Abstract

Presented Ph.D. Thesis is focused on the development of analytical methods applicable for determination of selected xenobiotic compounds and for monitoring DNA damage they can induce. The main attention has been paid to the development and testing of non-toxic electrode materials for preparation of miniaturized electrochemical devices and novel electrochemical DNA biosensors.

2-Aminofluoren-9-one (2-AFN) was selected as a model environmental pollutant, which belongs to the group of hazardous genotoxic substances. Its carcinogenic and mutagenic effects may represent a risk to living and working environment. 2-AFN has one oxo group, where the cathodic reduction occurs, and one amino group, where the anodic oxidation occurs.

The voltammetric behavior of 2-AFN in the negative potential region was investigated at a mercury meniscus modified silver solid amalgam electrode (m-AgSAE) representing a non-toxic and more mechanically robust alternative to mercury electrodes. This working electrode was subsequently used for the development of a newly designed miniaturized electrode system (MES), which has many benefits as the possibility of simple field measurements, easy portability, and the measurement in sample volume 100 μL. Moreover, a glassy carbon electrode (GCE) was used for further investigation of electrochemical transformations of 2-AFN in both cathodic and anodic potential regions and its determination. All the newly developed voltammetric methods were successfully applied on model samples of drinking and river waters.

In this Ph.D. Thesis, highly sensitive electrochemical techniques were also employed for investigating and monitoring DNA damage. An electrochemical DNA biosensor, based on the GCE and low-molecular-weight double-stranded DNA (dsDNA) from salmon sperm immobilized onto the electrode surface, was developed and characterized using modern advanced imaging techniques. Subsequently, a combination of several electrochemical techniques (direct and indirect) was used for investigation of the interaction between various xenobiotic compounds and dsDNA. Detrimental effects of selected derivatives of fluorene (2-AFN, 2-aminofluorene, 2-acetylaminofluorene, and 2,7-diaminofluorene) and hydroxyl radicals were studied. Hydroxyl radicals were generated electrochemically on the surface of a boron-doped diamond electrode and chemically (via the Fenton's reaction and the auto-oxidation of Fe(II)).