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Electrosorption Properties of Polarized Thermally Expanded Graphite Covered with Polypyrrole

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ABSTRACT. The problem of hemocompatibility is very important for synthesis of new medicine materials. One of the modern paths of decision of such goal is electrosynthesis of composite materials with given properties. Polarized thermally expanded graphite covered with polypyrrole was used as a model for proposed hemosorbent,electrosorption properties of the material towards some psychotropic drugs were investigated. The region of potential corresponding to maximal adsorption was found. *© 2014 Bull. Georg. Natl. Acad. Sci.*

Key words: hemocompatibility, polypyrrole, electropolimerization, thermally expanded graphite

Hemocompatibility is the most important property for materials used as hemosorbents. On the other hand, when hemocompatibility is achieved, adsorption activity towards exo- and endotoxicants should be maintained.

The method of electrochemical hemosorption uses negatively polarized carbon hemosorbents to prevent interaction between the hemosorbent and blood cells. Like charges of the blood cells and carbon sorbent ensure that any attraction between them is negated by their repulsion.Since the potential of a carbon electrode can be measured, it is possible to predict the type of interaction between blood cells and the carbon sorbent by means of ordinary measurement of carbon potential.

According to [1], the range of potentials, where the hemosorbent is indifferent toward blood, is between +0.05 V and –0.15 V (vs. Ag/AgCl). At the same time it is known that electropolymerization of pyrrole on metal surfaces makes such polypyrrole-covered surfaces biocompatible [2]. In addition, the electric conductivity of the polypyrrole (PPy) coating enables further modification of its characteristics by electrochemical polarization. It is also well known that the adsorption activity of electrodes depends on their potential [3].

The main goal of the present work was to find a way of controlling the adsorption properties of carbon electrodes covered with PPy by external polarization. This would provide an opportunity to utilize porous carbon materials modified with PPy as starting materials in the synthesis of new, effective, hemocompatible hemosorbents.

Adsorption of a model toxicant on the surface of a carbon material covered with PPy was studied. Potentials of the investigated electrode materials were

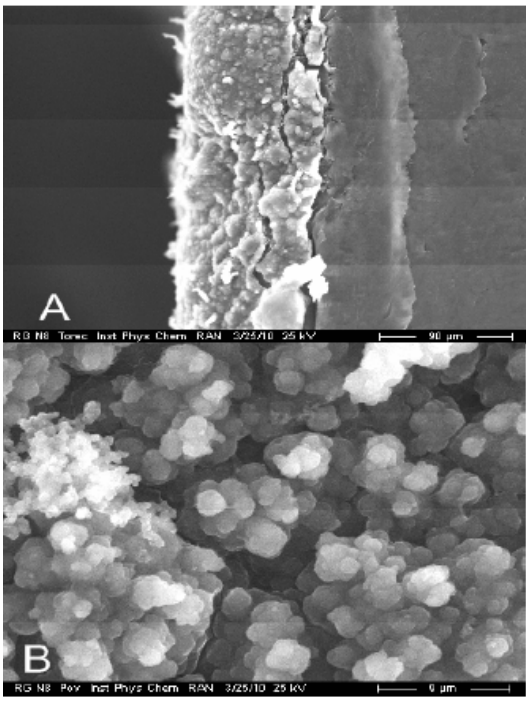

Fig. 1. Scanning electron microscopy of the TEG/PPy composite material.

measured against a saturated silver-silver chloride reference electrode. The model toxicant used was Chlorprothixene hydrochloride, while thermally expanded graphite (TEG) was used as the carbon material. Electropolymerization of pyrrole on TEG was carried out for 1 hr in a potentiostatic regime at E = 1.0 V in 2.05 M NaCl electrolyte containing 0.14 M pyrrole. Scanning electron microscope (SEM) images of the surface of TEG covered with PPy are shown in Fig. 1.

The measured open-circuit potential of the synthesized TEG/PPy composite material was 0.4 V. This composite was then immersed into an aqueous 0.15 M NaCl solution with 3.7×10-5 M Chlorprothixene hydrochloride for 30 min. The experiment was repeated using the TEG/PPy composite polarized to a potential of –0.05 V, as well as on the TEG support without PPy.

A considerable effect of the TEG/PPy composite potential on the adsorption of the toxicant was observed. For example, the ratio of Chlorprothixene hydrochloride adsorption on the TEG/PPy composite at E = –0.05 V to the adsorption at E = +0.40 V was 15:1 (the first two bars in Fig. 2). However, a constant value of adsorption of Chlorprothixene hydrochloride was observed on uncovered TEG in a wide range of potentials, including the initial and two polarized TEG samples at E = +0.05 V, +0.40 V, and –0.05 V, respectively (the last three bars in Fig. 2).

The data in Fig. 2 suggest that the observed potentialdependent selectivity of adsorption could be attributed to the catalytic activity of the composite material. This hypothesis was corroborated by data from a comparative study of oxygen electroreduction on TEG and TEG/PPy composite in a 0.17 M NaCl electrolyte saturated with air. Hydrogen peroxide formation was observed on the composite material as a result of electroreduction of oxygen. Moreover, the stationary limiting current for the above process exceeds the stationary current of the

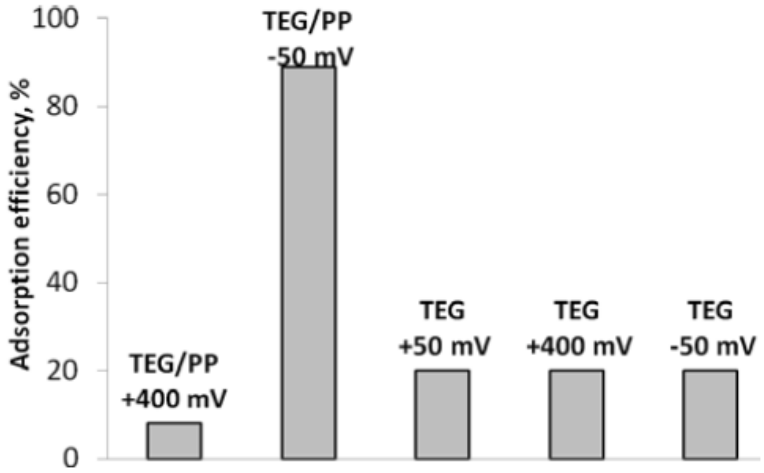

Fig. 2. The dependence of Chlorprothixene hydrochloride adsorption on TEG potential.

cathode process on TEG by a factor of three. This effect provides evidence for catalytic activity of the composite towards the electroreduction of oxygen.

The observed catalytic activity of the composite material makes it promising for use as a selective hemosorbent.

სამედიცინო მეცნიერებანი

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