NEW LASER ACTIVE MEDIUM WITH CYCLODEXTRIN INCLUSION COMPLEXES OF CADMIUM SELENIUM AND DYE MOLECULES

M. M. Asimov[1], S. S. Anufrik[2], G. G. Sazonko[2]

[1]B. I. Stepanov Institute of Physics
of National Academy of Sciences of Belarus, Minsk
E-mail: m.asimov@dragon.bas-net.by
[2]Yanka Kupala State University of Grodno, Grodno

Arising interest to nanoparticles like CdSe is based on photophysical and spectroscopic properties that are determined by their size. Nanoparticles are widely used in spectroscopic and biological investigations, in particular, as fluorescence marking substances of biological structures. Nanoparticles also investigated as laser material for multicolor generation.

Spectroscopic properties of nanoparticles are depended on their size. This phenomenon gives the possibility for creation variety of compositions with new spectral-luminescence properties in combination of dye molecules. Such materials are interesting for a different application such as spectral coding, active laser medium etc.

For investigations of spectral-luminescence characteristics of compositions nanoparticles of CdSe synthesized at the Institute of physics and chemical problems of Belorussian State University has been used. Initial concentration of CdSe nanoparticles in water solution was $2 \cdot 10^{-4}$ M/l. For prevention of aggregation processes all solutions stored at reduced temperature about +5 ^{0}C. This precaution guaranteed stability of solution during the measurements of spectroscopic characteristics of investigating compositions. The chemical structure of the molecule of Rhodamine 6G is presented in Fig. 1.

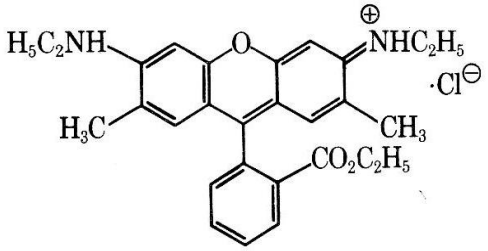

Fig. 1. Chemical structure of Rhodamine 6G

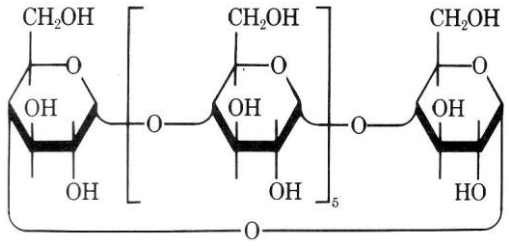

Fig.2. Chemical structure of Cyclodextrin

Spectral-luminescent characteristic of Rhodamine 6G molecules has been modified by formation of inclusion complexes with β – Cyclodextrin. In fig. 2 the chemical structure of cyclodextrin molecule is presented.

Cyclodextrins are cyclic, non-reducing oligosaccharides consisted from six, seven or eight glucopyranose units. This molecule is able to include into inner cavity different dye molecules. An attractive properties of β – Cyclodextrin is it high water solubility. Cyclodextrins are able to form "host-guest"

complexes with hydrophobic molecules given the unique nature imparted by their structure. Spectral-luminescence characteristics of new compositions of matter on the base of cadmium selenium nanoparticles and "inclusion complexes" of Rhodamine 6G with β – cyclodextrin demonstrate potential possibility of their practical application in spectral coding (fig.3).

Cadmium selenium nanoparticles with two separated fluorescence bands in thin films on the base of Methyl Isobuthil Ketone may be considered as compound for tracking and verification of different materials including documents and books. Optical method of express analysis the size of nanoparticles at the process of synthesis and purification based on their fluorescence excitation spectra is proposed.

An obtained result demonstrates domination of two sizes in synthesized CdSe/ZnS nanoparticles. According the fluorescence spectrum of CdSe/ZnS nanoparticles in thin film the maximum wavelength of shorter band correlates with size of particles few nanometers. Fluorescence band in long wavelength spectral range is due to particles with size of tens nanometers. At the same time in doped thin film the CdSe/ZnS nanoparticles there are number of amount particles with different sizes at a very low concentration. That way fluorescence spectrum of CdSe/ZnS nanoparticles consists from two intensive bands. The obtained results of investigation of spectroscopic properties synthesized CdSe/ZnS nanoparticles in thin film is interesting for practical application it using dual well spectrally separated fluorescence bands.

As it seen from fig. 3 under the excitation of investigating compositions at λ = 350 nm dual fluorescence is observed. Moreover long wavelength band is twice intensive than short-wave band of fluorescence. At the same time under the excitation at λ = 380 nm intensity of long wave fluorescence decreases more than the short-wave one. These results also demonstrate perceptivity developing unique multicolor compositions on the base of nanoparticles and different inclusion complexes of dye molecules with cyclodextrins for many practical applications.

Obtained results are promising in developing this approach in creating grate number of original multicolor heterogeneous compositions of matter with different nanoparticles, dye molecules and cyclodextrins. Proposed approach may be applied in developing an effective laser active medium for multicolor generation.

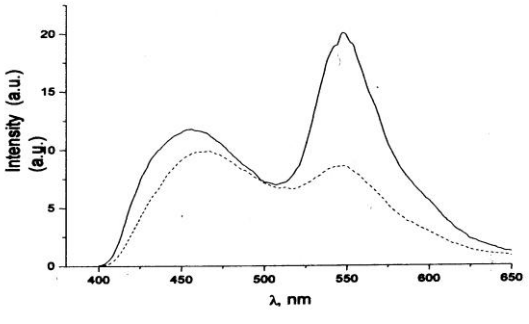

Fig. 3. Fluorescence spectra of compositions of CdSe/ZnS nanoparticles (concentration ~$1 \cdot 10^{-5}$ M) with inclusion complexes of Rhodamine 6G with β – cyclodextrin molecules (concentration ~$1 \cdot 10^{-6}$ M) in thin film under excitation of fluorescence at λ = 350 nm (−) and λ = 380 nm (---).