Journal of Polymer Research (2026) 33:27
https://doi.org/10.1007/s10965-025-04724-2

ORIGINAL PAPER

Synthesis and characterization of a new polyimine-modified electrode for voltammetric determination of copper and cadmium ions using square wave voltammetry

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Received: 16 September 2025 / Accepted: 8 December 2025

Abstract
Modified polymer electrodes are of particular importance in analytical and environmental applications. The goal of this paper is the modification of a polymer surface for sensing applications and the detection of trace- metal ions in aqueous solution. This study offers a novel electrochemical sensing device to detection copper and cadmium ions, created via modifying a glassy carbon electrode GC with a polyimine based pyrrole by using square wave voltammetry. Polyimine polymer film was characterized and examined via Fourier transform infrared (FTIR) spectroscopy, cyclic voltammetry (CV), and scanning electron microscopy (SEM). Spectroscopic devices were employed to identify the chemical structure of the prepared monomer, such as FTIR, ^{1}H NMR, ^{13}C NMR, and mass spectroscopy. Furthermore, rate of scan effects on the electrical performance of the polyimine film was also examined. Electro- experimental data were employed to calculate coverage of surface's substance and their electrical stability in blank solutions. Polyimine film thickness and the effects of (pH) of the medium were also investigated. Linear responses to Cu(II) and Cd(II) ions in the range of concentration (5 to 100 μg L^{-1}) were acquired. Limit of detection (LOD) for the assay of Cu^{2+} and Cd^{2+} ions were 1.81 μg L^{-1} and 2.68 μg L^{-1}, respectively. Encouraging results above indicated that modified polyimine films could potentially represent a viable candidate for electrochemical-sensor technologies.

Keywords Imine compound · Modified polymer electrodes · Metal ion detection · Amperometric and square wave voltammetry

Introduction

The accumulation of metal ions in the environment, as is well known, leads to numerous health problems in humans, animals, and plants alike, even at trace concentrations.[1, 2] These hazards increase daily due to the rapid industrialization and development currently taking place in the technological world. This increase in industrial activity has led to an increase in the concentrations of such toxic metal ions in our environment. Recently, the presence of metal ions, such as arsenic, cadmium, zinc, iron, copper, nickel, mercury, lead, and cobalt has become common in food and the environment, potentially driving to a scoop of serious health problems.[3, 4] The aggregation of these heavy metals can source serious harm to the human body, such as kidney damage [5], cognitive impairment [6], anemia. another reports pointed out that these heavy metals may cause respiratory disorders, liver damage, cancer, lung damage, osteomalacia, skin disorders, and digestive problems [7–9]. Further, International organizations like the World Health Organization has warned about the danger of these metals and has set limits for permissible concentrations of the metals mercury, lead, zinc, cadmium and copper for human exposure of (0.050, 5, 0.050 and 0.2) ppm respectively. [10, 11] Consequently, the formation of precise, sensitive, and selective analytical techniques to monitor these ions has become both necessary and urgent. Different methods have applied to determine the presence of metal ions, such as emission

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Published online: 09 January 2026