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Designing of layered biosensors, modified by semiconductor structures

Progressive neurological diseases connected with abnormal level of neurotransmitters, such as Parkinson and Alzheimer, according to *World Health Organization* affect together almost 90 million people around the world. Due to researchers prognosis, this number of patients in 2050 may reach even 120 million. Biosensors, allowing for continuous measurement, represent a strong group of alternative diagnostic methods and can provide fast, sensitive, low-cost and efficient analysis of neurotransmitters in the future.

Biosensors belongs to the group of chemical sensors, however, they are more selective and more sensitive, due to the presence of biological active material (e.g. enzyme, cell, bacteria or antibody) which is an inherent element in the receptor layer. The manipulation of nanostructured materials in conjunction with biological molecules has led to the development of a new class of hybrid modified sensors in which both enhancement of charge transport and biological activity may be preserved. In Poland, the Ministry of Economy has qualified the production of biosensors as one of the priority technologies identified in the industry technological foresight project - *InSight 2030*, which identifies key technologies and competitive industrial areas thanks to which Polish industry will be able to compete on the European and international market.

Due to the global demand for quick and cheap analytical methods, the main research goal which was carried out during PhD studies was to intensifying the work on the design of a new generation of miniature diagnostic devices with wide application possibilities. In my research, I focus on the construction of electrochemical and optical biosensors for the determination and monitoring of neurotransmitters (e.g. dopamine, epinephrine) in aqueous solutions that could be used, in the future, as portable devices for medical diagnostics (e.g. *Point-of-Care*).

Research in the construction of new enzymatic biosensor systems were executed in a several stages First stage of the researches involves selection of compounds for modification of electrodes. For this, it will be employed new-synthesized compounds, such as: amphiphilic, symmetric derivatives of heterocyclic compounds - derivatives of bis(selenophene)carbazole, bis(dithiophene)anthracene, or silicone containing compounds and functional nanomaterials. The next step was connected with study of the ability of selected semi-conducting compound to electropolymerize or self-assembly onto the solid substrates,

which was investigated using an electrochemical measurements (differential pulse voltammetry, cyclic voltammetry, chronoamperometry). Chosen compounds which form well-ordered stable films onto the electrodes, were evidenced using an Atomic Force Microscope, Scanning Electron Microscope and other spectroscopic techniques. Creation of bioreceptor part, which was a sequent stage, related with an enzyme immobilization on created semi-conducting structures-modified electrode. The activity of immobilized proteins from the class of oxidoreductases was determined by colorimetric methods (determining the enzymes' ability to oxidize substrates). The final stage was connected with the designing of the measuring system for specific analyte which was investigated. Depending on the kind of transducer, the measurements were carried out using two ways: first, the optical biosensors, which were designed based on the low temperature co-fired ceramic (LTCC) technology and fluorescence intensity measurements. Second, the electrochemical biosensor systems, which were a conventional three-electrode setup connect with the potentiostat Autolab PGSTAT128N, allowing for amperometric measurements.

All these steps lead to the designing of new, innovative biological sensor platforms (15 bio-systems) allowing the monitoring, identification and detection of the neurotransmitters in aqueous solutions.