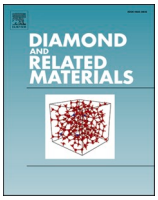
Diamond & Related Materials 150 (2024) 111740

Contents lists available at ScienceDirect

Diamond & Related Materials

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



Microwave aided synthesis of samarium hafnate pyrochlore-sulphur doped reduced graphene oxide for electrochemical detection of bendiocarb

K. Yogesh Kumar [a], M.K. Prashanth [b], H. Shanavaz [a], Fahd Alharethy [c], Byong-Hun Jeon [d,*], M.S. Raghu [e,*]

[a] Department of Chemistry, Faculty of Engineering and Technology, Jain University, Bangalore 562112, India
[b] Department of Chemistry, BNM Institute of Technology, Banashankari, Bangalore 560070, India
[c] Department of Chemistry, College of Science, King Saud University, 11451 Riyadh, Saudi Arabia
[d] Department of Earth Resources and Environmental Engineering, Hanyang University, 222, Wangsimni-ro, Seongdong-gu, Seoul 04763, Republic of Korea
[e] Department of Chemistry, New Horizon College of Engineering, Outer Ring Road, Bangalore 560103, India

ARTICLE INFO

Keywords:
$Sm_2Hf_2O_7$, S doped RGO
Bendiocarb
Sensors
Real samples

ABSTRACT

The current study reports the synthesis of pyrochlore type $Sm_2Hf_2O_7$ (SHO) and its nanocomposite with sulfur-doped reduced graphene oxide (SR). SHO/SR nanocomposite was synthesized using a simple hydrothermal method followed by a microwave-aided synthetic method. Morphological investigations indicate that long SHO particles are well-aggregated in the wrinkled two-dimensional SR. Modified the glassy carbon electrodes (GCE) using SHO, SR and SHO/SR and evaluated for the electrochemical detection of an insecticide, bendiocarb (BDC). Enhanced electrochemical performance was observed in SHO/SR@GCE compared to SHO and SR. Superior electrochemical performance in SHO/SR could be attributed to enhanced conductivity, surface area and stability. Differential pulse voltammetry (DPV) technique showed good sensitivity, and the observed range is 0.05 to 300 μM with a 0.671 μM limit of detection (LOD). In addition, DPV technique is used for the detection of BDC in tomatoes and cabbage, finding a good percentage recovery (97.12 to 99.47 %) with less than 2.65 % relative standard deviation (RSD). The stability of the SHO/SR@GCE was good, and the current response retention was found to be 88.6 ± 1.93 % even after twenty days. SHO/SR's versatile structure, stability, conductivity, and surface area make it an ideal material for developing pyrochlore-based materials for electrochemical and energy applications.

1. Introduction

In today's agriculture, pesticides are essential since they shield crops from weeds, illnesses, and pests. These chemicals are used to repel, regulate, or completely get rid of dangerous organisms that can harm crops and lower harvests [1,2]. Pesticides can increase agricultural output in a number of ways. Although pesticides are useful instruments for controlling pests, their careless application can harm both the environment and public health [3,4]. Runoff from pesticides has the potential to contaminate waterways, damage aquatic life, and foster the emergence of pests resistant to pesticides [5]. Pesticide exposure may also be harmful to consumers, wildlife, farmers, and agricultural workers [6]. Bendiocarb (2,2-dimethyl-1,3-benzodioxol-4-yl methylcarbamate: BDC) a carbamate insecticide, is used in agriculture to manage pests on crops like rice, cotton, vegetables, and fruit. Additionally, public health contexts employ bendiocarb to control vectors, specifically those mosquitoes that spread diseases like dengue fever and malaria [7,8]. Furthermore, bendiocarb is a component of some household pesticides used indoors to combat pests such as fleas, ants, and cockroaches [9]. Intake of BDC through food products or skin causes respiratory problems, renal diseases, and damage to the nervous system. Hence, it is desirable to monitor the pesticide content in soil, water and crops [10].

Researchers have explored several methods for the detection of BDC, including high-performance liquid chromatography (HPLC), spectrophotometry, spectrofluorometry, chemiluminescence, and electrochemical sensors [11–17]. Many of these techniques are tedious, require sample preparation steps, are laborious, have a narrow range of detection, lack selectivity and sensitivity, and are not economically viable [18,19]. The main characteristics of electrochemical sensors—low LOD,

* Corresponding authors.
E-mail addresses: bhjeon@hanyang.ac.kr (B.-H. Jeon), dr.msraghu@newhorizonindia.edu (M.S. Raghu).

https://doi.org/10.1016/j.diamond.2024.111740
Received 3 July 2024; Received in revised form 18 October 2024; Accepted 1 November 2024
Available online 3 November 2024