Voltammetric detection of damage to DNA caused by carcinogenic aminofluorenes using novel electrochemical DNA biosensors

V. Vyskocil\(^1\), M. Fatarova\(^1\), J. Barek\(^1\), J. Labuda\(^2\)

\(^1\)Charles University in Prague, Czech Republic, \(^2\)Slovak University of Technology in Bratislava, Slovakia

The emissions of gasoline and diesel engines contribute significantly to ever increasing pollution of living environment. A specific part of exhaust gases is composed of carcinogenic derivatives of polycyclic aromatic hydrocarbons. Amino derivatives of parent hydrocarbon fluorene, namely 2-aminofluorene (2-AF) and 2,7-diaminofluorene (2,7-DAF), are well-known hazardous air and water pollutants and their occurrence in living systems is also connected with a metabolic transformation of nitro derivatives of fluorene in mammalian cells. 2-AF is one of the most extensively studied examples of the aromatic amine class of carcinogens and it has been extensively used as a model for studying mechanisms of carcinogenesis.

In this work, four novel types of electrochemical DNA biosensors based on screen printed carbon paste electrodes (SPCPE) and a carbon film electrode (CPE) in the role of transducers have been used for investigation of the interaction between 2-AF/2,7-DAF and calf thymus double-stranded DNA (dsDNA). Two biocomponent responsive interfaces have been utilized for covering the surface of both SPCPE and CPE: (i) The layer of dsDNA immobilized at the electrode surface and (ii) chitosan–single-walled carbon nanotubes composite layer (CHIT-SWCNT) subsequently modified by the dsDNA layer. The biosensors have been fabricated and characterized regarding the DNA damage detection using voltammetric signals of guanine moiety, the ferricyanide anion as indicator present in solution phase, and electrochemical impedance spectroscopy. Damage to DNA caused by 2-AF and 2,7-DAF was indicated by a decrease of the guanine moiety peak current response in a concentration dependent manner.

This work was supported by the Ministry of Education, Youth and Sports of the Czech Republic (Projects MSM 0021620857, LC 06035, and RP 14/63) and by the European Union Lifelong Learning Programme (Erasmus). J.L. thanks to the Scientific Grant Agency VEGA of the Slovak Republic (Project 1/0182/11) for financial support.

Keywords: Electrochemical DNA Biosensors, DNA Damage Detection, Carcinogenic Aminofluorenes, Nanostructured Interfaces