Sensors & Actuators: B. Chemical 273 (2018) 1501–1507

Contents lists available at ScienceDirect

Sensors and Actuators B: Chemical

journal homepage: www.elsevier.com/locate/snb

An effective non-enzymatic biosensor platform based on copper nanoparticles decorated by sputtering on CVD graphene

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ARTICLE INFO

Keywords:
Single layer graphene
CVD
Cu nanoparticle
Glucose sensing
Magnetron sputtering

ABSTRACT

It has become inevitable to design non-enzymatic biosensors to eliminate the drawbacks of enzymatic biosensors prepared using enzymes which are expensive and without long-term stability. For this purpose, a single layer graphene film was prepared by chemical vapor deposition method on Cu foil and transferred to the FTO glass slide. After that copper nanoparticles (CuNP) were decorated by the inert-gas condensation method based on DC magnetron sputtering on it. The prepared CuNP decorated graphene film was characterized and used as a non-enzymatic sensor platform for the detection of glucose. The sensor platform exhibited a fast response time of less than 4 s and the sensitivity of 430.52 μA mM^{-1} cm^{-2} with linear concentration range (0.01–1.0 mM) having detection limit 7.2 μM. Electrochemical investigations indicate that the sensor platform which is decorated CuNP graphene film possess an excellent performance toward glucose.

Prepared biosensors platform could be used and applied in the field of new drug discovery, biomedical, clinical diagnosis and forensic science to miniaturize of detection instrument and reduce detection sample and period.

1. Introduction

Currently, biosensors have been researched and applied in the field of new drug discovery, biomedical, clinical diagnosis and forensic science to miniaturize of detection instrument and reduce detection sample and period [1–9]. In particular, enzymatic biosensors prepared by surface modified platforms with enzymes have been developed to provide specific detection [4,10–15]. However, enzymatic biosensors have disadvantages such as short shelf life, high cost, complex production procedures, which are faced with market challenges [16].

In addition, enzymatic biosensors are not suitable for long term in situ application as the immobilized enzyme may degrade. To overcome these limitations, researchers have working intensively on non-enzymatic biosensors that optimized for critical issues such as sensitivity, stability, selectivity and detection limit. Especially nanomaterials with extraordinary properties are very promising in the development of non-enzymatic biosensors. Nowadays, most of the researches on biosensors have been focused on non-enzymatic biosensors produced by nanomaterials [17–22]. Nanotechnology can solve many problems of non-enzymatic biosensors. With the discovery novel characteristics of nanostructured materials, it can be expected that new improvements in the glucose biosensor industry in the near future.

Graphene and metal nanoparticles are the most suitable nanomaterials for biosensors. Graphene is a one-atom-thick layer of carbon atoms with sp^2 hybridized arranged in a hexagonal lattice. Due to the structural properties of the graphene, it has superior mechanical, electrical optical and thermal properties. For this reason, it has been used many field applications [23–25]. Graphene has also an extremely high surface-to-volume ratio, therefore the graphene useful for a large area sensing application. Furthermore, graphene is used for the production of glucose biosensors due to its extraordinary electrical properties.

In recent years, copper-based nanoparticles produced from copper metal, which have been abundant and affordable, have attracted a great

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https://doi.org/10.1016/j.snb.2018.07.064
Received 16 April 2018; Received in revised form 4 July 2018; Accepted 12 July 2018