New quarternary system for individual quantum dots: CdTe/ZnSe

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The efficiency of photoluminescence from typical CdTe/ZnTe QDs at high temperatures is limited by low confinement energy of holes. The same reason hinders studies of higher positively charged excitonic complexes. The CdTe/ZnSe QDs overcome these limits by exhibiting a deeper binding potential for holes.

Samples were grown using Molecular Beam Epitaxy on a GaAs substrate with 1 μm thick ZnSe buffer. Various CdTe deposition techniques were studied and the best results were obtained for atomic layer deposition and Se/Cd/Te/Cd/Se growth sequence at the QDs layer. The microphotoluminescence (μ-PL) studies were performed at helium cryostat equipped with a 2-axis superconducting magnet with a spacial resolution below 1 μm at temperatures between 1.5 K - 300 K.

The μ-PL was excited at 2.8 eV. Typically a high QDs density (see figure 1.a) precluded studies of individual QDs lines. This is a result of large CdTe/ZnSe lattice mismatch (14%)[1]. However, the incorporation of a small density of Mn^2+ ions during the growth of CdTe layer was found to decrease a number of QD emission lines by orders of magnitude enabling the studies on spectrally resolved lines of individual QDs (fig. 1.b). Additionally, a few quantum dots with a single Mn^{2+} ions were identified (fig. 1.c).

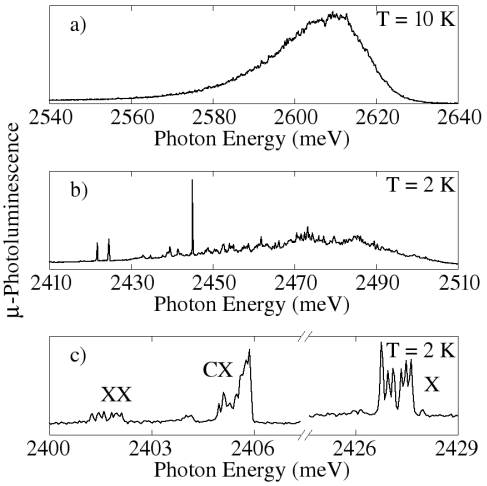

Fig. 1: a) μ-PL spectrum of CdTe/ZnSe QDs, b) μ-PL of CdTe:Mn/ZnSe QDs. Decreased density of QDs' lines is evidenced, c) μ-PL of a single CdTe/ZnSe QD width a single Mn^{2+} ion.

The much deeper binding potential in valence band was revealed by possibility to trace the photoluminescence of a single dot up to estimated temperature of approximately 105 K. This is better than for typical CdTe/ZnTe QDs[2]. At increasing temperatures exciton in CdTe/ZnSe QDs exhibits faster decrease of intensity compared to biexciton. This can be interpreted as a efficient spin-flip of an exciton into optically not active dark exciton after the recombination of a biexciton.

The methods used to identify lines originating from the exciton, charged exciton and biexciton recombination, were linear polarization in-plane anisotropy, excitation power dependence and magnetic field measurements up to 3 T in both, Voigt and Faraday configurations. The determined parameters of the dots: exciton anisotropy splitting (100-700 μeV), g-factor (1.49 $\pm$ 0.07) and diamagnetic shift (0.5 $\pm$ 0.2 μeV/T2) indicate that CdTe/ZnSe dots are more similar to CdSe/ZnSe than to CdTe/ZnTe system.

[1] I. V. Sedova, O. G. Lyublinskaya, S. V. Sorokin, A. A. Sitnikova, A. A. Toropov, F. Donatini, Le Si Dang, and S. V. Ivanov, *Semiconductors* **41**, 1345 (2007)
[2] L. Besombes, K. Kheng, L. Marsal, and H. Mariette, *Phys. Rev. B* **63**,155307 (2001)