TEMPERATURE DEPENDENCE CONTROL OF THE PHOTOLUMINESCENCE FROM SELF-ASSEMBLED InAs/GaAs QUANTUM DOTS

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InAs/GaAs quantum dots (QD's) emitting in the 1.3-1.55µm [1] know a huge interest, due to their potential application as light emitting diodes (LED's), and low threshold laser suitable for telecommunications range. These QD's based devices are expected to work at room temperature (RT) or higher. However, their emission is still handicapped by the temperature factor. In fact, for the most reported works [2, 3], an emission quenching is observed for temperatures lower than RT. The photoluminescence (PL) quenching effect is commonly attributed to thermal escape of the carriers from QD's to the surrounding matrix, followed by their non-radiative recombination.

In this work, we report a sample growth treatment [4] using CCl_4 that suppresses the quenching phenomenon (Fig.1). A decrease in the concentration of defects in the near-surface region of the GaAs matrix, resulting from the treatment, is suggested as the main reason for this effect. Experimental results and theoretical arguments supporting this explanation are provided.

The mechanisms of radiative recombination in the QD will be discussed. In fact, in all recorded PL spectra, two peaks are observed. They are attributed to the radiative recombination, from the ground and first excited QD state in the QD conduction band (CB), respectively, and the hole state in the valence band (VB). A notable difference between ground states and excited states radiative recombination was observed, when changing the doping of the surrounding matrix from n-type to p-type. In fact, a high radiative recombination ratio was observed for the first excited state (Fig.2), even at low temperature (20K) and low excitation power ($0.5 W/cm^2$).

References:

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Figures:

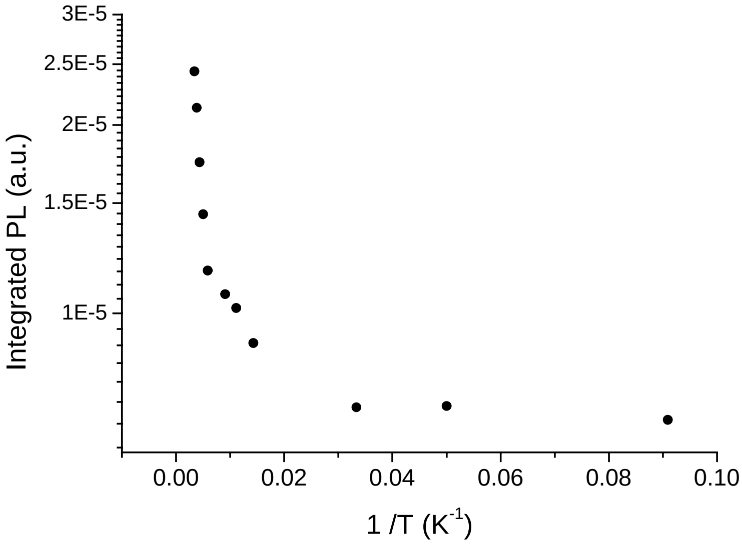

Fig.1: Temperature dependence of the emission from the QD ground states. The PL is shown to increase at room temperature.

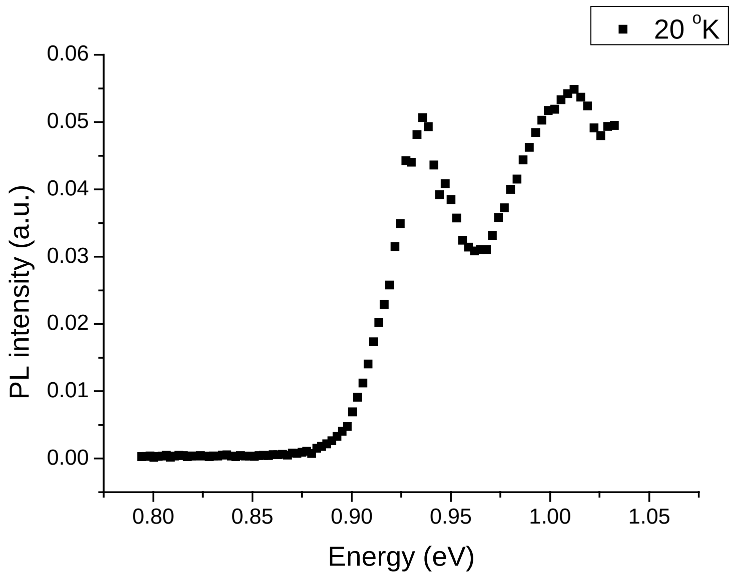

Fig. 2: PL spectrum from InAs QD's embedded in p-type matrix. The emission from the first excited state seems to be preponderant at 20 K.