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A sensitive and selective voltammetric sensor based on multiwall carbon nanotubes decorated with $MgCr_2O_4$ for the determination of azithromycin

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ABSTRACT

In this report, we synthesized $MgCr_2O_4$ nanoparticles and then multiwall carbon nanotubes were decorated with the $MgCr_2O_4$ nanoparticles. The characteristics of the new materials were studied with different techniques such as transmission electron microscopy, Fourier transform infrared spectroscopy, atomic force microscopy and electrochemical impedance spectroscopy. The multiwall carbon nanotubes decorated with $MgCr_2O_4$ nanoparticles were used as a new mediator for voltammetric determination of azithromycin. The oxidation peak of azithromycin was appeared at a potential of about 720 mV at a surface of the modified electrode. Differential pulse voltammetry exhibited two wide linear dynamic ranges of 0.25–4.0 and 4.0–10.0 μmol L^{-1} azithromycin with a detection limit of 0.07 μmol L^{-1} at pH 7.0. The influence of potential interfering compounds on the selectivity was studied. Finally, the modified electrode showed good sensitivity, selectivity and stability for the determination of azithromycin in real samples.

1. Introduction

Preparation, investigation, and application of nanomaterials are important in material and chemical science. Nowadays, nanoparticles of a variety of compositions, size and shapes are changing the bioanalytical measurement [1]. One of important methods in medicine, environmental monitoring, biotechnology and industrial process control is electrochemical methods [2]. The use of bare electrodes for such analysis have several limitations such as lack of reproducibility, electrode fouling, sluggish electron transfer, high overpotential, low selectivity and sensitivity [2,3]. Therefore, modification of electrodes surface with suitable compounds is an important objective in this field. Different substances and methods have been used for the modification of electrodes [4–7]. Recent research into developing new electrode materials is now focused on carbon nanotubes (CNTs) and nano-sized metal colloids [8–11]. Modification of the surface of CNTs with different materials such as metals, metal oxides, complex metal oxides, CNTs-metal nitride and tungsten carbide/CNTs composite [12–16] can improve the CNTs characteristics [17–19]. The catalytic properties and application in fuel cell electrode of chromite with spinel structure have been reported [20–22]. $MgCr_2O_4$ is one of nanoparticles that could be used for the oxidation of CO and C_3H_6 [23].

Azithromycin is a 15-cyclic lactone antibiotic and semisynthetic erythromycin derivative. Azithromycin plays a leading role in the treatment of respiratory tract infections, toxoplasmosis, and non-classical pathogens such as *Helicobacter pylori*, pediatric infections and opportunistic infections in AIDS. Azithromycin has been used to treat respiratory infections, skin and soft tissue infections and some sexually transmitted diseases [24]. Several methods have been reported for the determination of azithromycin using different analytical techniques such as microbiological method [25], high performance liquid chromatography (HPLC) [26–29], HPLC–mass spectrometry [30,31], liquid chromatography (LC) [32], LC–mass spectrometry [33–35], and spectrophotometric methods [36–38]. HPLC and HPLC–mass spectrometry methods demand expensive equipment and they are not readily available in many laboratories. Spectrophotometric reported methods have not enough selectivity and sensitivity and require a prior derivatization of the drug. In recent years, the electrochemical determination of azithromycin on glassy carbon [32,39–41], graphite [42], mercury [43,44], platinum [45], gold [46], carbon paste [47], multiwall carbon nanotubes (MWCNTs) [48] and graphene electrodes [49] have been frequently published.

In this work citrate sol–gel method was used to synthesis the nano-composite of MWCNTs decorated with spinel $MgCr_2O_4$. Different methods such as Fourier transform infrared (FT-IR) spectroscopy, transmission electron microscopy (TEM), atomic force microscopy (AFM), and electrochemical impedance spectroscopy (EIS) were used to characterize the new nano-composite ($MgCr_2O_4$-MWCNTs). The suitability of $MgCr_2O_4$-MWCNT was checked

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