Changing the properties of the CdTe/ZnTe quantum dots by \textit{in situ} annealing during the growth

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We present an attempt to control the average size and sheet density of CdTe/ZnTe quantum dots during their formation in the process of molecular beam epitaxy (MBE). All samples under consideration are grown by the same procedure. Firstly, a 4\(\mu\)m thick CdTe buffer layer is deposited on GaAs substrate. The CdTe buffer is followed by a 1\(\mu\)m thick ZnTe barrier. The quantum dots are formed by deposition of 6 monolayers of CdTe, which are covered with an amorphous tellurium layer at a low substrate temperature [1]. After thermal desorption of the Te layer at 350 \(^{\circ}\)C, a clear phase transition from a 2D to a 3D surface can be observed by electron diffraction. The transition is a strong proof of the formation of self assembled QDs.

The annealing process is applied \textit{in-situ} in the MBE deposition chamber just after the formation of the QDs and before capping them with 100 nm of ZnTe. Depending on the annealing temperature and annealing time, one observes two different effects. After annealing at relatively high temperatures, e.g., 380 \(^{\circ}\)C the photoluminescence band shifts towards higher energies and narrows as shown in Fig 1a. This indicates a significant desorption of the CdTe deposit which results in the decrease of the average size of the QDs. This desorption process enhances the homogeneity of the QD ensemble. In the case of annealing at lower temperatures, e.g. 310 \(^{\circ}\)C (Fig. 1c), one observes that the PL shifts toward lower energies in comparison to the as-grown samples. This effect can be explained in terms of ripening process which takes place in the uncapped QD ensemble and results in formation of dots with relatively large sizes.

Moreover, in the micro-PL measurements, when the excitation spot is of the order of 2\(\mu\)m, one observes that the sharp lines associated with the emission from individual QDs can be better resolved from each other, which indicates a considerable decrease of the total density of the QDs. This effect is more pronounced in the case of QDs annealed at higher temperatures and can be used for single dot spectroscopy.


This Work is partly supported by the Foundation for Polish Science ( Subsidy 8 / 2003 ) and SANDIE Network of Excellence