Energy transfer in the system of CdSe Quantum Dots embedded in quasi-bulk ZnSe layers.

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Semiconductors planar nanostructures based on self-assembled Quantum Dots (QDs) exhibits an essential potential in application in novel photonics devices, for example, in integral optical circuits as emitters, amplifiers, ultrafast switchers etc. Development of technology of such devices requires a comprehensive study of electronic and optical properties of these nanostructures and of main mechanisms of energy and charge transfer processes between ensembles of QDs and the matrix material.

Ultrathin layers of CdSe have been deposited by ALE-MBE technique on the 1,5 μm thick (001) ZnSe/GaAs substrate and covered by a 400 nm thick ZnSe cap layer. Stress relaxation of in this material system leads to the formation of CdSe QDs with an average thickness about 2,6 nm. The lateral dimensions of the QDs are in the order of 30 nm. These nanostructures show high quantum efficiency of exciton emission in the green-yellow spectral region even at room temperature. Micro-PL measurements show intensive, very narrow emission lines characteristic for single QD (Fig.1).

One of the most remarkable property of the studied structures is a very effective transfer of optical excitation from the electronic states in the bulk ZnSe to the CdSe QDs. The effectiveness of emission from CdSe QDs exceeds the PL emission from the ZnSe bulk by three orders of magnitude. This fact indicates a strong coupling of the electronic states of the QDs with electronic states of the ZnSe matrix. PLE spectra of CdSe QD reveal two excitation mechanisms: excitation via ZnSe exciton states and direct excitation of excitons in QDs. In the first case the mechanism of energy transfer due to auto-ionization of excitons states in QDs, interacted with excitons in ZnSe matrix, seems to be possible. In detailed study of CdSe/ZnSe QD PLE spectra we observed characteristic features of the Fano resonance.

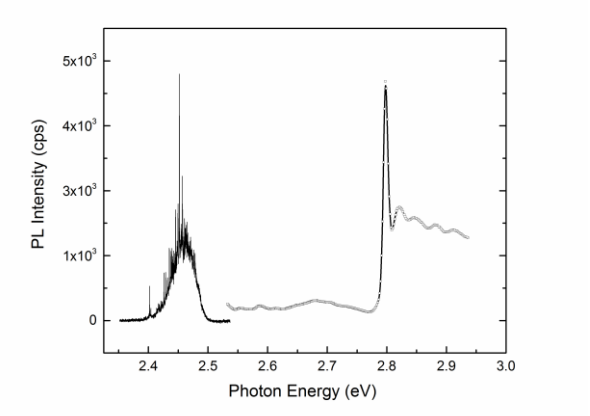

Fig.1. μ-PL and PLE spectra of QD CdSe/ZnSe at T=10K.

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