

Purification non-aqueous solution of quantum dots CdSe-CdS-ZnS from excess organic substance-stabilizer by use PE-HD membrane

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Abstract. Recently, a new simple method for the purification of CdSe-CdS-ZnS quantum dots by using membrane filtration, the filtration process, successfully separated the oleic acid from quantum dots through membranes purification after synthesis; purification of quantum dots is a very significant part of post synthetical treatment that determines the properties of the material. We explore the possibilities of the Langmuir-Blodgett technique to make such layers, using quantum dots as a model system. The Langmuir monolayer of quantum dots were then investigated the surface pressure-area isotherm. From isotherm, we found the surface pressure monolayer changed with time.

1. Introduction

The interest of nanoparticles – semiconductor quantum dots, – it was continued to increase in last decades. Quantum dots have a scientific interest due to unique physical properties. Purification of quantum dots – it's very important process after synthesis. Purified quantum dots (QDs) are the foundation for the creation of light-emissive devices.

Nanoparticles rectify it's very difficult due to small size (2-5 nm). As well it's difficult due to a small selection of suitable solvents, irreversible adsorption with other materials, aggregation. Aggregation nanoparticles lead to a change in the size of the system elements. Change in the size of the system to make difficult selection of membrane with pore to a certain size.

Is now used many methods of purification [1]. In this work presented the results of studied that show the possibility of purification by membrane filtration solutions QDs in chloroform and toluene. Present results of experimental use one of low-cost materials for the membrane. This filter with nanopores - its high density polyethylene. It was used for separation of organic molecules of the stabilizer (oleic acid) from initial solution QDs.



2. Experiment

Purification of QDs, stabilized oleic acid, was carried out with using a specially assembled unit (see Fig. 3) for 168 hours. Isotherm compression of the external solution were removing for observation and diffusion control during this time.

A series of pilot experiments to select a suitable membrane. There were three options materials – cellulose dialysis membrane, plastic films of low and high density (LD-PE and HD-PE). As a result of the experiments was chosen high density polyethylene.

Cellulose dialysis membrane and low density polyethylene film were excluded for various reasons. Firstly, they have pores too large: there through QDs permeate. Secondly, the dialysis membrane is most convenient for the filtration of aqueous solutions. In organic solvents, dialysis membrane retains fragility, resulting in the formation of microcracks at the bend and the loss of functionality.

The solution of colloidal quantum dots stabilized oleic acid in chloroform to about 10^{-6} M concentration of 125 μ l was placed in a dialysis bag which was immersed in the box with chloroform. The internal volume of the solution in the package was 125 μ l (Fig. 1a), the volume of the external solution in a bank – 50 ml (Fig. 1b).

As a vessel for carry through a membrane filter was taken jar reagent plastic screw cap 100 ml.

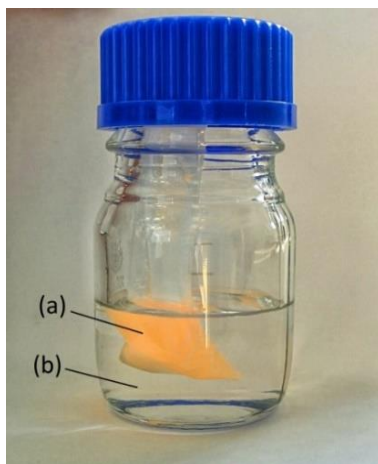


Figure 1. Chemical reaction apparatus for carrying out the process of separation: QD membrane solution bag (a), chloroform (b).

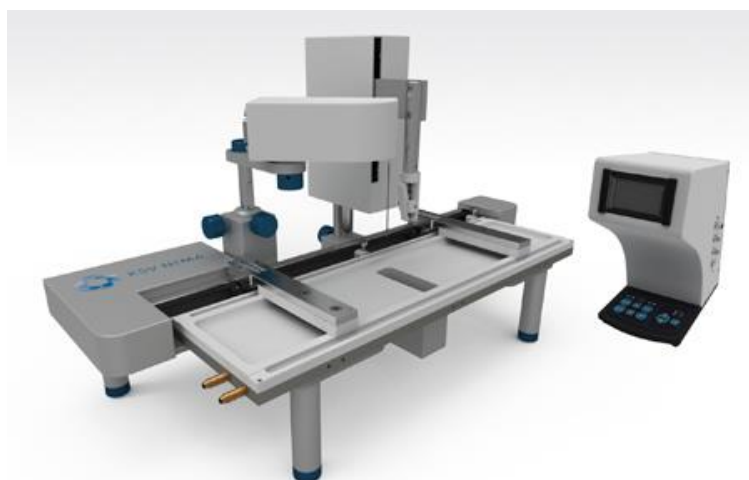


Figure 2. KSV Nima LB Trough KN2002.

Control and monitoring the diffusion of the surfactant through the membrane was done by measuring the surface pressure (isothermal compression) of the external solution. To measure the surface pressure setting used KSV Nima LB Trough KN2002 (Fig. 2) [2].

3. Results

Compression isotherms were recorded every 24 hours. For cleanliness before each measurement surface degreasing bath and purified with chloroform. As subphase used deionized water with a resistivity of $18 \text{ MOhm} \times \text{cm}$. On the surface of the water each time make the same amount of material from the outer volume (of the solution in a glass container) – $800 \mu\text{l}$.

After evaporation of the solvent (8 minutes) and the monolayer was compressed isothermally movable barriers at a constant rate – $8 \text{ cm}^2/\text{min}$.

The data obtained during the compression isotherm measurement shown in (Fig. 3). It is noticeable that the increases of maximum surface pressure with increasing filtration time, (Fig. 4). Obviously the Reducing of length of gas phase of external solution is due to increase the number of surfactant molecules in the external volume of the solution. This growth is due to the process of diffusion of unbound molecules of oleic acid through polyethylene membrane.

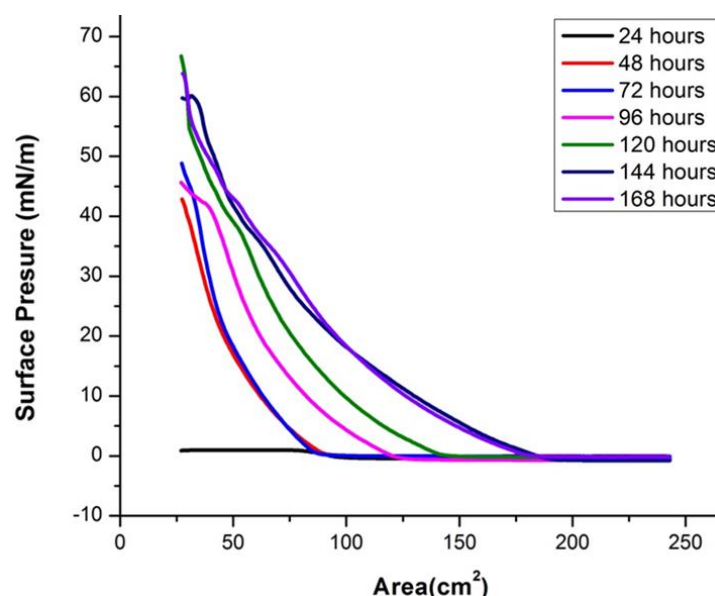


Figure 3. Compression isotherms surfactants of external solution.

When comparing images obtained by the method of Brewster angle microscopy, it can be seen that with increasing filtration time increases the amount of surfactant in the external volume. Monolayers were formed from solutions past 48 hours (Fig. 5) and 168-hour filtration (Fig. 6).

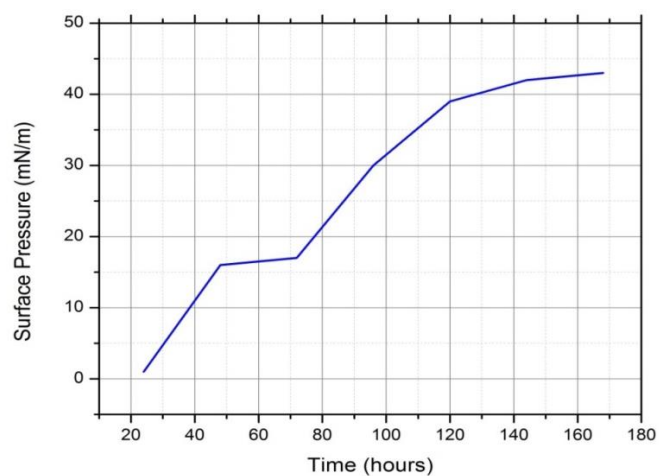


Figure 4. The growth of surface pressure over time.

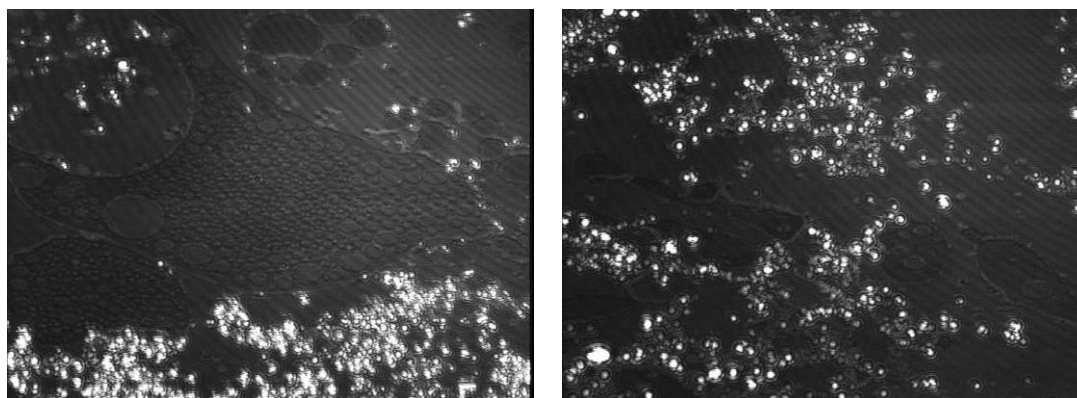


Figure 5. Images BAM outer monolayer of the solution after filtration of the solution to RT for 48 hours.

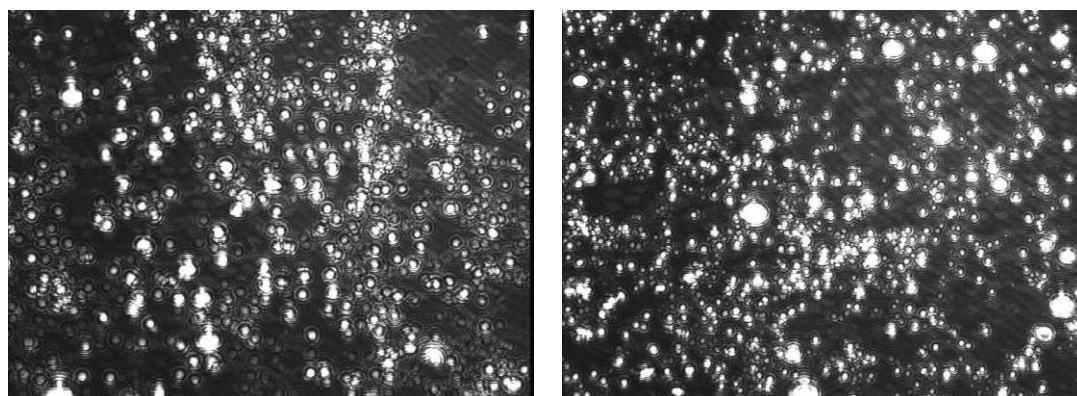


Figure 6. Images BAM outer monolayer of the solution after filtration of the solution at RT for 168 hours (right).

Thus, a method of purifying a solution of quantum dots, CdSe-CdS-ZnS by membrane filtration of unbound molecules from the excess oleic acid [2,3].

4. Conclusions

To investigate the changes in the number of surfactant in the external volume of the solution used Langmuir-Blodgett technique. In the process of compression isotherms were taken the outside solution during the membrane filtration of the solution of quantum dots. In the solution the unbound surfactant molecules leaving from a stock solution of QDs. Isotherms obtained at significantly increasing the maximum surface pressure and reduce the length of the gas phase in monolayers with increasing time filtering solution QDs scan, which shows an increase in surfactant concentration on the surface of the water surface.

Gratitude

The work is supported by grant № 14-12-00275 of Russian Science Foundation and Saratov State University

References

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