APPLICATION OF MOLECULARLY IMPRINTED POLYPYRROLE FOR ELECTROCHEMICAL SENSOR DESIGN

Raimonda Boguzaite[1], Vilma Ratautaite[1,2], Urte Samukaite-Bubniene[1,2], Deivis Plausinaitis[2], Ernestas Brazys[2] Arunas Ramanavicius[1,2]

[1]Center for Physical Sciences and Technology, Department of Functional Materials and Electronics, Laboratory of Nanotechnology, Sauletekio av. 3, Vilnius LT-10257, Lithuania, raimonda.boguzaite@ftmc.lt

[2]Vilnius University, Faculty of Chemistry and Geosciences, Institute of Chemistry, Naugarduko str. 24, Vilnius LT 03225, Lithuania

The principal of production of the molecularly imprinted polymers (MIP) is based on the artificial modelling of the specific sites for analyte binding on the MIP. The interest in the development of MIPs has grown during recent years [1].

MIPs are used in analytical systems dedicated for the determination of low and high molecular weight analytes [2, 3]. The main interaction types of monomer with the template molecule can be distinguished as: chelation, electrostatic, hydrophobic interactions, and the formation of hydrogen bonds [4].

Various polymers and polymerization methods are used for the formation of MIPs. Polypyrrole (Ppy) among many other conducting polymers like polyaniline (PANI), polythiophene, poly(ethylenedioxythiophene) (PEDOT), etc., is the most frequently used for the formation of MIP-based sensing structures due to possible electrodeposition from aqueous solutions [4]. The advantage of conducting polymers is that conducted polymers-based layers can be deposited using well controllable various electrochemical deposition methods. However, mostly potential cycling (cyclic voltammetry) or potential pulses [3, 5] are applied.

As an example of the MIP application the development of a uric acid sensor based on the Polypyrrole could be mentioned [6]. Uric acid is a small molecule with a molecular weight of 168 g/mol.

Also, the MIP-based sensor for the determination of SARS-CoV-2-S glycoprotein was designed. Platinum electrode was served as a working electrode for the deposition of Ppy layer imprinted with a protein. For this purpose, the SARS-CoV-2-S glycoprotein and pyrrole were dissolved in phosphate buffered saline (PBS) solution, pH 7.4. The polymeric layers were formed by a sequence of 20 potential pulses of +950 mV for 1 s, between these pulses 0 V potential for 10 s was applied.

To conclude, the molecular imprinting of the conducting polymers is an attractive method for the development of the electrochemical sensors for the detection of molecules of various sizes.

References

1. A. Kidakova, R. Borozniak, J. Reut, A. Öpik, M. Saarma, V. Syritski, Molecularly imprinted polymer-based SAW sensor for label-free detection of cerebral dopamine neurotrophic factor protein, Sensors and Actuators B: Chemical, 308 (2020) 127708.
2. Wang, Y.; Liu, X.; Lu, Z.; Liu, T.; Zhao, L.; Ding, F.; Zou, P.;Wang, X.; Zhao, Q.; Rao, H. Molecularly imprinted polydopamine modified with nickel nanoparticles wrapped with carbon: Fabrication, characterization and electrochemical detection of uric acid. Microchim. Acta 2019, 186, 414.
3. Ratautaite, V.; Topkaya, S.N.; Mikoliunaite, L.; Ozsoz, M.; Oztekin, Y.; Ramanaviciene, A.; Ramanavicius, A. Molecularly imprinted polypyrrole for DNA determination. Electroanalysis 2013, 25, 1169–1177.
4. Ramanavicius, S.; Ramanavicius, A. Conducting polymers in the design of biosensors and biofuel cells. Polymers 2021, 13, 49.
5. Lian, H.; Sun, Z.; Sun, X.; Liu, B. Graphene doped molecularly imprinted electrochemical sensor for uric acid. Anal. Lett. 2012, 45, 2717–2727.
6. Ratautaite, V.; Samukaite-Bubniene, U.; Plausinaitis, D.; Boguzaite, R.; Balciunas, D.; Ramanaviciene, A.; Neunert, G.; Ramanavicius, A. Molecular Imprinting Technology for Determination of Uric Acid. Int. J. Mol. Sci. 2021, 22, 5032.