Dynamics of Single InGaN Quantum Dots

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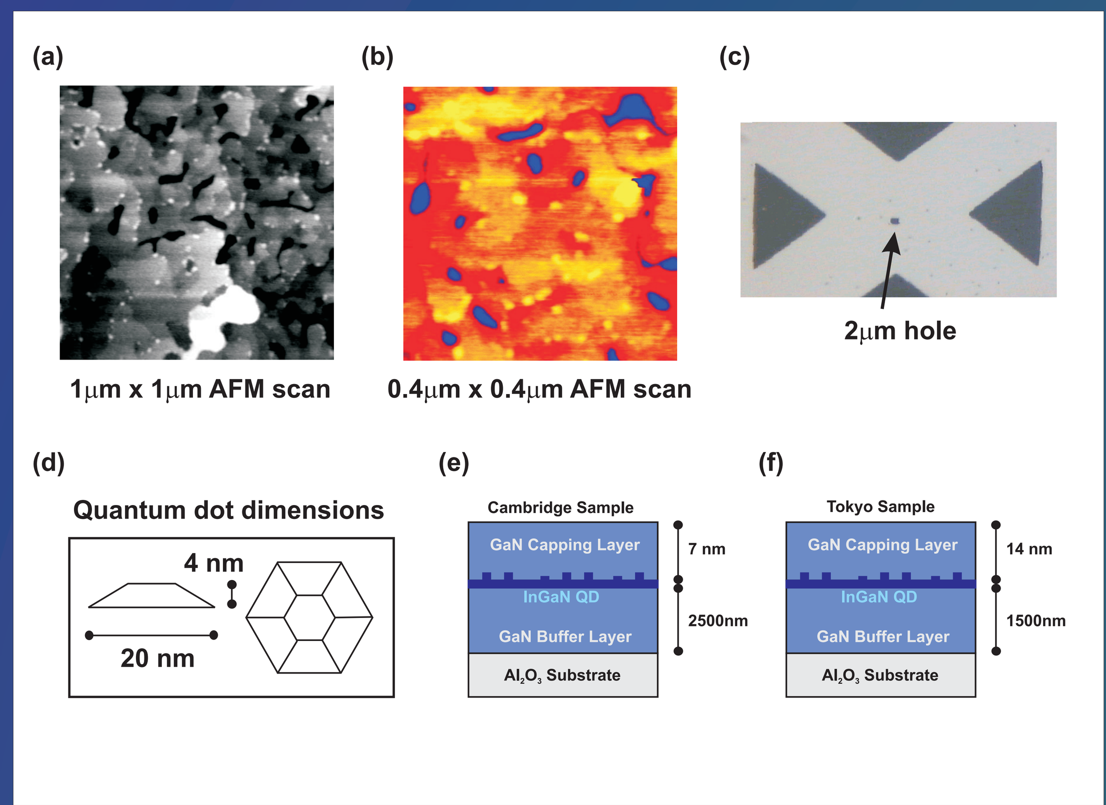

Figure 1. (a) and (b) - AFM scans of uncapped dot samples grown in Cambridge. (c) Opitcal microscope image of Al mask on dot sample. (d) Dimensions of typical dot from Cambridge sample. (e) and (f) - Schematic of growth layers in both the Cambridge and Tokyo sample.

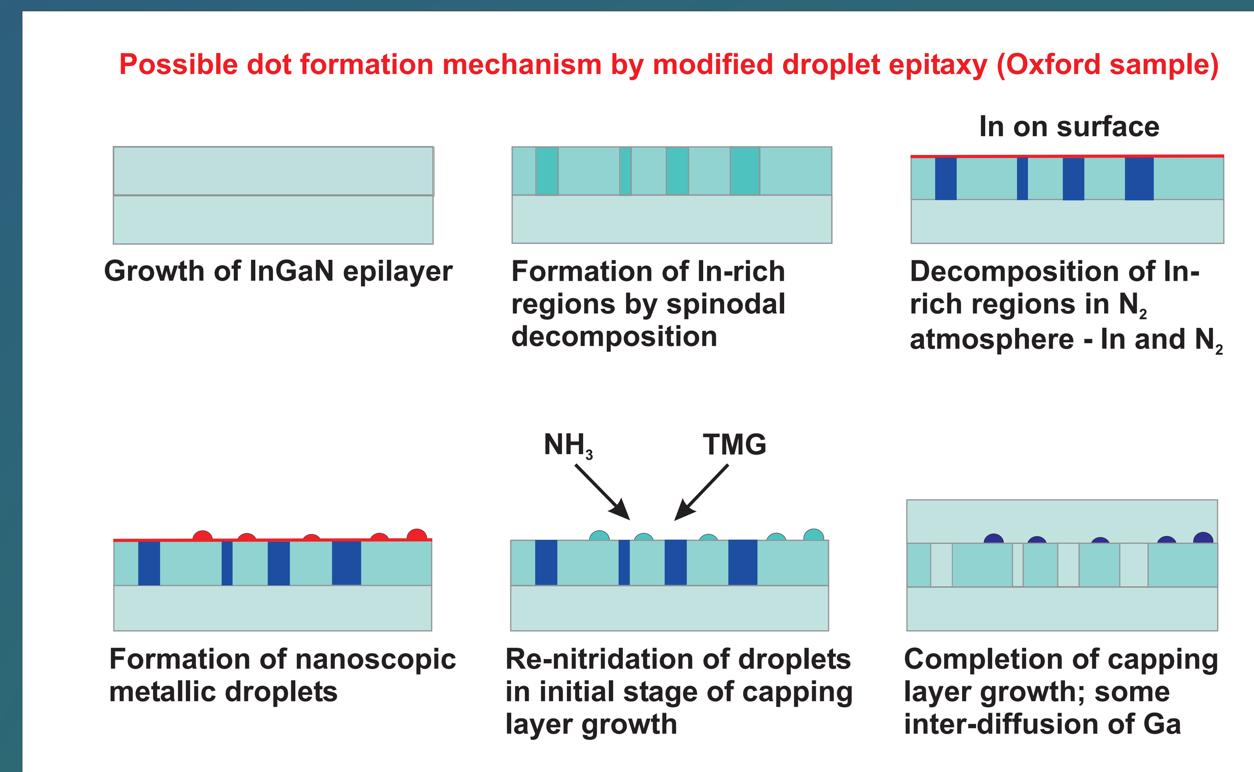

Figure 2. Diagram showing the suggested stages involved in the growth of the Cambridge sample.

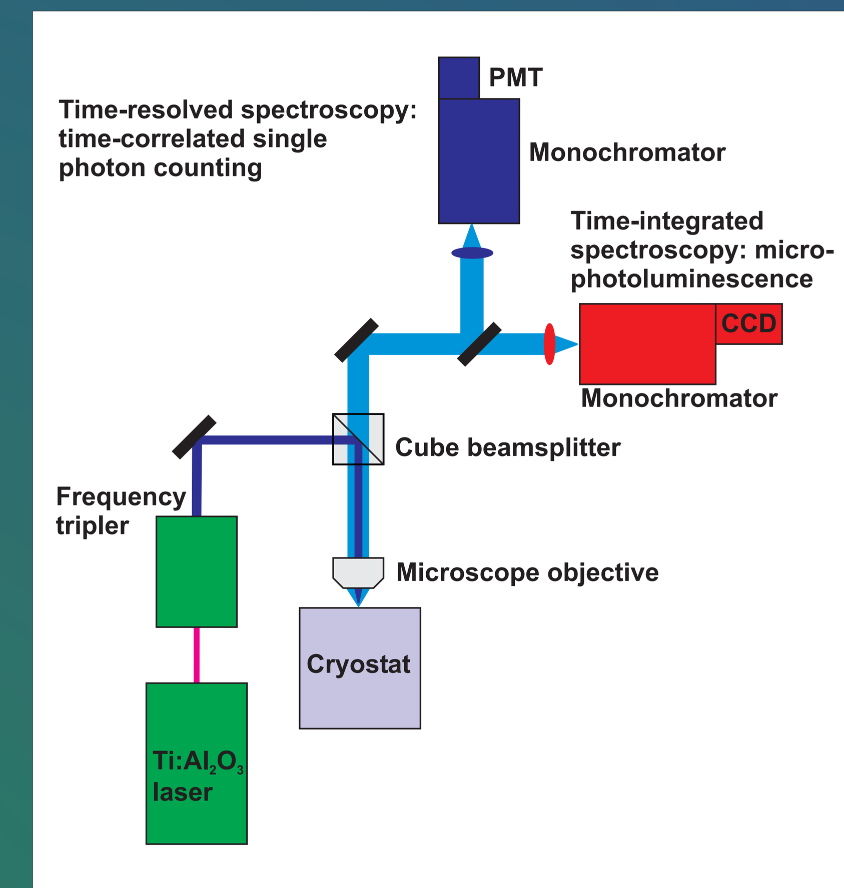

Figure 3. Experimental arrangement for time-resolved and time-integrated single dot spectroscopy. The excitation source is a frequency-tripled Ti:sapphire laser, giving 100fs pulses at 266 nm. The microscope objective is a 36x catadioptric unit. The time-correlated photon counting unit has a time-resolution of 150 ps.

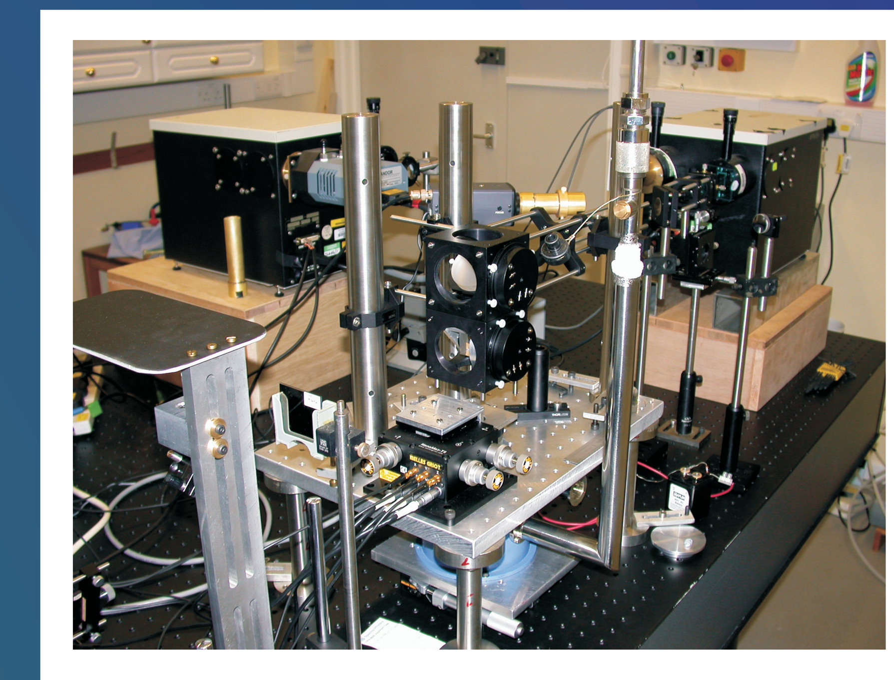

Plate 1. Experimental layout showing the two spectrographs used for detection. In the foreground the piezo mounted catadioptric objective can be seen. The microscope cryostat is mounted on an xy stage below the objective.

Experiment

The photoluminescence decay of single InGaN QDs has been measured between 4.2 K and 60 K using a time-correlated photon counting system in conjunction with a conventional micro-photoluminescence setup. Two different samples, grown in Cambridge and in Japan, were studied. The recombination is characterized by a single exponential decay, in contrast to the non-exponential decay from the wetting layer. We have shown that for ensemble measurements a non-exponential signal may arise from the combination of the QD and wetting layer luminescence. Our results suggest that different growth methods give rise to fairly similar luminescence properties. Increasing the temperature leads to a reduction in the PL decay time of a single InGaN QD over the range measured.

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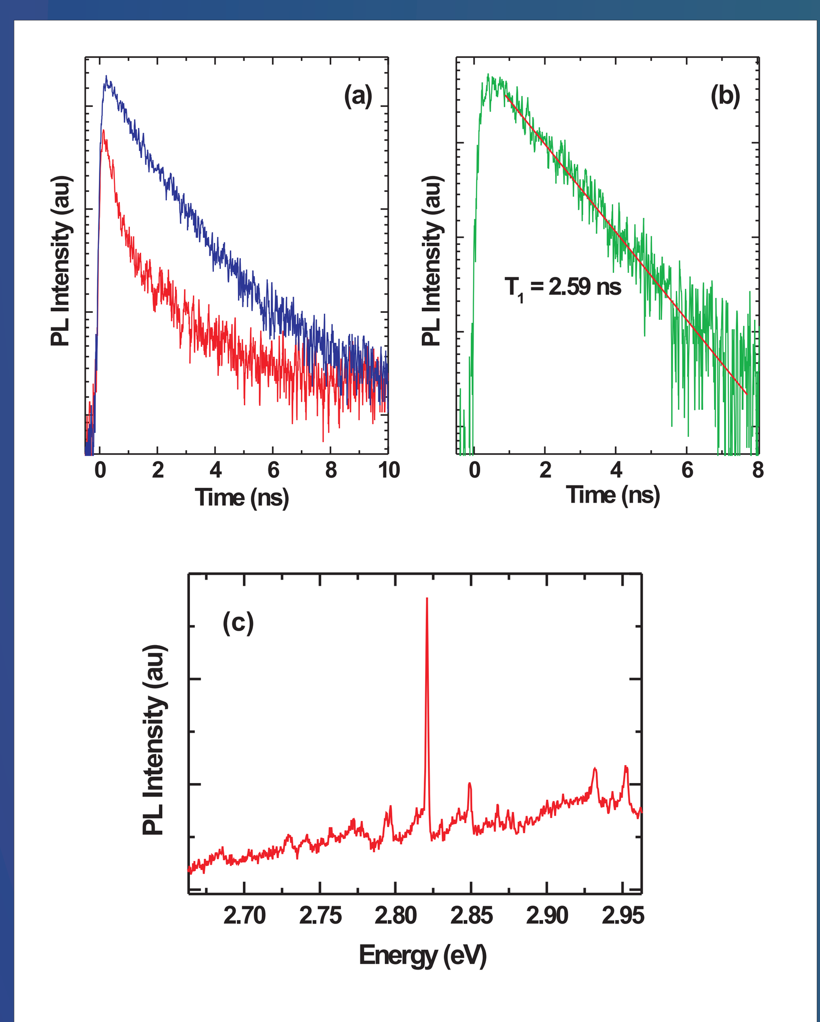

Figure 4. (a) Time-resolved PL from a single InGaN QD at 4.2 K (Cambridge sample). PL trace recorded at 2.824 eV corresponding to the dominant dot in (c), together with the wetting layer emission at 2.817 eV (curve with faster decay). (b) Corrected QD decay trace from the InGaN QD following subtraction of wetting layer. (c) Time-integrated photoluminescence from InGaN QDs at 4.2 K at an excitation power of 275 μW, indicating the dot used for the time-resolved measurements.

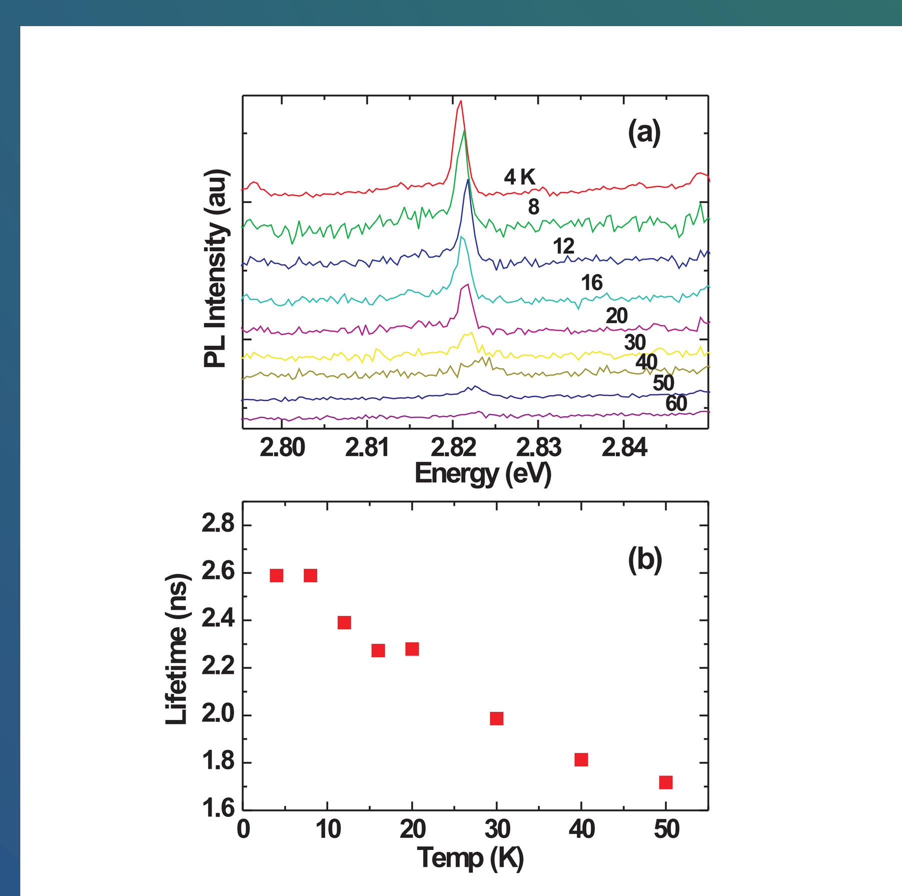

Figure 6. (a) Time integrated PL spectra for a single InGaN QD from 4.2 K to 60 K (Cambridge sample). (b) Variation in T_1 with temperature for the single QD shown in (a).

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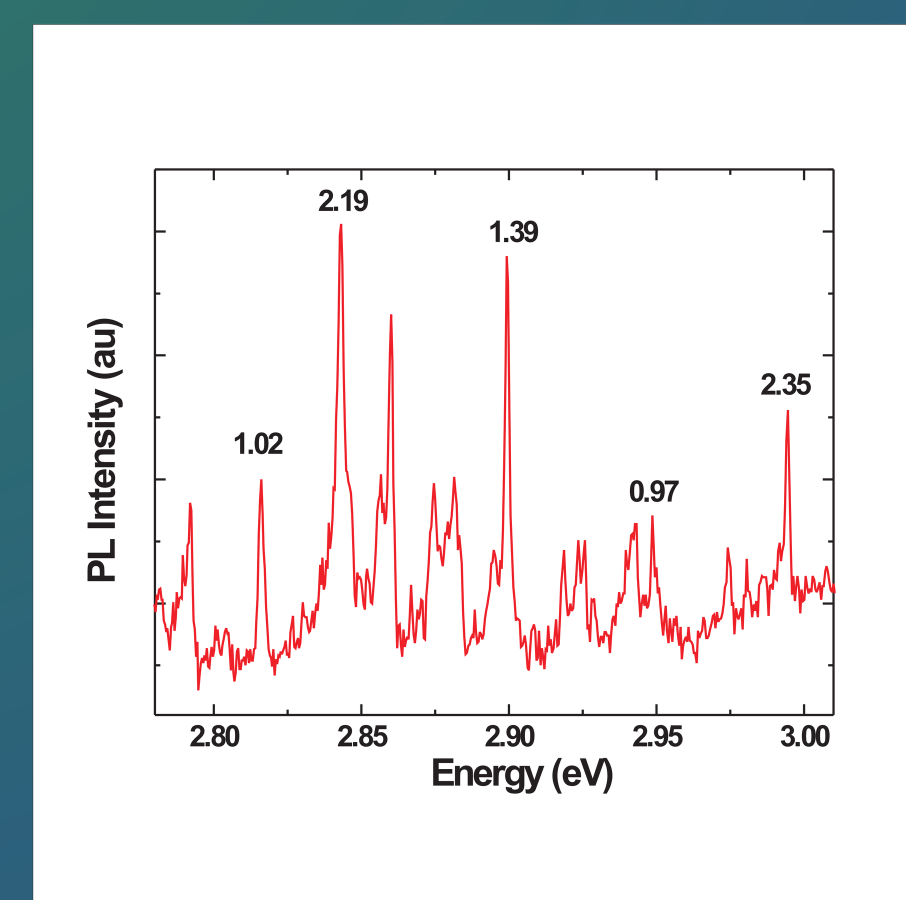

Figure 7. Micro-PL spectra from several single dots at 4.2 K. The measured decay times in nanoseconds for some individual dots are shown above each dot.

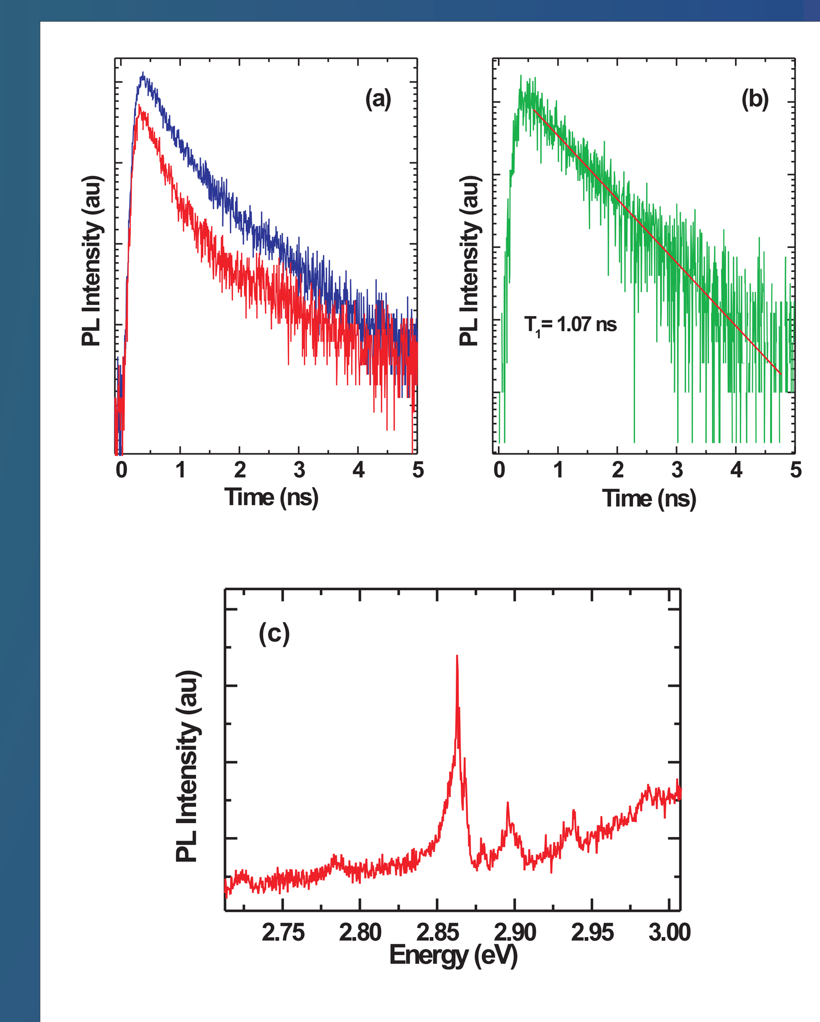

Figure 5.(a) Time-resolved PL from a single InGaN QD at 4.2 K (Tokyo sample), trace recorded at 2.863 eV corresponding to the dominant dot in (c), together with the wetting layer emission at 2.873 eV (curve with faster decay). (b) Corrected QD decay trace from the InGaN QD following subtraction of wetting layer. (c) Time-integrated photoluminescence from InGaN QDs at 4.2 K at an excitation power of 70 μW.