UDC 544

INKJET PRINTING OF OPTICAL BIOSENSORS FOR MENTAL DISORDERS DETECTING

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Abstract. These days, the problem of diagnosing mental disorders is reduced to subjective factors, despite the high degree of prevalence of such diseases. Thus, the idea of creating a multi-marker diagnostic device for such diseases is in great demand. In this study, the optical sensor on the glutamic acid for schizophrenia detection was developed considered. Two different glutamate oxidase (GOD) and glutamate dehydrogenase (GDH) enzymes were tested. In the first case, the optical response was related with formation of peroxocomplexes of H2O2 with TiO2, in the second case, it is due to a color change in the complexation reaction of metal cations with ammonium. It was shown, that using obtained sensors led to the detection of glutamic acid in the range of concentration from 0 to 0.025 Mol/l. Various paper options as a substrate were considered, and a matrix was selected. In results, obtaining the optimal parameters for the optical biosensor.

Introduction. Mental disorders have serious consequences for the social sphere, human rights, and the economy. These days, schizophrenia is a serious mental disorder and affects about 1% of the world's population. Moreover, the incidence rate will remain stable over time.

The most important stage of psychiatric care for patients is the timeliness and correctness of the diagnosis which helps to avoid the serious consequences of the disease and also helps reduce the risk of decompensations in subsequent periods of life. However, existing clinical methods of diagnosis depend on subjective factors. Therefore, there is a need to create additional objective laboratory or instrumental research methods. The proposed solution to this problem is to create a test system that includes several markers of mental disorders.

For creation, some multi-marker test system is necessary to determine as the biomarkers of mental disorders as the optical responses to them. Relying on the literature data analysis a few markers, which can be used in this system were found. There are glutamic acid; antibodies to brain proteins e.g. S-100 protein or myelin basic protein; mpst enzyme (3-mercaptopurvate sulfotransferase) and marker hormones and neurosteroids, such as cortisol and dehydroepiandrosterone and its sulfate (DHEA-S), respectively. Currently, on this project, the detection of glutamic acid was chosen as the first step.

Results and discussion. This research demonstrated the results of the detection glutamic acid test system creation. It can be released by two variants of optical biosensors, which can be created using inkjet printing. The differences between these types due to enzymes variations for detection such as GOD and GDH. The glutamate distinction of healthy individuals (10,566 ± 0,507 nMol/ul) and patients with schizophrenia (21,106 ± 0,428 nMol/ul) in the blood serum is doubled so fixing these changes by the optical response could be possible. Different products of reactions give some optical response depending on the value of the concentration of glutamic acid. In one case, the hydrogen peroxide released during the glutamic acid and GOD reaction interacts with the titanium xerogel in the substrate layer and forms a yellow color. In the second case, the obtained ammonium cation gives optical response with the indicator layer. It includes some metal ions which can form colored complexes with the ammonium cation. Of the cations of copper (2+), nickel (2+) and cobalt (2+). Based on the data about ammonium concentration in blood serum, the concentration range of metal cation was selected from 0.0125 to 0.2 Mol/l, given that the ammonium concentration was 0, 0.01, 0.015, 0.02, 0.025, and 14.92 Mol/l. In addition, various options for the substrate for the biosensor were considered and also was selected the matrix such as boehmite aluminum, xerogel titanium

dioxide or without any matrix layer that was optimal for each type of enzymes. It was taken into account that the matrix is important for supporting the enzyme on the sensor itself, coinciding with the pH range of the enzyme.

Conclusions. In this study, the concept of a glutamic acid biosensor by inkjet printing was developed. It was found that, as an indicator in a biosensor with the GDH enzyme, the best results were achieved with Co 2+ cation, the optical changes of which turned out to be more significant than in the case of nickel and copper, which was confirmed in addition to the visual change by deviations in RGB deviation. In sensor with GDH, it was best optical response was with boehmite matrix or without matrix at all, in the second type of sensor with the GOD enzyme, where the matrix of titanium dioxide xerogel used an indicator layer.

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