Graphene/tungsten oxide nanocomposite for flow amperometric detection of hydrogen peroxide

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Abstract

Graphene/tungsten oxide nanocomposite for flow injection analysis of hydrogen peroxide with amperometric detection.

Introduction

Recently, graphene based nanocomposites have attracted much attention in different fields like nanoelectronics, biosensing, gas sensor, water purification, photocatalytic and optical applications[1]. Among them, tungsten oxide has potential applications in sensor and photocatalytic fields[2]. In this work the performance of a working electrode - a FTO substrate modified with reduced graphene oxide (rGO) and tungsten oxide (WO_3) was evaluated by amperometric detection of hydrogen peroxide (H_2O_2) in flow injection analysis (FIA) system.

Results and Discussion

The nanocomposite was electro-synthesized under FTO substrates using cyclic voltammetry technique. The aqueous electrolyte was prepared by adding tungsten powder into H_2O_2 (30%) under stirring until totally dissolution of the metal precursor and then this solution was diluted in GO dispersion (0.5 mg mL^{-1}]. All materials were characterized by different techniques and then applied as sensor using FIA technique. Fig. 1 shows the cyclic voltammograms of H_2O_2 obtained in 100 mmol L^{-1} phosphate buffer solution, pH 6.86.

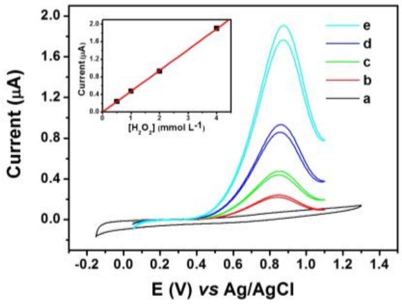

Figure 1: Cyclic voltammograms of H_2O_2 in (a) 0.10 mol L^{-1} phosphate buffer solution, pH 6.86; (b-e) 0.5; 1.0; 2.0 and 4.0 mmol L^{-1} of H_2O_2. Scan rate: 40 mV s^{-1}.

The oxidation of H_2O_2 at graphene/tungsten oxide (rGO-WO_3) begins at 0.40 V *vs* Ag/AgCl and attains a current peak at 0.85V. For amperometric measurements, the working electrode was operated at 0.90 V. The analytical procedure shows linear response to H_2O_2 from 10 to 600 µmol L^{-1}. Ten repetitive current peaks measured after sequential injections of 200 µmol L^{-1} shows a mean current peak of 16.5 nA and a relative standard deviation (RSD) of 4.7%. Figure 2 shows typical I-t signals obtained with successive injections of 50 µL of H_2O_2 standard solution in 50-600 µmol L^{-1} concentration range.

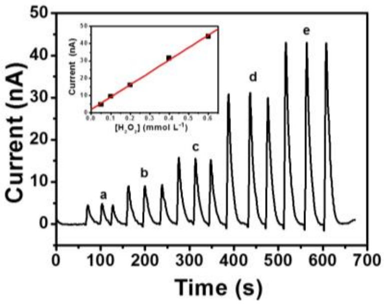

Figure 2: Current-time signals obtained with injections of H_2O_2 solution in 0.1mol L^{-1} phosphate buffer solution. H_2O_2 concentration corresponds to: a) 50; b) 100; c) 200; d) 400 and e) 600 µmol L^{-1}. E = 0.90 V vs Ag/AgCl; S_v= 50 µL.

At 1.0 mL min^{-1} flow rate, the analytical throughput corresponds to 100 determinations/hour. The method has a detection limit of 7.5 µmol L^{-1} (3σ). The rGO-WO_3 FTO modified electrode shows good stability for H_2O_2 detection in flowing solutions. After one week of diary use, the electrode sensitivity changed less than 10%.

Conclusions

The amperometric response of FTO electrode with rGO-WO_3, combined with flow injection analysis exhibits good performance for H_2O_2 determination at micromolar concentration range.

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