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Original scientific paper

Electrochemical analysis of indigo carmine using polyarginine modified carbon paste electrode

D'Souza S. Edwin[1,2], Jamballi G. Manjunatha[1,✉], Chenthattil Raril[1], Tigari Girish[1], Doddarasinakere K. Ravishankar[3] and Huligerepura J. Arpitha[4]

[1]Department of chemistry, FMKMC College, Madikeri, Constituent College of Mangalore University, Karnataka, India
[2]Department of Chemistry, St. Philomena College, Puttur, Karnataka, India
[3]Department of Chemistry, Sri. Mahadeshwara Govt. First Grade College, Kollegal, Chamarajanagar, Karnataka, India
[4]Department of Physics, Sri Adichunchanagiri First Grade College, Channarayapatna, India

Corresponding author: ✉manju1853@gmail.com; Tel.: +91- 08272228334

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Abstract

Suitable electrocatalytic method is established for the selective determination of indigo carmine (IC) at polyarginine modified carbon paste electrode (PAMCPE). Surface morphological study of bare carbon paste electrode (CPE) and PAMPCE is done by field emission scanning electron microscopy (FESEM). The influence of different parameters such as IC concentration, solution pH and potential scan rate on the electrode responses is studied using cyclic and differential pulse voltammetry techniques. The prepared PAMCPE shows better electrochemical response towards IC than CPE. No interference is noticed at simultaneous presence of IC and riboflavin (RF) in the solution. The electrocatalytic current of IC at PAMPCE is varied linearly with its concentration in two separate ranges, from 2×10^{-7} to 10^{-6} M, and 1.5×10^{-6} to 3.5×10^{-6} M. Limits of detection (LOD) and quantification (LOQ) are determined as 2.53×10^{-8} and 8.43×10^{-8} M, respectively. The developed PAMCPE is showing successful reproducibility and stability. It is also found sensitive and reliable for trace amounts of IC in some real water and food samples. Since preparation of PAMCPE sensor is simple and easy, it could become a part of the standard method for determination of IC in real samples.

Keywords

Carbon paste; electropolymerization; food dye; real samples; cyclic voltammetry; differential pulse voltammetry

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Article

Electro-Polymerized Titan Yellow Modified Carbon Paste Electrode for the Analysis of Curcumin

Edwin S. D'Souza [1,2], Jamballi G. Manjunatha [1,*], Chenthattil Raril [1], Girish Tigari [1], Huligerepura J. Arpitha [3] and Suvarnalatha Shenoy [4]

1 Department of Chemistry, FMKMC College, Madikeri, Constituent College, Mangalore University, Mangalore, Karnataka 571201, India; edwin_shal@yahoo.in (E.S.D.); rarilchenthattil9633@gmail.com (C.R.); girishtigari@gmail.com (G.T.)
2 Department of Chemistry, St. Philomena College, Puttur, Karnataka 574202, India
3 Department of Physics, Sri Adichunchanagiri First Grade College, Channarayapatna, Karnataka 573116, India; appiaru@gmail.com
4 Department of Physics, Sri Bhuvanedra College, Karkala, Karnataka 574104, India; suvarnalathashenoy@gmail.com
* Correspondence: manju1853@gmail.com; Tel.: +91-08272228334

Abstract: A modest, efficient, and sensitive chemically modified electrode was fabricated for sensing curcumin (CRC) through an electrochemically polymerized titan yellow (TY) modified carbon paste electrode (PTYMCPE) in phosphate buffer solution (pH 7.0). Cyclic voltammetry (CV) linear sweep voltammetry (LSV) and differential pulse voltammetry (DPV) approaches were used for CRC detection. PTYMCPE interaction with CRC suggests that the electrode exhibits admirable electrochemical response as compared to bare carbon paste electrode (BCPE). Under the optimized circumstances, a linear response of the electrode was observed for CRC in the concentration range 2×10^{-6} M to 10×10^{-6} M with a limit of detection (LOD) of 10.94×10^{-7} M. Moreover, the effort explains that the PTYMCPE electrode has a hopeful approach for the electrochemical resolution of biologically significant compounds. Additionally, the proposed electrode has demonstrated many advantages such as easy preparation, elevated sensitivity, stability, and enhanced catalytic activity, and can be successfully applied in real sample analysis.

Keywords: curcumin; titan yellow; cyclic voltammetry; electrochemical behavior; carbon paste electrode

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1. Introduction

Naturally occurring phytochemical in rhizomes of Curcuma longa or turmeric is poly phenol curcumin (1, 7 bis [4-hydroxy-3-methoxy phenyl]-1, 6, heptadione-3, 5-dione), commonly known for its medicinal properties. In recent years, the primary yellow bioactive component of turmeric, CRC, has received considerable attention in medicine [1–3]. It is known for its antiviral, antifungal, antibacterial, antioxidant [4], anti-inflammatory [5], antitumor [6] activities without any side effects [7–9]. It also regulates the substitutive typical pathways in the nervous system and also in the handling of dementia, multiple sclerosis, and Alzheimer's disease [10–12]. Yellow-colored CRC is a common food additive used as a spicy and coloring agent. CRC adulteration with non-permitted colored compounds for economic gain is recently observed. Excessive usage of these compounds beyond limits can cause infertility, liver damage, cancer, birth defects, and allergy [13]. Hence, it is very much essential to develop a suitable procedure to monitor the CRC in the presence of non-permitted dyes.

The existence of the methoxy group in the phenyl moiety of CRC makes it exhibit redox properties. In addition, CRC can form stable complexes [14–20] with metallic cations such as Fe^{2+}, Ni^{2+}, Fe^{3+}, and Co^{2+} due to its chelating agent property. Medicinal uses of CRC have created tremendous interest in research and a facile process is essential for

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Highly Efficient Visible-Light-Driven Photocatalytic Hydrogen Production Using Robust Noble-Metal-Free $Zn_{0.5}Cd_{0.5}S$@Graphene Composites Decorated with MoS_2 Nanosheets

Puttaswamy Madhusudan, Run Shi, Bananakere Nanjegowda Chandrashekar, Shengling Xiang, Ankanahalli Shankaregowda Smitha, Weijun Wang, Haichao Zhang, Xian Zhang, Abbas Amini, and Chun Cheng*

Solar water splitting using semiconductor photocatalysts is considered to be one of the economical and significant techniques for hydrogen evolution. In this study, graphene–$Zn_xCd_{1-x}S$ (ZCS) heterojunction is fabricated by hydrothermal method followed by simple photodeposition of ultrathin few layers of molybdenum sulfide (MoS_2) nanosheets. The results show that compared with pristine ZCS and 1 wt% graphene mixed ZCS photocatalysts, the 1 wt% graphene and 1 wt% MoS_2 photodeposited ZCS composited sample shows 39.5 mmol h^{-1} g^{-1} hydrogen production activity, which is 6.9 and 1.9 times significantly higher, respectively, with an apparent quantum yield of 53% at 420 nm visible light is recorded. The improved photocatalytic activity can be attributed to the formation of heterostructure interface between p-type MoS_2 nanosheets with n-type ZCS host, which allows for the faster transfer of the photogenerated electrons and thus significantly promotes the separation of photogenerated charge carriers.

1. Introduction

The depletion of fossil fuels and drastically increase in global demand for renewable energy has stimulated intense research on sustainable energy conversion, storage, and solar water splitting.[1] Meanwhile, the production of hydrogen and oxygen from water and semiconductor catalysts is considered as a promising means of utilizing solar energy. The main aspect of water splitting is the fabrication of photocatalysts that are stable, cheap, and responsive to visible light, and have high quantum efficiency.[2] In this regard, considerable efforts have been devoted to investigating suitable semiconductor-based photocatalysts and their composites with excellent photocatalytic hydrogen evolution.[3] Although the past couple of decades have witnessed outstanding progress in the efficiency and stability of the catalysts, fundamental issues from the material's perspective are still lingering.[4] Among various photocatalysts, zinc cadmium metal sulfide (ZCS), as an n-type band-gap semiconductor, has been proven to be a general photocatalyst for solar H_2 production.[5–7] This is because the band gap of nonstoichiometric $Zn_xCd_{1-x}S$ (ZCS) can be tuned to ≈2.4 eV, which can be easily excited under visible-light irradiation.[8] Nevertheless, the pristine ZCS catalyst suffers greatly from the high recombination rate of photoexcited charge carriers as well as low photocatalytic activity and stability.[9–11] The valence band (VB) of ZCS consists of S^{2-} with a small electronegativity, so the photogenerated holes on the VB are responsible to be self-oxidation other than oxidizing water molecules, resulting in photocorrosion.[12] Hereof, a series of strategies are developed to improve the photocatalytic performance of ZCS, such as doping with metal or nonmetal elements, copolymerization, nanostructuring, constructing different hybrid heterojunctions or composites with other semiconductors or metal–organic frameworks.[13–30] However, achieving efficient and durable charge separation on ZCS-based catalysts is still a significant challenge.

2D carbon-based materials like graphene, graphene oxide (GO), carbon nitride, and holey graphene have emerged as

Dr. P. Madhusudan, R. Shi, Dr. B. N. Chandrashekar, S. Xiang, A. S. Smitha, W. Wang, H. Zhang, X. Zhang, Prof. C. Cheng
Department of Materials Science and Engineering
Southern University of Science and Technology (SUSTech)
Shenzhen 518055, P. R. China
E-mail: chengc@sustech.edu.cn
Dr. P. Madhusudan, Prof. C. Cheng
Shenzhen Engineering Research and Development Center for Flexible Solar Cells
Southern University of Science and Technology (SUSTech)
Shenzhen 518055, P. R. China
Dr. P. Madhusudan, Prof. C. Cheng
Guangdong Provincial Key Laboratory of Energy Materials for Electric Power
Southern University of Science and Technology (SUSTech)
Shenzhen 518055, China
Prof. A. Amini
Center for Infrastructure Engineering
Western Sydney University
Kingswood NSW 275, Australia
The ORCID identification number(s) for the author(s) of this article can be found under https://doi.org/10.1002/admi.202000010.

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Vichara Vihara

Editors:

Dr. Haniyuru ChandreGowda -

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