Controlling the network properties of polymer matrixes for improvement of amperometric enzyme biosensors: Contribution of positron annihilation

T. Kavetskyy,[1,2*] Y. Kukhazh[1], K. Zubrytska[1], O. Smutok[3], O. Demkiv[3], M. Gonchar[3], O. Šauša[4], H. Švajdlenková[5], S. Kasetaite[6], J. Ostrauskaite[6], V. Boev[7], V. Ilcheva[7], and T. Petkova[7]

[1]*Drohobych Ivan Franko State Pedagogical University, Drohobych, 82100, Ukraine*
[2]*The John Paul II Catholic University of Lublin, Lublin, 20950, Poland*
[3]*Institute of Cell Biology, National Academy of Sciences of Ukraine, Lviv, 79005, Ukraine*
[4]*Institute of Physics, Slovak Academy of Sciences, Bratislava, 84511, Slovak Republic*
[5]*Polymer Institute, Slovak Academy of Sciences, Bratislava, 84541, Slovak Republic*
[6]*Kaunas University of Technology, Kaunas, 50254, Lithuania*
[7]*Institute of Electrochemistry and Energy Systems, Bulgarian Academy of Sciences, Sofia, 1113, Bulgaria*

The development of new approaches for monitoring xenoestrogens as the most dangerous pollutants of wastewater is a topical problem to improve human life first of all. To do that, the most promising in analytical biotechnology seems to be amperometric biosensors – bioanalytical devices that combine the best features of bioelements (selectivity) and physical transducers (high sensitivity and accuracy). Establishment of the most suitable polymer matrixes and nanocarriers for immobilization of enzymes and construction of improved amperometric biosensors of the 'third generation' on the base of the created biorecognition films is a challenge and needs a lot of efforts. In the present study the organic (conductive polymers, photopolymers and others) and organic-inorganic hybrid (ureasil-composite, Nafion-composite and others) polymer matrixes with micro/nanoparticles (graphenes, nanoparticles of noble metals), oxide nanoparticles were used for immobilization of microbial laccase and construction of new prototypes of amperometric biosensors for potable water analysis with improved operational parameters (sensitivity, selectivity, stability, and reproducibility).

The knowledge of the properties of the microstructure of such polymer materials is important in terms of optimizing the regulated properties of the amperometric biosensors. A swelling test provides information about a crosslink density and flexibility of polymer network and is commonly used to characterize the structure of a cross-linked polymer. At the same time, positron annihilation lifetime spectroscopy (PALS) is known as a progressive method for microstructural analysis of macromolecular structures. Combination of these both methods allowed to get information about network properties of the polymer matrixes and the results obtained were further compared with sensitivity of bioelectrodes constructed using the polymer matrixes [1-4]. A role of free-volume and crosslink density in the host polymer matrixes used for improvement of operational parameters of laccase-based amperometric biosensors was established. Finally, it is found that the coefficients for the thermal expansion of free-volume holes α_{F1}, α_{F2} below and above T_g as well as their difference ($\alpha_{F2} - \alpha_{F1}$) obtained with help of PALS could be used as controlling parameters of polymer matrixes for improvement of functionality of amperometric enzyme biosensors constructed based on the polymer matrixes.

References

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[*]Corresponding author, Email: kavetskyy@yahoo.com