The study of surface morphology of conductive biopolymer matrices

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Currently, it is very important to develop bio-conducting materials for the further construction of biosensors and biofuel cells. In such electrochemical devices, chemical energy is converted to electrical energy using biocatalysts. They can be enzymes (enzyme fuel cells) or organelles and whole cells (microbial fuel cells), in which energy is transformed by the metabolic activity of microorganisms. The widespread introduction of such elements will significantly reduce the consumption of organic fuel without reducing the level of energy consumption.

Sample preparation

Biopolymer samples were synthesized using sequential modification of solutions of the following polymers: polyvinylpyrrolidone (PVP), acetylcellulose (CA), polyaniline (PAN). The modifying agents were a solution of chitosan (with hit) and glutaraldehyde (Glu). The active part of the biopolymer matrices was the redox enzymes peroxidase (HRP) and glucose oxidase (GOx) in a ratio of 2:5. Reactions catalyzed by the redox complex of enzymes are shown in schema (1,2).

$$O_2 + \beta\text{-D- glucose} \xrightarrow{GOx} \beta\text{-D- glucose -}\delta\text{- lactone} + H_2O_2 \quad (1)$$

$$ABTS + 2H_2O_2 \xrightarrow{HRP} ABTS + H_2O \quad (2)$$

The following samples of biopolymer materials were obtained: PVP / Hit / Glu / HRP: GOx, ACT / Chitosan / Glu / HRP: GOx, PAN / Hit / Glu / HRP: GOx.

Analysis of the specific surface area of the samples

Based on the data obtained, the pore size distribution was presented.

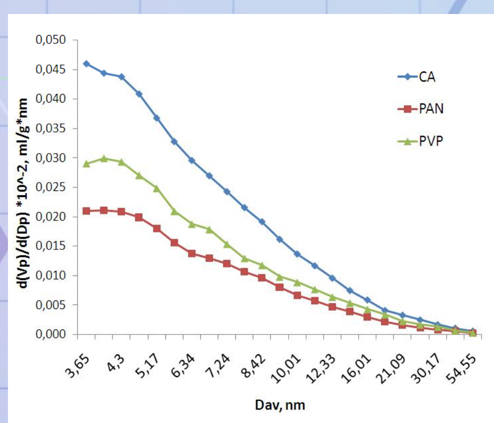

Fig.1. Diagram of pore distribution depending on their diameter for pure samples

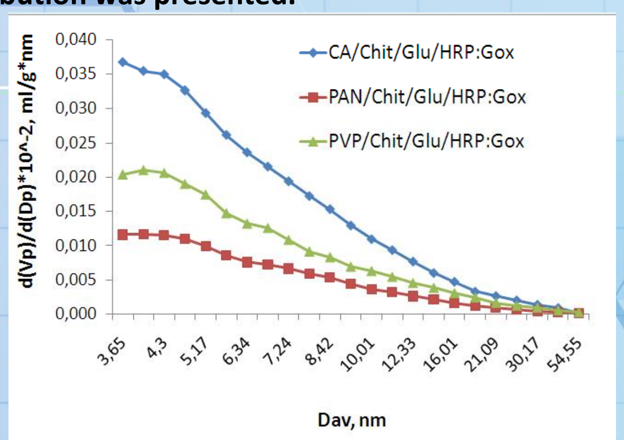

Fig. 2. Diagram of pore distribution depending on their diameter after modification and application of enzymes

Based on the obtained data on low temperature nitrogen adsorption, it can be concluded that all the samples presented have a mesoporous structure. The pore diameter averages 3.65-9 nm, which provides free access of enzyme molecules, having an average diameter of the native structure of 4-7 nm. During the modification of polymer carriers, the number of mesopores with a diameter of 8-16 nm decreases. This allows us to make an assumption about the localization of large molecules of covalently crosslinked enzymes in the macroporous surface of polymer carriers.

In this way, presented biopolymer matrices can be recommended for applying to electrodes and increasing the performance of biofuel cells.