Ultrasonics - Sonochemistry 48 (2018) 473–481

Contents lists available at ScienceDirect

Ultrasonics - Sonochemistry

journal homepage: www.elsevier.com/locate/ultson

Simple sonochemical synthesis of novel grass-like vanadium disulfide: A viable non-enzymatic electrochemical sensor for the detection of hydrogen peroxide

R. Karthik[a], J. Vinoth Kumar[b], Shen-Ming Chen[a,*], P. Sundaresan[a], B. Mutharani[a], Yu Chi Chen[a], V. Muthuraj[b]

[a] *Electroanalysis and Bioelectrochemistry Lab, Department of Chemical Engineering and Biotechnology, National Taipei University of Technology, No. 1, Section 3, Chung-Hsiao East Road, Taipei 106, Taiwan, ROC*

[b] *Department of Chemistry, VHNSN College, Virudhunagar 626001, Tamil Nadu, India*

ARTICLE INFO

Keywords:
Grass-like
Vanadium disulfide
Electrochemical sensor
Hydrogen peroxide
Milk and urine samples

ABSTRACT

Design and fabrication of novel inorganic nanomaterials for the low-level detection of food preservative chemicals significant is of interest to the researchers. In the present work, we have developed a novel grass-like vanadium disulfide (GL-VS_2) through a simple sonochemical method without surfactants or templates. As-prepared VS_2 was used as an electrocatalyst for reduction of hydrogen peroxide (H_2O_2). The crystalline nature, surface morphology, elemental compositions and binding energy of the as-prepared VS_2 were analyzed by X-ray diffraction, Raman spectroscopy, field-emission scanning electron microscopy, energy-dispersive X-ray spectroscopy and X-ray photoelectron spectroscopy. The electrochemical studies show that the GL-VS_2 modified glassy carbon electrode (GL-VS_2/GCE) has a superior electrocatalytic activity and lower-reduction potential than the response observed for unmodified GCE. Furthermore, the GL-VS_2/GCE displayed a wide linear response range (0.1–260 µM), high sensitivity (0.23 $\mu A\,\mu M^{-1}\,cm^{-2}$), lower detection limit (26 nM) and excellent selectivity for detection of H_2O_2. The fabricated GL-VS_2/GCE showed excellent practical ability for detection of H_2O_2 in milk and urine samples, revealing the real-time practical applicability of the sensor in food contaminants.

1. Introduction

Hydrogen peroxide (H_2O_2) is an important chemical oxidizer, has been widely used in pharmaceutical and industrial applications [1]. In addition to oxidizing properties, it also has excellent antibacterial properties and has been widely used as a food preservative in milk, cheeses, pharmaceutical, medical sterilizations, and paper bleaching [2]. H_2O_2 has played an important role in biological process and human metabolism [3,4]. The higher concentration of H_2O_2 can cause diverse effects includes skin diseases, diabetic vasculopathy, asthma, atherosclerosis, inflammatory arthritis, osteoporosis, neurodegenerative diseases, cancer and Alzheimer's disease [5,6]. Therefore, the accurate detection of H_2O_2 is of interest to the biological and pharmaceutical fields. Till date, various analytical methods such as chromatography, titrimetry, spectrometry, and fluorometry have been developed for the sensitive detection of H_2O_2 [7]. Compared to available methods, the electrochemical techniques offered many advantages for detection of H_2O_2 such as fast response, easy fabrication, higher sensitivity, low-cost and portability [8–10].

Over the past decades, inorganic nanostructured materials are found tremendous interest due to their unique physicochemical properties [11]. In particular, transition metal dichalcogenides (TMDCs; AS_2, A = Mo, W and V etc.,) has possess similar properties to graphene such as excellent chemical, physical, optical, mechanical, magnetic and electrical properties. The unique properties that enable them to use in diverse fields including electro-catalysis, Li-ion batteries, photoelectric devices, and energy storage applications [12–16]. Among different metal dichalcogenides, vanadium disulfide (VS_2) is an interesting material, has been widely used in supercapacitors, Li-ion batteries, moisture responsiveness, intercalation, hydrogen evaluation reactions, spintronics and field emitters. It also has interesting properties such as high specific surface area, intrinsic ferromagnetism, and good mechanical properties [17–27]. Until now, numerous synthetic routes have been developed for the fabrication of nanostructured VS_2

* Corresponding author.
E-mail address: smchen78@ms15.hinet.net (S.-M. Chen).

https://doi.org/10.1016/j.ultsonch.2018.07.008
Received 2 April 2018; Received in revised form 27 June 2018; Accepted 4 July 2018
Available online 05 July 2018
1350-4177/