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Abstract

Nanocomposites Based Electrosensitive Platforms for Nitrite and Biogenic Amines Determination †

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Abstract: Highly electrosensitive platforms have been developed using different nanocomposite materials based on carbon allotropes and different metallic nanoparticles for determination of nitrite and biogenic amines (BAs). The nitrification process occurred in soil represents an important source of pollution. The nitrification consists in biological oxidation of the relatively immobile ammonium (NH_4^+) to highly mobile nitrate, via nitrite. This process is carried out mainly by the ammonia–oxidizing bacteria (*Nitrosomonas* sp. and *Nitrobacter* sp.) present in the soil microbial population [1,2]. The nitrite contamination of ground and surface waters represents the major concern associated with the nitrification process. Additionally, the growing needs for food and environmental safety has led to an increase in research for the detection of biogenic amines (BAs) in recent years. Despite the fact that BAs are increasingly present in food and beverages, causing toxic effects in the body, legislation that limits their presence in food chains needs to be updated, thus requiring sensitive tools for their detection [3,4]. Miniaturized analytical tools have been developed based on nanocomposite materials obtained through combination of different carbon allotrope materials (nanoribbons, nanotubes—single and multiwalled—and nanofibers) with metallic nanoparticles (Ag, Au-Ag, Pt, Cu). Thus, carbon based screen-printed electrodes (SPE) were chemically modified with the obtained nanocomposite materials and further characterized using different electrochemical techniques. In order to allow a selective and sensitive determination of analytes, an electropolymerized film was deposed on the modified sensors. For BAs determination were realized with two configurations of biosensors, a bienzymatic one consisting in immobilization of diamine oxidase (DAO) and horseradish peroxidase (HRP) onto the modified sensors, and, respectively, a mono-enzymatic system based on immobilization of DAO onto the modified sensors. It was taken into account that the charge of carbon-based nanomaterials on the surface of the sensors should not exceed 5%, in order to ensure a low based current. Morpho-structural and electrochemical characterization studies of the modified SPEs have been performed in order to achieve a high sensitivity and selectivity of detection, applying a low overvoltage. The co-polymeric film ensured a better stability of the nanocomposite material layers at the electrode surface and an optimal matrix for enzymes immobilization. Optimization of the nanocomposite-based sensors were performed, and finally detection of biogenic amines was carried out using biosensors based on single-walled carbon nanotubes and Pt nanoparticles, while nitrite determination was performed using multi-walled carbon nanotubes and AgNP modified sensors at applied potentials between −0.45 and +0.6 V vs. Ag/AgCL. The developed sensors and biosensors showed good sensitivities of nitrite and BAs detection. Although the enzyme DAO has a low enough activity to catalyze the oxidation of amine of interest, the detection limits were lowered due to the electrocatalytic activity of nanocomposite materials and the HRP enzyme used.

Keywords: carbon allotropes; metallic nanoparticles; nitrite; biogenic amines

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