

Abstract

This diploma thesis deals with the study of electrochemical behavior and detection of two structurally different neurotransmitters, dopamine (DA) and serotonin (5-HT), in solutions commonly used for neuron cultivation, namely Neurobasal (NB), NB with phenol red and in phosphate buffer (PB) of a pH close to the physiological value. An electrode based on boron-doped diamond was used for the study, examining two types of surfaces obtained after oxidation (O-BDD) and mechanical polishing (p-BDD). The results were obtained by two voltametric techniques, namely cyclic and differential pulse voltammetry. The study revealed that DA oxidation is a quasi-reversible process, whereas 5-HT oxidizes irreversibly on O-BDD and p-BDD. Nevertheless, for both neurotransmitters their anodic oxidation on both BDD surfaces is controlled by diffusion. Due to the passivation of the electrode surface by the oxidation products, anodic reactivation ($E_{\text{act}} = +2400 \text{ mV}$, $t = 30 \text{ s}$) was first tested to regenerate the O-BDD surface during DA and 5-HT measurements. There was no continuous decrease in DA peak currents on O-BDD and the measured signals were characterized by high repeatability in all studied media ($s_r(I_p)$ 1.1% in PB of pH 7.0, 1.7% in NB of pH 7.34, 0.9% in NB with phenol red of pH 7.48). In the case of 5-HT, the anodic reactivation was successfully applied only in the PB medium of pH 7.0 ($s_r(I_p)$ 0.18%), while in both Neurobasal media it was impossible to reach repeatable signals ($s_r(I_p)$ 19 – 22%). Subsequently, the surface termination was changed from O-BDD to p-BDD by mechanical polishing of the surface on alumina particles, which led to an increase in the peak currents of both neurotransmitters in all examined media, but also to a slight deterioration in repeatability of measured signals. The possibility of simultaneous detection of DA and 5-HT in a mixture using a p-BDD and O-BDD electrode was also verified, but the oxidation peaks of individual neurotransmitters could not be distinguished due to the considerable proximity of their oxidation potentials. Calibration dependences were measured in PB of pH 7.0 by the DPV method. It has been revealed that both O-BDD and p-BDD electrodes are suitable for the detection of DA and 5-HT, but p-BDD provides better analytical parameters: lower noise and lower limit of detection and quantification, wider linear dynamic range, and higher sensitivity. It was also confirmed that the potential windows of both NB media are shortened in the anodic region due to oxidation of their electroactive components.