Absorption and Raman scattering processes in InN films and dots

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We report the observation of a broad absorption in the 1.25 eV region that is typical of thin InN films. Such a feature we attribute to light absorption at the energy of the fundamental direct band gap of InN, while we attribute the low energy 650-750 meV photoluminescence to an extrinsic recombination process analogous to the process that give the blue band in AlN and the yellow band in GaN. The substantial broadening is attributed to both the residual doping, and strain.

Next, by combining Raman spectroscopy measurements and X-ray investigations in large size InN quantum dots and in InN films deposited by Metal-organic vapor phase epitaxy, we show these frequencies to experience a blue shift with increasing compression. We show that all the phonon frequencies reported in the literature are correlated to the strain state of InN and are, within the experimental uncertainty, consistent with each other. The usual shape of the dots corresponds to truncated pyramids with a hexagonal base as revealed by atomic force microscopy measurements. The E_2 phonon frequency shift detected in the micro-Raman spectra, recorded from single dots of sizes ranging from 480 nm down to 30 nm in height, allowed to evaluate roughly the residual strain field. Careful analysis of these data makes clear that the islands are weakly strained likely due to the formation of dislocations at the InN / GaN interface. Nevertheless, the reduction of the size of InN islands leads to an increasing strain field. Finally, a slight strain increase was evidenced when capping the dots with a thin GaN top surface layer, thus reinforcing the major role played by the plastic strain relaxation.