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Fabrication of spinel magnesium stannate-polyaniline nanocomposite for electrochemical detection of fenitrothion pesticide and supercapacitor applications

Sathya Jyothi N V [a,b], Revathi V [a,*], Chakradhar Sridhar B [c], Yogesh Kumar K [d], Prashanth M K [e], Fahd Alharethy [f], Byong-Hun Jeon [g,*], Raghu M S [h,*]

[a] Department of Physics, New Horizon College of Engineering, (Affiliated to Visvesvaraya Technological University, Belagavi) Bangalore 560103, India
[b] Department of Physics, SHVNM Govt. PU College, Malleswaram, Bangalore 560003, India
[c] Department of Physics, Raichur University, University Main Campus 584104, India
[d] Department of Chemistry, Faculty of Engineering and Technology, Jain University, Bangalore 562112, India
[e] Department of Chemistry, BNM Institute of Technology, Banashankari, Bangalore 560070, India
[f] Department of Chemistry, College of Science, King Saud University, Riyadh 11451, Saudi Arabia
[g] Department of Earth Resources and Environmental Engineering, Hanyang University, 222, Wangsimni-ro,Seongdong-gu, Seoul 04763, Republic of Korea
[h] Department of Chemistry, New Horizon College of Engineering, Outer Ring Road, Bangalore 560103, India

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ABSTRACT

Fenitrothion (FNT), a commonly used organophosphorus pesticide used in agriculture poses numerous health hazards to living beings and the environment. Therefore, monitoring the dosage of FNT in agriculture is becoming increasingly important. The current work aims to develop an electrochemical sensor for the sensitive detection of FNT. A simple green method using avocado seed extract as a reducing agent has been developed for the synthesis of spinel-structured Mg_2SnO_4 (MSO), which is combined with polyaniline (PANI) to generate the MSO/PANI nanocomposite. Glassy carbon electrode (GCE) was modified using MSO, PANI and MSO/PANI were examined for electrochemical performance using cyclic voltammetry (CV) and differential pulse voltammetry (DPV) techniques. Superior electrochemical performance is observed in MSO/PANI-modified GCE compared to MSO and PANI-modified GCE. Superior activity in MSO/PANI could be attributed to the improved electroactive sites, conductivity, and easy electron exchange at the electron/electrode system. FNT detection was carried out using different electrodes and found to show a wide range of detection (0.01 to 390 μM) using DPV with a 0.04 nM limit of detection (LOD). FNT detection was pursued in the presence of grapes and river water and the percentage recovery is in between 97.1 to 99.1. MSO/PANI has been used as electrode material and found to exhibit specific capacitance of 695 F g^{-1} at a scan rate of 10 mV s^{-1}. Good recyclability, superior performance, stability, and real sample performance make MSO/PANI a material of choice towards electrochemical performance as a sensor and supercapacitor and serve towards sustainability towards the environment, health, and energy.

1. Introduction

Since the world's population is growing quickly, there is a greater need than ever for food to feed everyone. In order to increase crop yield, guarantee food security, and manage weeds, pests, and diseases that threaten agricultural productivity, pesticides are now an essential tool in agriculture [1–3]. By focusing on particular organisms that damage crops, insecticides can boost yields and lower the annual financial losses farmers incur. However, there are serious environmental concerns associated with the extensive and frequently heavy use of pesticides [4, 5]. These pesticides can harm non-target species, taint soil and water, and disturb natural ecosystems, even though they protect crops. Additionally, the accumulation of pesticide residues in the environment may harm pollinators, biodiversity, and even human health [6–8]. Fenitrothion (FNT) is one such powerful organophosphate insecticide that is commonly used in agriculture, forestry, and public health to control a

* Corresponding authors.
E-mail addresses: dean_research@newhorizonindia.edu (R. V), raghuhassan2009@gmail.com (R.M. S).

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