Post-growth rapid thermal annealing of InAs quantum dots grown on GaAs nanoholes formed by droplet epitaxy

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The deposition of InAs on GaAs nanoholes formed by droplet epitaxy can be used to tailor the shape and size of InAs QDs while preserving the low areal density (~$2x10^8$ cm^{-2}) imposed by the nanohole pattern [1,2]. Our previous micro photoluminescence (μPL) study of individual InAs QDs grown by this method revealed that the single QD emission was largely affected by the charged environment surrounding the nanostructure. This charged environment, attributed to the presence of As vacancies, leads to multicharged exciton emission and spectral diffusion effects which might limit the suitability of these QDs in quantum light emitting applications. An intense single peaked emission with radiation limited linewidth and null fine structure splitting (FSS) would be desirable to fully exploit the size and shape control capabilities of droplet epitaxy based methods. The aim of the present study is to reduce the presence of the As vacancies near the QDs by applying a post-growth rapid thermal annealing (RTA) to the sample. Besides, the small FSS (~41 μeV) [1] found typically in these QDs might be reduced further by the RTA processes [3].

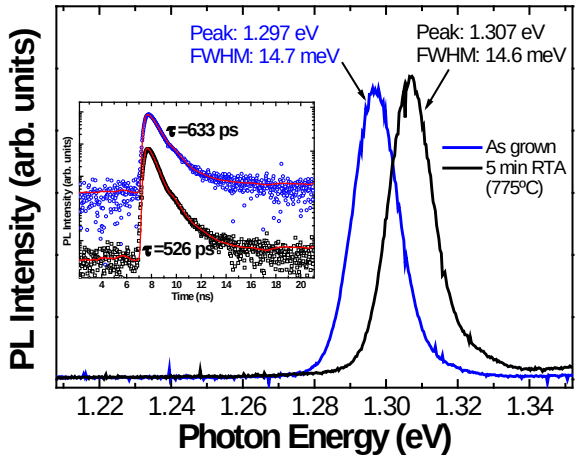

Fig. 1. Time integrated PL spectrum and time resolved PL curves (inset) before and after the RTA process.

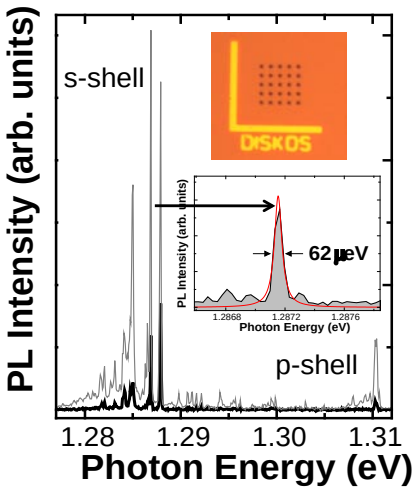

Fig. 2. Micro-PL spectra of a single QD located in a 2-μm-diameter mesa at two different powers. Inset: Zoom over a single peak of the spectrum with resolution limited FWHM.

Figure 1 shows the ensemble PL of our sample before and after the RTA process at 775º C during 5 minutes. The optimization of the growth procedure explained in [1] gives rise to a narrow emission band centered at 1.296 eV with FWHM=14.6 meV. A blue shift of the PL band and a reduction of the decay time are clearly observed after the RTA without noticeable change of the FWHM. To study the same single QDs before and after the RTA process we have defined arrays of 2-μm-wide mesa structures on the sample surface (inset Fig. 2). Before the RTA, the s-shell emission is dominated by multicharged exciton complexes and shows narrow emission linewidths (<100 μeV) limited by our spectrometer resolution (Fig. 2). Results after RTA process will be shown.

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[2] P. Alonso-González, J. Martín-Sánchez, Y. González, B. Alén, D. Fuster, and L. González, *Crystal Growth & Design*, **5,** 2525 (2009).
[3] D. J. P. Ellis, R. M. Stevenson, R. J. Young, A. J. Shields, P. Atkinson and D. A. Ritchie, *Appl. Phys. Lett.*, **90**, 011907 (2007).

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