

Editorial

Some typical examples of graphene and ZnO microelectrode based electroanalytical biosensors**Nikoleli GP¹, Bratakou S¹, Psychoyios VN¹, Karapetis SK¹, Nikolelis DP^{2*}, Tzamtzis N¹, Psaroudakis N³ and Varzakas TH⁴**¹Laboratory of Inorganic & Analytical Chemistry, School of Chemical Engineering, Dept 1, Chemical Sciences, National Technical University of Athens, 9 Iroon Polytechniou St., Athens 15780, Greece²Laboratory of Environmental Chemistry, Department of Chemistry, University of Athens, Panepistimiopolis-Kouponia, GR-15771 Athens, Greece³Laboratory of Inorganic Chemistry, Department of Chemistry, University of Athens, Panepistimiopolis-Kouponia, GR-15771 Athens, Greece⁴Higher Technological Educational, Institute of Kalamata, School of Agricultural Technology, Department of Food Technology, Antikalamos, 24100 Kalamata, Greece.

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Introduction

Cholesterol is an essential structural component in the cell membranes of most vertebrates. Stabilized polymeric lipid membranes can be excellent host matrices for maintenance and transduction of the activity for the number of biochemically selective species such as enzymes, antibodies and receptors [1]. In this study, the fabrication of graphene with polymeric lipid membrane based electrochemical potentiometric cholesterol biosensor was done. The possibility of the practical use of this biosensor has been investigated on manually prepared cholesterol solution as well as on the real blood serum samples.

Carbamate pesticides are widely used in agriculture and their determination becomes increasing important due to their biological activity and low persistence as compared to, e.g., organochlorine pesticides [2,3]. The graphene electrode was used for the development of a selective and sensitive chemical sensor for the detection of carbofuran by immobilizing an artificial selective receptor on stabilized lipid films. The preparation of this artificial receptor was recently described in our papers [4]. The presented potentiometric carbofuran chemical sensor is easy to construct and exhibits good reproducibility, reusability, selectivity, rapid response times, long shelf life and high sensitivity of ca. 59 mV/decade over the carbofuran logarithmic concentration range from 10^{-6} M to 10^{-3} M.

Uric Acid is the product of purine metabolism in the human

body and is related to many clinical disorders. The physiological concentration of uric acid in healthy controls is 370 $\mu\text{mol/L}$ in men and 260 $\mu\text{mol/L}$ in women. A novel potentiometric uric acid biosensor was constructed by immobilization of uricase into stabilized lipid films using zinc oxide (ZnO) nanowires as measuring electrode. The performance of this proposed uric acid/ZnO sensor in buffer solutions to determine uric acid level were investigated. The above electrode was examined for selectivity, response, reproducibility, linearity, thermal stability and foreign interferences. The biosensor was applied using either in continuous or in stopped - flow mode between the injections.

Experimental

The fabrication procedure of the cholesterol or carbofuran electrodes was recently reported elsewhere [5, 6], whereas the construction of the uric acid electrode is given in one of our recent articles [7].

Results and discussion

The cholesterol biosensor reveals an appreciable reproducibility, good selectivity and high sensing capability with linear slope curve of ca. 64 mV/decade. The strong biocompatibility among the stabilized polymeric lipid membrane and human biofluids provides the possibility to use for the real blood samples/practical applications [5].

The electrochemical response of the carbofuran biosensor shows a nernstian response over a wide logarithmic range of the carbofuran concentrations from 1×10^{-6} M to 1×10^{-3} M. Due to the largest surface area to volume ratio among all the known nanomaterials, graphene based carbofuran biosensor depicts an

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excellent sensitivity slope curve with the value of ~ 60 mV per decade confirming the enhancement in the potential value near the surface of the biosensor as the concentration of the analyte increases. Reproducibility and repeatability have been investigated with five repeated experiments from a single biosensor and it has been observed that the biosensor reveals excellent reusability (ca. 5%) with negligible change in the measured EMF values.

The carbofuran biosensor was used to detect this insecticide in a large number of fruit and vegetable samples to evaluate the practical application of this sensor. A recovery study was carried out with the sensors using the standard addition method and direct interpolation in the linear regression. The determined values were in agreement with the assigned value for carbofuran in the samples. The satisfactory recoveries (95.0–105.0%) of carbofuran detection in fruit and vegetable samples confirm that this material is a stable and sensitive sensor for the analysis of real samples [6].

The novelty of the uric acid biosensor is also that the use of the lipid film containing a positively charged lipid enhances the concentration of uric acid at the electrode surface thus providing increased twice as large slope. A rapid response time was observed over the whole concentration range with 95% of the steady state voltage achieved within 6 s, with a sensitivity of ca. 31 mV/decade for a sensor electrode without the lipid film membrane and 61 mV/decade with the lipid film. The sensor response had no interferences from ascorbic acid, glucose, urea, proteins and lipids [e.g. interferent to analyte = 1000 : 1] [7].

Since the sensor is low cost with appreciable reproducibility, it may offer an easy extension to on-spot clinical diagnosis. It is also convenient to assemble into portable chip based sensing devices suitable to unskilled users. Finally, the biosensor uric acid electrode was used in FIA experiments that will be useful for the clinical analysis.

A slight modification of the present devices will allow the construction of portable electrochemical devices based on nanotechnology that can be used for the rapid detection of toxicants in markets and for in house applications.

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