indicating total electric field in QW close to zero.

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[1] Y.-R. Wu, R. Shivaraman, K.-C. Wang and J.S. Speck, *Applied Physics Letters* **101**, (2012).