NANOSPHERES DOPED WITH QUANTUM DOT AND PHOTOCHROMES

A. Shcherbovich[1], P. Karpach[2]

[1]Belarusian State University, ISEI BSU,
Minsk, Republic of Belarus
[2]Yanka Kupala State University of Grodno,
Grodno, Republic of Belarus
scherbovich.a.a@gmail.com

In recent years, considerable attention has been paid to the study of the properties of photochromic systems and photoinduced fluorescence of organic and inorganic compounds using photochromic substances and inductive or Förster resonance energy transfer (FRET) [1]. It is promising to use semiconductor nanocrystals (NCs), in particular, CdSe/ZnS nanoparticles [2], which have a core-shell structure, as fluorophores. They possess the important properties as follows: a wide fluorescence excitation spectrum, a narrow fluorescence band, high luminosity, and photo stability.

Keywords: nanospheres, photochromes, quantum dot, Förster resonance energy transfer.

During the research, nanospheres containing CdSe/ZnS nanocrystals and the photochromic compound diarylethene F-18 were obtained (Fig. 1). The technique for obtaining such structures is based on the application of the solubilization of nanocrystals, as a result of which a thin polymer layer is formed on the nanocrystal surface due to hydrophobic interactions between the ligands on the nanocrystal surface and the hydrophobic groups of the amphiphilic polymer. The hydrophilization of nanocrystals by creating a shell on them from a copolymer of maleic anhydride and 1-tetradecene is carried out due to hydrophobic interactions.

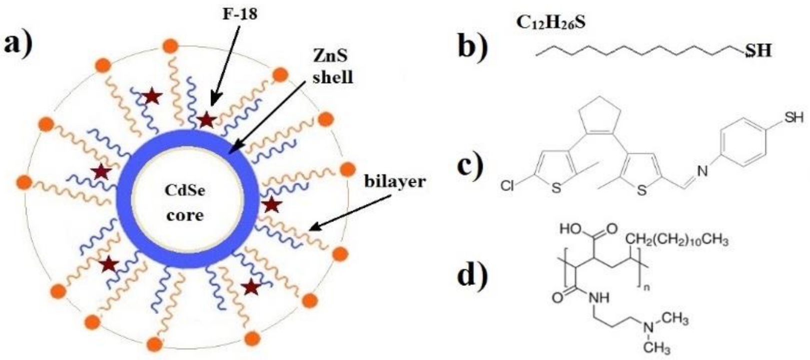

Fig. 1. – a) the structural model of the created nanosphere doped with a CdSe/ZnS quantum dot and photochromic diarylethene molecules F-18, b) the structural formula of dodecanethiol, c) the structural formula of the photochromic compound diarylethene F-18, d) the structural formula of Poly(maleic anhydride-*alt*-1-tetradecene)

As a result of studies of the absorption and fluorescence spectra of the resulting structures, it was found that nanostructures exhibit photochromic properties. Thus, under UV irradiation, the luminescence intensity of nanostructures containing CdSe/$(ZnS)_{0,5}$-DAE1, i.e., nanocrystals with a smaller thickness of the ZnS shell, decreases by ~ 75 %, and the luminescence intensity of nanostructures containing CdSe /$(ZnS)_2$-DAE1 , i.e., nanocrystals with a larger thickness of the ZnS shell decrease by ~ 45 %. After subsequent irradiation of the samples with visible light, the brightness of the sample luminescence is restored by about 95 %. These results are in qualitative agreement with the data on the probabilities of the FRET in the samples studied above. An increase in the thickness of the ZnS shell leads to an increase in the distance between donors and acceptors of energy, as a result of a decrease in the efficiency of quenching of luminescence of nanocrystals and a decrease in the quality of reverse photo-control of luminescence.

The use of solubilization technology made it possible to obtain nanostructures containing CdSe/ZnS nanocrystals with a ZnS shell thickness of 0,5 and 2,0 nm coated with a polymer layer in which DAE1 molecules are localized. The sizes of the obtained nanostructures are estimated at 5 and 21 nm. In the case of nanostructures with a thin (0,5 nm) ZnS shell, effective control of the luminescence intensity of nanocrystals with a reversible structural change in the photochromic DAE molecules is revealed. The proven technologies and the obtained photochromic properties of CdSe/$(ZnS)_{0,5}$-DAE1 nanostructures seem to be useful for creating various photocontrolled nanodevices.

BIBLIOGRAPHY

1. *Cusido, J.* Fluorescent Switches Based on Photochromic Compounds / J. Cusido, E. Deniz, F. M. Raymo // Eur. J. Org. Chem. – 2009. – № 13. – P. 2031–2045.

2. *Yildiz, I.* Fluorescence modulation with photochromic switches in nanostructured constructs / I. Yildiz, E. Deniz, F. M. Raymo // Chem. Soc. Rev. – 2009. – Vol. 38. – P. 1859–1867.

CHANGES IN THE ENVIRONMENTAL SITUATION IN THE VOLGA REGION FROM 2000 TO 2016

Y. Shelkov

Lomonosov Moscow State University, MSU,
Moscow, Russia
yarik250798@yandex.ru

The study is devoted to the dynamics of changes in the ecological situation in the Volga region. Chronological period from 2000 to 2016 is selected for the period of the research. Taking into account ecological and economic aspects allows us to trace the dependence of changes in the environmental situation on trends in the economy. The study was carried out taking into account the analysis of the main environmental problems of the region, as well as the study of the origins of their formation. The result of the study is an integrated assessment of the environmental situation in the Volga region on the basis of the ecological and economic index.

Keywords: the Volga region, environmental situation, assessment, integral index.

The current environmental situation in many regions of Russia has become a reflection of both the global trends of the twentieth century and the results of the socio-economic policy of the Soviet Union. The command and administrative model of the economy, which assumed large-scale industrialization and increase of production power, caused the emergence of environmental problems in the Volga region - one of the industrial centers of the USSR. Among the modern environmental problems of the Volga region include: soil pollution, water bodies and atmospheric air, reduction of forest area, reduction of biological diversity, shallowing of rivers, destruction of the ecological system of the Volga river.

Today, the importance of the Volga region for the economic, social and cultural development of the country is very great because of the existing economic and natural resource potential and beneficial EGP. The Volga economic region is one of the largest macro-regions of Russia and occupies a leading position in the development of economic sectors: in terms of industrial development, the Volga region ranks third after the Central and Ural Federal districts, and in terms of agricultural development-second after the Central Federal district and surpasses all CIS countries except Ukraine.

To assess the anthropogenic impact on the natural environment, indicator systems in a disaggregated form and integrated indices are used, allowing to take into account both environmental and economic indicators. Since the calculations require statistical data reflecting the dynamics of the impact on the environment in different periods, the indicators available in open statistical sources (Rosstat) were taken as a basis: the volume of investments in fixed assets aimed at environmental protection and rational use of natural resources (IOS); emissions of pollutants into the atmosphere from stationary sources; the level of discharge of pollutants from wastewater into river basins; the volume of waste and MSW.

Table 1