Book of Abstracts

International Conference on Ultrafast Optical Science

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Invited

Photoluminescence and nonlinear-optical effects in CdSe quantum dots in liquid-crystal polymer matrix

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Semiconductor quantum dots (QD) and nanocomposites based on them attract a great deal of interest as media to generate and control laser radiation. In particular, this can be done with the help of polymer-QD nanocomposite. Employment of liquid-crystal polymers (LCP) is very promising since they allow formation of ordered QD arrays and high QD concentration. Measurement of QD-LCP nanocomposite photoluminescence (PL) spectra and PL kinetics is the first stage of study of such nanocoposites. It would be also very instructive to compare results obtained both for LCP and amorphous polymer matrices and study possible nonlinear-optical effects. We employed CdSe and core/shell CdSe/ZnS QD embedded into smectic BA-6PA and amorphous PMBA-6A polymers with various QD mass fractions (up to 60%). QD diameter was 4.1 nm.

PL was excited by picosecond laser pulses at 532 nm. The PL spectra contain two bands (2.15 and 1.70 eV) corresponding to exciton radiative recombination and radiative recombination in defects (traps) at QD-matrix interface, the latter band intensity increases for CdSe in LCP matrix in comparison with amorphous one and practically disappear in CdSe/ZnS QD nanocomposites. Increase of QD concentration results in PL lifetime decrease for QDs in LCP matrices. Comparison of LCP and amorphous matrix QD nanocomposites evidences faster PL decay and less quantum yield in the latter case. Core/shell QDs exhibit more effective PL and weaker effect of the matrix then CdSe QDs.

Employing femtosecond laser pulses (1250 nm, 80 fs, 80 MHz) allowed us to detect the second-harmonic (SH) and up-converted signals. The latter spectrum coincides with one excited at 532 nm. The up-conversion could be considered as an anti-Stokes PL in the QDs excited by the SH.

In conclusion, PL and up-conversion measurements of CdSe and CdSe/ZnS QDs embedded in the polymer matrices indicate potential use of the LCP for formation of QD nanocomposites allowing effective light generation.

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