Alanine decorated polydopamine coated reduced graphene oxide based electrochemical sensor for Fe^{2+} ion detection

Monika Patel[1,2], Dehi Pada Mondal[1,2], Chetna Dhand[1,2]

[1]Alloy Composite and Cellular Materials, CSIR- Advanced Materials and Processes Research Institute (CSIR-AMPRI), Hoshangabad Road, Bhopal, Madhya Pradesh-462026, India

[2]Academy of Scientific and Innovative Research (AcSIR), Ghaziabad, 201002, India

Abstract

Heavy metal contamination in the environment is becoming more prevalent as a result of growing urbanization and industrial expansion, posing a major threat to public health [1]. Heavy metals (HMs) are highly poisonous and non-biodegradable; thus, they remain in the system for decades after poisoning [2]. On exposure to HMs, severe health problems can be occurring such as central nervous system failure, neurodegenerative diseases, respiratory, gastric, and cardiovascular systems. In soil, HMs affect the enzyme's function, inhibit the growth of the microbial community, and overall deteriorate the soil quality [3]. Therefore, detection of HMs is essential, for which various developed techniques are atomic absorption spectroscopy, inductively coupled plasma mass spectrometry, and flame atomic absorption spectrometry but all these techniques are sophisticated, costly, and require trained personnel to perform. Therefore, a simple method with high sensitivity and rapidity is an urgent need for real-time detection [4, 5]. In this work, we developed a sensitive electrochemical sensor for the detection of Fe^{2+} ion. A composite of alanine, reduced graphene oxide, and polydopamine (ALA/rGO/pDA) was used for the first time in the HMs detection. Alanine has an excellent binding capability with metal ions and forms chelate; polydopamine is rich in functional group such as amine and catechol which possess strong binding affinity, it also helps to improve the performance of material and in covalent conjugation. On coated onto rGO layer, it activates the surface for further chemical molecules. The rGO provides a large surface area, high electrical conductivity, and high charge exchange kinetics [6, 7]. Graphene oxide was prepared by modified Hummer's method from modified graphite flakes and analyzed by X-ray diffraction, Raman Spectroscopy, Fourier Transform-Infrared Spectroscopy (FTIR), UV/Visible analysis, and Field Emission Scanning Electron Microscope (FESEM). Polymerization of dopamine and reduction of graphene oxide was a single-step reaction by using Tris-HCl (pH 8.5). As-synthesized nanocomposite confirms by the FTIR and UV/Visible analysis. Glassy Carbon Electrode (GCE) was used as a working electrode and modified GCE was prepared by drop-casting method; electrochemical characterization of the modified electrode was examined by cyclic voltammetry using Phosphate buffer saline (0.1 M containing 5mM

Fe^{2+}/Fe^{3+}). Sensing of ion studied by differential pulse voltammetry (DPV), for better sensing different influencing parameters was optimized such as supporting electrolyte, electrolyte pH, deposition potential, and deposition time. The proposed electrochemical sensor is sensitive for Fe^{2+} detection. The main objective is to develop a sensitive and robust sensor for HMs detection in real samples and in real-time.

Keywords: Electrochemical sensor, Polydopamine, Reduced graphene oxide

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