Colloidal synthesis and optical properties of two-dimensional semiconductor $A^{II}B^{VI}$ heteronanostructures

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Preparation of various heterostructured semiconductor nanoparticles (SNPs) attracted considerable attention, since it provides fabrication of nanomaterials that exhibit intriguing optical and electronic properties which could be altered to the large extent [1]. To day a lot of methods for the colloidal synthesis of various SNPs and heteronanostructures on their basis were developed. At the same time, flat 2*D* nanocrystals or nanoplatelets (NPLs) composed of cadmium chalcogenides that were introduced in 2008 gained less attention [2].

Recently we introduced 2*D* heteronanoplatelets with "core-wings" architecture (Figure 1, C) that could be manufactured by selective lateral overgrowth of core CdSe nanoplatelets with the wide gap CdS "wings" [3]. In the current study we demonstrate that similar approach allowed us to prepare heterostructured CdSe–CdTe NPls with type-II band offset (see Figure 1, B). Elemental and phase composition of the obtained NPls were confirmed by XRD, EDX and HAADF STEM-images. Optical properties were examined by means of UV-Vis spectroscopy, PL, PLE and PL lifetime measurements. It was found that NPls exhibit extremely narrow and intensive bands in absorption and at the same time their PL bands are considerably red-shifted for up to 150 nm (Figure 1, A). Time-resolved PL decay measurements showed that due to spatial charge separation average excited state lifetimes are increased by a factor of 10–40.

Owing to anisotropic separation of electrons and holes coupled with high surface area, flat 2*D* CdSe–CdTe NPls are believed to be highly promising materials for photocatalytic and photovoltaic applications. At the same time large Stokes shift along with giant oscillator strength effect and high absorption in the visible region makes such NPls of high interest for efficient optical down-converters.

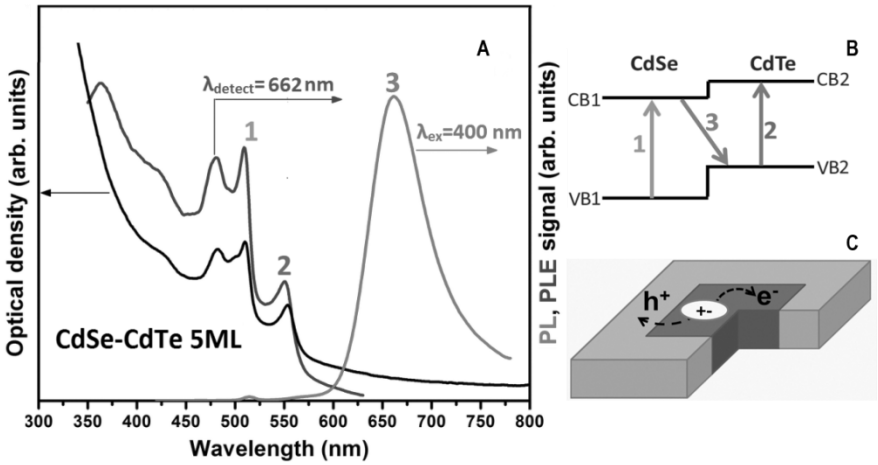

Fig. Absorption, PL and PLE spectra of 5 ML-thick "core-wings"CdSe–CdTe NPls (A), band level diagram (B) and schematic image of "core-shell" NPls (C)

References

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3. A. Prudnikau, A. Chuvilin, M. Artemyev *J. Am. Chem. Soc.* (2013) 14476.