Selenium induced emission energy variation in Cd(Se,Te)/ZnTe self-assembled quantum dots

P. Wojnar[1], P. Baranowski[1], M. Szymura[1], J. Płachta[1], S. Chusnutdinow[1], G. Karczewski[1], and T. Wojtowicz[2]

[1] *Institute of Physics, Polish Academy of Sciences, 02-668 Warsaw, Poland*
[2] *International Research Centre MagTop, Institute of Physics, Polish Academy of Sciences, 02-668 Warsaw, Poland*

Semiconductor heterostructures can be classified either as type I or type II depending on the relative alignment of conduction and valence band edges. In type I heterostructures electrons and holes tend to localize in the semiconductor with the smaller energy gap, Figure 1a (right-hand side panel). On the other hand, electron and holes tend to separate in type II heterostructures. For electrons it is more favorable to enter into another semiconductors than for holes, (Figure 1a, left-hand side panel).

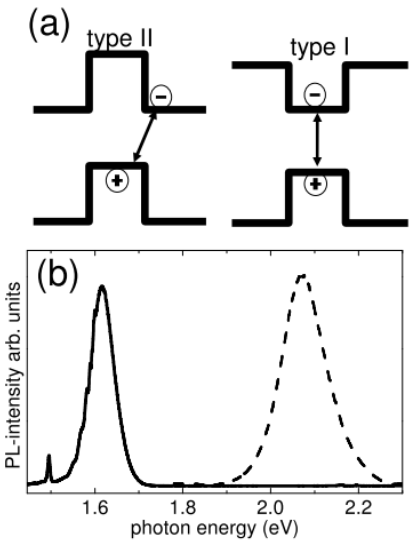

Fig. 1 (a) band edges in type II and type I heterostructures; arrow – optical transition (b) Photoluminescence from CdTe/ZnTe (dashed line) and Cd(Te,Se)/ZnTe (solid line) self assembled quantum dots. Excitation 405nm, T=5K

In this work, we report on optical properties of self-assembled Cd(Se,Te)/ZnTe quantum dots (QDs) grown by molecular beam epitaxy. All structures are characterized by low temperature photoluminescence and micro-photoluminescence. First of all, we observe that increasing Se concentration has a significant impact on the excitonic emission energy. After inserting of only one CdSe monolayer into six monolayers thick CdTe QD-layer, the emission energy shifts by about 500 meV, from about 2.1 eV to 1.6 eV (Figure 1b). Simultaneously, the excitonic lifetime increases significantly up to several hundreds of nonoseconds.

The observed effects can be interpreted in terms of type I to type II band alignment transition which occurs as a result of Se incorporation into CdTe quantum dots. The increase of the excitonic lifetime is due to carrier separation at type II interface.

The emission from individual QDs is studied by means of micro photoluminescence. First of all, we find that the broad emission centered at 1.6 eV splits into several sharp emission lines coming from individual dots when the excitation spot size is reduced down to 1μm. While increasing the excitation power, several additional emission lines appear related to multiexcitonic complexes. Interestingly, biexcitonic emission lines appear at higher energies compared to excitonic emission in quantum dots containing Se, which is not the case in pure CdTe quantum dots.

In the next step, the heterostructures with type II band alignment will be used in an attempt to observe the optical Aharonov-Bohm effect.

This work has been partially supported by the National Centre of Science (Poland) through grant 2017/26/E/ST3/00253, and by the Foundation for Polish Science through the IRA Programme co-financed by EU within SG OP.