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Metal-clay nanocomposites in electrochemical sensor for detecting oxygen reduction and hydrazine oxidation

Abstract

Background: By employing a direct chemical approach, we developed halloysite nanotubes (HNT), Ag/f-HNT, and Au/f-HNT nanocomposites. Moreover, an established electrocatalyst aided in the reactions of hydrazine (Hz) oxidation and oxygen reduction (ORR). Methods: The prepared nanocomposites were examined using Fourier transform infrared spectroscopy (FT-IR), Ultraviolet–Visible spectroscopy (UV–Visible), X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), Thermal gravimetric analysis (TGA), Field emission scanning electron microscopy (FE-SEM), and High-resolution transmission electron microscopy (HR-TEM). Using HNT/GCE, Ag/f-HNT/GCE, and Au/f-HNT/GCE, the voltammetric approach was employed under ideal experimental conditions to detect Hz electrochemically at + 0.39 V, +0.394 V, and + 0.42 V (vs. Ag/AgCl). Chronoamperometry tests were conducted to identify the rate of Hz reaction and diffusion coefficient on modified electrodes. With high current sensitivity and superior peak resolution, a sensitive and quantitative approach for detecting Hz was achieved, and the DPV method did not result in any peak current value overlap. Due to their dynamic linear ranges 0.05 x 10^{-8} M to 1.49 x 10^{-8} M, 0.06 x 10^{-8} M to 1.5 x 10^{-8} M and 0.04 x 10^{-8} M to 1.52 x 10^{-8} M at HNT/GCE, Ag/f-HNT/GCE, and Au/f-HNT/GCE, respectively, the amperometric technique was utilized for the sensitive and selective identification of Hz. Significant findings: Based on S/N = 3, it was discovered that the limits of detection for HNT/GCE, Ag/f-HNT/GCE, and Au/f-HNT/GCE were 0.42, 0.36, and 0.29 nM, respectively. Furthermore, in an alkaline medium, the improved electrodes exhibit greater stability and robust durability for ORR. The result not only shows a prepared material for ORR, which also open up new possibility for nanotubular clay act as an electrocatalyst for ORR.

Keywords

Electrochemistry; Halloysite: Amperometry; Hydrazine, Oxygen reduction; Water samples