Behaviour of CdSe/ZnS quantum dots in LC matrix

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Over the past decade the optical properties of hybrid structures based on liquid crystals (LCs) and semiconductor nanoparticles have attracted increasing attention of scientists [1]. To control the properties of quantum nanoparticles they are introduced into various matrices [2], which can be conditionally divided into 2 types - passive and active. Using liquid crystals as active matrix opens new possibilities to control of quantum dots (QDs) luminescence by means of an electric field [3]. The absence of a general theory describing the mechanisms of interaction of LCs and semiconductor nanoparticles, explaining the observed changes in luminescent properties of LCs and QDs, makes it urgent to conduct detailed studies of their composites. We studied the optical properties of semiconductor CdSe/ZnS QDs in a nematic LC matrix under action an external electric field.

The composites were prepared by adding a sample of dry hydrophobic CdSe/ZnS QDs with a core diameter of 3.5 nm and 5 nm to a nematic liquid crystal LC-1289 with a positive dielectric anisotropy. The LC cells of the sandwich type assembled from two quartz substrates coated with indium-tin oxides layers and a planar orienting polyimide layers. The composites were obtained using ultrasonication process during from 30 minutes to 4 hours. The LC structures with 1 wt. % QDs have a homogeneous orientation after filling the cells.

The enhancement of the CdSe/ZnS QDs photoluminescence (PL) in LC has been observed with an increase in the electric field applied to the LC cell. The maximum of the PL intensity was found about 0.125 V/μm. That is associated with passivation of centers of recombination of QDs in the LC matrix and also with energy transfer from liquid crystals to semiconductor nanoparticles. A further increase in the electric field strength led to a significant quenching of the PL intensively of the QDs. This could be explained by a decrease in the probability of recombination of the electron-hole pair as a result of a decrease in the overlapping of the wave functions of the electron and hole in the excited nanoparticle and an increase in the size of QDs aggregates as a result of the reorientation of the nematic director in electric field.

References

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