PL studies of a single InGaN QD

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Quantum dots (QDs) possess many physical properties that are attractive for quantum information processing (QIP) schemes. Many QIP schemes that employ QDs require the electronic states within individual QDs to be studied and controlled. QDs can be produced from various material combinations including III/IV nitride based QD nanostructure systems (ex. InGaN, and AlGaN). These QD materials possess interesting electronic properties such as piezo-electric fields and long lived excitonic states [1], properties attractive for QIP applications. These physical properties have prompted schemes to create a solid state excitonic quantum computer made using III/IV nitride based QDs [2].

Here, we present PL studies of single InGaN QDs. Samples were masked with a 100-nm-thick Al layer which was evaporated onto the sample surface and an aperture pattern fabricated by electron-beam lithography. Micro-PL of the InGaN QD through 500 nm and 200 nm apertures in the Al mask reveals very sharp peaks indicating localization of electronic states as shown in fig.1 [3]. The linewidth of the peaks (Γ = 650 meV) being limited by the resolution of the spectrometer. Time resolved measurements for single InGaN QDs reveal single exponential decays (shown in fig.2) in contrast to non-exponential decays from the 2D wetting layer and from ensemble measurements [4]. The effect of temperature upon single InGaN QDs was monitored by micro-PL. Sharp peaks observed in the micro-PL of the InGaN QDs broaden and merge into the wetting layer background as the temperature rises from 4 K to 60 K where the peak is no longer visible. Time resolved PL spectra of a single InGaN QD recorded when varying the temperature from 4 to 60 K show that the decay times decrease from 2.6 ns to 1.7 ns for excitons.

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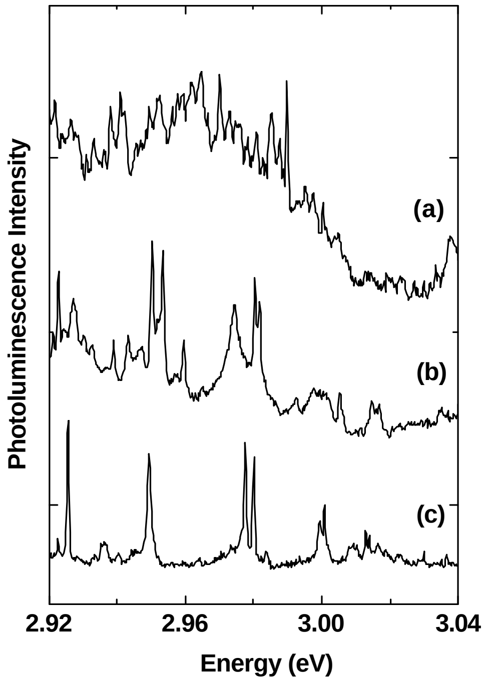

Fig.1. (a) Macroscopic PL spectrum from InGaN quantum dot sample (b) μ-PL spectrum from masked QD sample employing a 500 nm aperture, (c) employing a 200 nm aperture. All spectra were recorded at 4.2 K.

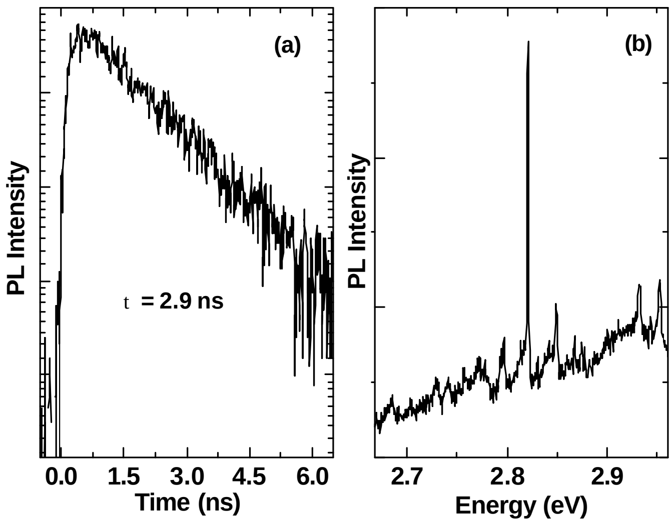

Fig.2. (a) Time resolved PL spectrum from a single InGaN QD at 4.2 K. (b) Corresponding *in-situ* μ-PL spectrum identifying the single InGaN QD at 4.2 K.