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Multiwall carbon nanotubes decorated with $NiFe_2O_4$ magnetic nanoparticles, a new catalyst for voltammetric determination of cefixime

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ABSTRACT

Multiwall carbon nanotubes were decorated with synthesized $NiFe_2O_4$ magnetic nanoparticles. The new materials were characterized with different techniques such as transform infrared spectroscopy, transmission electron microscopy, atomic force microscopy and electrochemical impedance spectroscopy. The multiwall carbon nanotubes decorated with $NiFe_2O_4$ magnetic nanoparticles was used as a new mediator for the voltammetric determination of cefixime. Under the optimum conditions at pH 8.0, the oxidation of cefixime was occurred at 850 mV at the surface of the modified electrode. Linear sweep voltammetry exhibited two wide linear dynamic ranges of 0.1–100 and 100–600 $\mu mol\,L^{-1}$ cefixime. The detection limit was found to be 0.02 $\mu mol\,L^{-1}$ cefixime. Finally, the modified electrode showed good sensitivity, selectivity and stability for the determination of cefixime in real samples.

1. Introduction

Preparation, investigation, and application of nanomaterials are very important in chemical science. Nanoparticles of a variety of shapes, sizes and compositions are changing the bioanalytical measurement nowadays [1]. Carbon nanotubes (CNTs) is one of the best candidates for the preparation of the electrocatalytic nanocomposite materials. CNTs have attracted considerable attention due to their fascinating physical, optical, chemical, mechanical, and electrical properties [2–5]. The nanostructures with large specific surface area could provide an important and feasible platform for catalysis [6], separation [7], sensing [8–10] and fuel cells [11]. Modification of the surface of CNTs with different materials such as metals, metal oxides, complex metal oxides and polymers [12–14] can improve CNTs characteristics [15,16]. Decoration of CNTs by spinel ferrites nanoparticles with chemical formula MFe_2O_4 (M = Mn, Co, Ni, Mg, or Zn), which are very important magnetic materials, can improve optical, magnetic and electrochemical properties of CNTs [17–19]. The magnetic CNTs have applications as magnetic data storage [20], microwave absorbing materials [21] and magnetic composites for drug delivery [22].

Electrochemical methods of analysis have become one of the important methods in medicine, environmental monitoring, and biotechnology, and industrial process control [23]. Modified electrodes are very important tools for the analysis of several compounds at trace and ultra trace levels. The sensitivity and selectivity of the voltammetric methods depend on the characteristics of the modifier.

Cefixime [6R-[6a,7b(Z)]]-7-[[(2-amino-4-thiazoyl)[(carboxymethoxy)imino]acetyl]amino]-3- ethenyl-8-oxo -5 - thia-1-azabicyclo[4.2.0]oct-2-ne-2-carboxylic acid, is an oral third generation cephalosporin antibiotic. Cefixime is a cephalosporin antibiotic used to treat infections caused by bacteria such as pneumonia, bronchitis, gonorrhea, and ear, lung, throat and urinary tract infections. Cefixime is available as the trihydrate [24] (Scheme 1A). Forty to fifty percent of the oral dose of cefixime is adsorbed from the gastrointestinal tract. The plasma half-life is usually about 3–4 h and may be prolonged when there is renal impairment. There is no evidence of metabolism of cefixime in vivo [24]. To date, numerous methods have been proposed for the analysis of cefixime using different analytical techniques such as fluorimetry [25,26], high performance liquid chromatographic-electrospray ionization mass spectrometric [27–29], high performance liquid chromatography [30], high performance thin layer chromatography [31], liquid chromatography (LC)–tandem mass spectrometry [32], and voltammetry [33–35].

This work describes the synthesis and study of a magnetic nanocomposite of MWCNTs decorated with spinel ferrite $NiFe_2O_4$ using citrate sol–gel method. The multiwall carbon nanotubes decorated with $NiFe_2O_4$ nanoparticles ($NiFe_2O_4$-MWCNTs) was characterized with different methods such as transform infrared spectroscopy

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