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Use of the monodisperse Pt/Ni@rGO nanocomposite synthesized by ultrasonic hydroxide assisted reduction method in electrochemical nonenzymatic glucose detection

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ABSTRACT

An electrochemical non-enzymatic sensor was developed for the detection of glucose based on an electrode modified with monodisperse platinum-nickel nanocomposites-decorated on reduced graphene oxide (Pt/Ni@rGO) which was synthesized using a new ultrasonic hydroxide assisted reduction method. Because the nanocomposites prepared by using NaOH (OH^- ligands) are much smaller nanocomposites on the supports compared to the ones without OH^- ligands. Such a monodisperse Pt/Ni@rGO nanocomposites-based electrode exhibited a high electrochemical activity for electrocatalytic oxidation of glucose in alkaline solution. Amperometric analysis showed a glucose sensitivity of 171.92 μA/mM cm^2 of, the detection limit of 6.3 μM and a linear range of 0.02–5.0 mM glucose concentration. Fabricated sensor platform demonstrated long-term stability and good reproducibility, in addition to high selectivity.

1. Introduction

The significance of biosensor using in biomedical and food industries, environmental applications and clinical diagnostics is increasing day by day [1–3]. Especially, for glucose sensing, generally, electrochemical sensing has a great deal of interest for the fabrication of glucose sensors because this method has a low power requirement and high sensitivity [4–7]. One of the two main categories of electrochemical glucose biosensors, enzymatic glucose biosensors which uses glucose oxidase enzyme have been examined for determination of glucose in food or beverages [8–14]. In spite of the fact that enzymatic glucose sensors despite highly sensitivity, they suffer from thermal and chemical instability because of the nature of enzymes [15–17]. In order to solve these problems, great efforts have been made in order to produce the electrochemical glucose sensor without using the enzyme [18]. For this purpose, non-enzymatic electrochemical sensor mechanism works based on the direct electro-oxidation of glucose at the electrode surface. For example, noble metals such as Au, Pd, Pt, and some transition metals such as Co, Cu, Zn, Ni, and their metal oxide compounds have been applied for the electro-oxidation of glucose [19–21]. As a result of these works, it has been understood that those non-enzymatic sensor systems show very well response with low cost and non-toxicity.

Even though Pt and Pt like metals are special metal with high electro-oxidation activity against glucose oxidation in neutral media, it has got some disadvantageous such as the decline in the performance of sensor activity because of the poisoning of the surface of the sensor with some intermediates. Therefore, Pt-based glucose sensors have some critical limitations [22]. This limitation could be eliminated effectively by developing some bimetallic materials which are produced by using Pt and another transition metal simultaneously. These composite materials have shown very good activities than the other sensors owing to the synergistic effect of the metals. For example, Pt/Pd core-shell was used in enhancing glucose oxidation process [23]. Furthermore, sensitive Pt/Ni/Graphene sensor was used in H_2O_2 determination [24]. Another study shows that Pt/Cu nanochains sensor was used in sensitive glucose detection depend on synergetic electronic effects of the alloyed atoms [25].

Nickel is another interesting metal that also indicates great potential for glucose detection since it has a catalytic activity to glucose oxidation in alkaline medium. Besides, Ni is more stable towards experimental poisoning as well as low cost than Pt [26].

Meanwhile, carbon-based materials such as graphene, activated carbon, carbon nanotubes have great deal attention in research areas recently [27–43]. Especially, due to its superior structural and electronic properties, carbon-based materials have been widely used for the

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