# CdS, PbS AND CuS QUANTUM DOTS ANALYZED BY FLOW INJECTION WITH ELECTROCHEMICAL DETECTION

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# **INTRODUCTION**

Nanotechnology is generally referred to science research and development, which deals with the targeted creation of material structures at a scale of several nanometers. Nanotechnology and nanomaterials are very extensive in the sectors of physics, chemistry and biology.

These materials include fluorescent semiconductor nanocrystals, commonly known as quantum dots (QDs, "quantumdots"). Quantum dot is bounded conductive region of very small dimensions with large band gap energy. One of the most important feature is the ability of optical dots stain. This ability is linked to the size of quantum dots. Big dots shade in the red spectrum and little dots shade in the blue spectrum. This ability is again as sociated with the distribution of energetic layers in the dot and its ability to absorb only electrons but also photons.

# **MATERIAL AND METHODS**

The first step of the experiment was preparation of quantum dots (QDs). CdS quantum dots were prepared with a s lightly modified method published in [5] Cadmium nitrate tetrahydrate Cd(NO3)2·4H2O (0.03085 g, 0.1 mM) was dissolved in ACS water (25 ml).



# **MATERIAL AND METHODS**

3-mercapto propionic acid (35  $\mu$ l, 0.4 mM) was slowly ad ded to stirred solution. After wards, pH was adjusted to 9.11 with 1M NH<sub>3</sub> (1.5 ml). Sodium sulfide nanohydrate Na<sub>2</sub>S·9H<sub>2</sub>O (0.02402 g, 0.1 mM) in 23 ml of ACS water was poured into the first solution with vigorous stirring. Obtained yellow solution was stirred for 1 h.

The next step was a flow injection analysis. Microfluidic system for fully automated electrochemical detection was suggested (SFIA-ED). The electrochemical flow cell includes one low volume (1.5  $\mu$ I) flow-through analytical cell (CH Instruments), which consisted of doubled glassy carbon (GC) working electrode, Ag/AgCl electrode as the reference electrode and output steel tubing as an auxiliary electrode. Electrochemical flow cell was connected to miniaturized potentiostat 910 PSTAT mini (Metrohm, Switzerland) as a control module. The differential pulse voltammetry (DPV) as measuring method was used and parameters were as follows: initial potential -1.2 V, end potential -0.2 V, modulation amplitude 0.05 V, step potential 0.001 V. All experiments were carried out at laboratory temperature. Acetate buffer (0.2 M, pH 5) was used as the supporting electrolyte. Every measuring sample consists from 10  $\mu$ I of sample solution which was diluted in acetate buffer. The data obtained were processed by the PSTAT software 1.0 (Metrohm, Switzerland). The experiments were carried out at 20 °C. Flow injection analysis of QDs was preceded by optimization methods for Cd(NO<sub>3</sub>)<sub>2</sub> • 4H<sub>2</sub>O (200  $\mu$ M). The calibration curves of cadmium ions were measured in the concentration range from 0.098  $\mu$ M - 1.5625  $\mu$ M. Optimized parameters were: time of accumulation (30, 60, 120, 180, 240, 360, 420 sec.) and deposition potential (-1.2, -1.1, 1.0; -0.9, -0.8 and -0.7 V). Parameters and measurement system was the same as the system for the detection of QDs.



Fig.1 Optimization of measuring conditions: time of accumalition (0, 30, 60, 120, 180, 240, 360, 420 s)



Fig.3 Calibration curve of Cd (measurement parameters:

### **RESULTS AND DISCUSION**

In our work we focused on the detection of QDs using an electrochemical method of differential pulse voltammetry on microfluidic injection system.

At the beginning of experiment the method was optimized for the preparation of QDs. These QDs were subsequently detected by the concentrations of Cd using differential pulse voltammetry. This method has been optimized for the standard solution of  $Cd(NO_3)_2 \cdot 4H_2O$  in the concentration range from 0.098 to 1.5625 µM. Optimized parameters were: time of accumulation and deposition potential. For our setting was chosen accumulation time 360 s. This dependence is shown in Fig.1. Deposition potential of -1.2 V is recorded in Fig. 2. Limit of detection was determined 0.17 nM. The calibration curves is shown in Fig.3. For the detection of QDs has been fed into the measuring cell volume of 10 µl. Voltammograms of QDs is shown in Fig. 4. Peak height of Cd in quantum dots was 21.788 nA, which corresponds to a concentration of 1.28 µM



Fig.2 Optimization of measuring conditions: deposition potential (-1.2; -1.1; -1.0; -0.9; -0.8; -0.7 V)



Fig.4 Voltammograms of quantum dots, characteristic peak

time of accumulation 360 s, deposition potential -1.2 V, dispensed volume 10 µl),DPV method was applied.



#### of QD Cd in -0.6 V

#### CONCLUSION

Differential pulse voltammetry in connection with microfluidic injection system was a suitable method for the electrochemical detection of Cd in quantum dots. Specified concentration of Cd in quantum dots was 1.28 µM. The method was optimized and due to appropriate parameters we obtain a representative results.

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Fig. 5 Detail on flow cell (1-working electrode, 2-flow cell body, 3-working electrode fixture)

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