GaN quantum dot density control by rf-plasma molecular beam epitaxy

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We report on the growth of GaN quantum dots and the control of their density in the Stranski-Krastanov mode on AlN (0001) by rf-plasma molecular beam epitaxy at 750 C. After depositing the equivalent of 2-3 monolayers GaN coverage, as limited by N-fluence under Ga-droplet growth conditions, excess Ga was desorbed and Stranski-Krastanov islands formed under vacuum. We present the dependence of island density as a function of GaN coverage (for two growth rates: 0.10 and 0.23 monolayers per second), as estimated from atomic force microscopy and cross-sectional transmission electron microscopy. With a GaN growth rate of 0.23 monolayers per second, the island density was found to vary from less than $3.0*10^8$ to $9.2*10^{10}$ cm^{-2} as the GaN coverage was varied from 2.2 (critical thickness) to 3.0 monolayers. For a GaN growth rate of 0.10 monolayers per second, the island density varied from $2.0*10^{10}$ to $7.0*10^{10}$ cm^{-2} over a GaN coverage range of 2.0 to 3.0 monolayers. For each growth rate, the GaN islands were found to be of nearly uniform size, independent of the quantum dot density.

Additionally, we report on the observation of strong QD luminescence up to 750 K. The PL characteristics, both of the GaN wetting layer, and GaN QDs is dominated by the large polarization-induced internal electric fields.