Effect of Ph of Synthesis on Cds/L-Cys Colloidal Solutions Optical Properties

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Nanosized CdS has been extensively studied in the past decades due to its applications as photocatalyst, light-emitting diodes, hybrid solar cells, and others. Capped by bio-conjucting agent L-cystein such nanoparticles (NPs) attract attention as fluorescent probes for biological imaging. In most papers researhers used empirically chosen the precursors concentration range that complicated a total view for the NPs synthesis optimization. In [1] it had been shown advantages of a mathematical method of the experiments planning (simplex-lattice designs suggested by Scheffe) for the data generalization.

The aim of this paper is systematization by the Scheffe method of experimental data on the CdS/L-Cys colloid solutions synthesized at pH=7; 9 and 11 absorption and fluorescence spectra observed at r. t. The Cd^{2+} – S^{2-} – L-cys system composition ranges were first determined from the literature data at various pH (pH= 4 ÷ 11.8). It was obtained that a highest quantum yield QY (up to 35%) demonstrated by the NPs synthesized at pH=7 in the presence of Cd-ions excess or at $[Cd^{2+}]/[S^{2-}] = 1$.

After exclusion the composition of unstable solutions the study was concentrate for the following ones: $[Cd^{2+}]$ ranged 0,1 ÷ 0,35; [L-cys] 0,55 ÷ 0,8; $[S^{2-}]$ 0,1 ÷ 0,35 mM.

The experimental conditions for 1-2 nm spherical NPs production with narrow sizes distribution were determined from TEM-observations. Using the simplex-lattice design gives a possibility to obtain similarity of absorption spectra edge (λ_{edge}) of NPs synthesized at pH=7 and 9. Increase of pH up to 11 decreases the NPs sizes and consequently the λ_{edge} value. This could be attributed to the density of hydroxy-ions on the surface of the nanocrystals that effectively passivate the nanocrystals surface.

It was observed also that an important factor - coordination number (c.n.) = $[L\text{-cys}]/[Cd^{2+}]$ unmonotonically (Gaussian distribution) governs the NPs optical properties. For example, maximum QY at $[Cd^{2+}]/[S^{2-}] = 1$ occurs at c.n.=2,5 at pH=7; 3,5 at pH=9 and 4,5 at pH=11.

1. O.V. Krupko, Y.B. Khalavka, L.P. Shcherbak. Synthesis of CdS/L-cys nanoparticles colloid solutions with predetermined optical properties. Materials Research Bulletin (2014) 60, 264-269.