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Synthesis of silver/multi-walled carbon nanotubes composite and its application for electrocatalytic reduction of bromate

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HIGHLIGHTS

- Silver/multi-walled carbon nanotubes composite was synthesized by reduction method.
- The Ag/MWNTs composite has good electrochemical activity and stability.
- Electrocatalytic reduction of bromate on Ag/MWNTs modified electrode was investigated.
- This electrode exhibit remarkable catalytic performance for bromate reduction.
- Ag/MWNTs modified electrode could be employed as an amperometric sensor for bromate.

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ABSTRACT

The silver nanoparticles decorated multi-walled carbon nanotubes composite (Ag/MWNTs) was prepared and used to fabricate a modified electrode. The composite was examined by transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS). The electrochemical performance of Ag/MWNTs modified glassy carbon electrode (Ag/MWNTs/GCE) was evaluated for electro-catalytic activity towards bromate reduction in buffer solutions by cyclic voltammetry (CV), linear sweep voltammetry (LSV) and multi-potential steps method. The experimental data shows that the silver nanoparticles were well deposited on MWNTs and Ag/MWNTs/GCE exhibit high electrocatalytic activity towards bromate reduction. It is proposed that firstly the bromate ions diffused to the active sites and then the electrochemical reduction occurred. The bromate reduction on Ag/MWNTs/GCE was proved to be an irreversible and diffusion controlled process. Furthermore, Ag/MWNTs/GCE is characterized by good stability and relatively high sensitivity with respect to bromate concentration.

1. Introduction

Bromate, an oxyhalide disinfection byproduct (DBP), is very inert in the environment [1,2]. Various approaches have been evaluated to eliminate and determine bromate pollution in water solutions, including adsorption, membrane treatment, UV radiation and biofiltration [3–8]. There among, the use of electrochemical approach is considered attractive since they are relatively clean, environmentally friendly and often cost efficient [9–11].

Over the last few years, research has been directed towards the synthesis and application of metal nanoparticles for their unique properties compared to the bulk metal [12,13]. Among the different metal particles, silver nanoparticles (Ag NPs) have received considerable attention because of their unusual properties and potential applications in diverse fields [14–16]. Ag NPs exhibited catalytic activity towards hydrogen peroxide [17,18], oxygen [19], chromium [20] and trichloroacetic acid [21]. Besides, the electrocatalytic performance of silver particles towards electroreduction of bromate, chlorite and nitrite in alkaline solutions was evaluated by Casella and Ritorti [22]. Since the discovery of carbon nanotubes in 1991 by Iijima, carbon nanotubes have attracted great interest in most fields of science and engineering due to their unique physical and chemical properties [23,24]. These properties allow them to be applied for a wide range of applications. Thus, silver decorated carbon nanotubes are gaining extensive attention for their potential applications as catalyst, broad-band optical limiters, electrodes, and advanced materials.

In the present paper, the silver/multi-walled carbon nanotubes composite (Ag/MWNTs) was self-synthesized and employed to modify electrode for the electrocatalytic reduction of bromate. The composites were characterized by transmission electron microscopy (TEM) and X-ray photoelectron spectroscopy (XPS). The property of the modified electrode was investigated by cyclic voltammetry (CV), linear sweep voltammetry (LSV) and multi-potential steps (STEP). Meanwhile, the electrocatalytic

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