Nanocomposites and nanomaterials

Synthesis of CdTe nanocrystals in aqueous solution and their structural characterization

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Luminescent semiconductor nanocrystals (NCs) are part of a special class of materials occupying a transitional position between macroscopic crystals and single molecules, and they have some unique photochemical and photophysical properties. These properties make the CdTe NCs promising for various optoelectronic and biological applications: light-emitting diodes, living cells' fluorescent labels, photovoltaic devices etc.

We describe the optical and structural characterization thioglycolic acid-Capped CdTe nanocrystals synthesized in water. All samples exhibit high luminescence that increases with time. Their absorbance spectra display a well resolved excitonic peak in the 350-510 nm range, whilst photoluminescence peaks shift red (500-600 nm) due to the Stokes shift. Spectroscopic studies have allowed revealing the features of CdTe NCs depending on the conditions of their production. It is known that for bulk CdTe position of the longitudinal (LO) and transverse (TO) optical phonons are 169 and 141 cm^{-1} respectively. It is necessary to take notice that intensity of combination dispersion of light on LO-phonons of CdTe in colloid solutions considerably higher, than in the crystals obtained by the mechanical grinding in a ball mill. This can be explained by more homogeneous spread of NCs size in these structures as well as surface passivation of colloidal NCs film by thioglycolic acid. In the Raman spectra of colloidal solution of CdTe NCs the strip of longitudinal phonon LO (163 cm^{-1}) is shifted to low frequency side on 6-14 cm^{-1} in comparison with the bands for bulk CdTe. The latter can be explained by the effect of localization of optical phonons in NCs. For spherical NCs the wave vector of localized optical phonons is determined by the expression $q = \pi m/d$, where m is a quantum number of localized modes, and d is a diameter of NCs. Dispersion $\omega(q)$ of LO phonon of CdTe is negative, so the frequency of the first localized mode is lower than its bulk value. In the Raman spectrum there is no band corresponding to TO-mode of CdTe (141 cm^{-1}), however there is a wide stripe in the region close to the LO-mode (169 cm^{-1}). It allows assuming that apart from CdTe NCs in solution there are also larger crystals (≥ 1 μm).