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Mediator Enhanced Glucose Detection Using Organic–Inorganic Hybrid Supramolecular Assembly on Gold Electrodes

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Abstract

In this study, a new organic-inorganic material, based on an alpha-metatungstate $[H_2W_{12}O_{40}]^{6-}$ cluster, was synthesized via the hydrothermal method by using aminopyridinium $(APy)^+$ cations as the hybrid material, and characterized by FT-IR and UV spectra analysis. The hybrid composite was immobilized on a gold electrode decorated with gold nanoparticles (AuNPs) and the modified electrode exhibited excellent electrocatalytic activities towards the reduction of H_2O_2 at neutral pH with a response time of less than 10 s. The H_2O_2 response at the modified electrode displays a linear response ranging from 40 µM to 10 mM.

Based on the H_2O_2 reduction activity, the $(APy)_6[H_2W_{12}O_{40}]$ composite was successfully used for the fabrication of a novel enzymatic glucose biosensor. The glucose oxidase enzyme (GOx) was immobilized onto the hybrid composite on AuNPs/gold electrodes; the $(APy)_6[H_2W_{12}O_{40}]$ composites were used as both mediation and bridging molecules. A multilayer architecture was constructed from hybrid POM alternating with (GOx), using glutaraldehyde as a covalent attachment cross-linker. Cyclic voltammetry (CV), SWV and chronoamperometry were used to determine the electrochemical properties of the mediator and characterize its reaction with (GOx). The resulting glucose biosensor exhibits a wide linear response for glucose from 40 µM to 10 mM with a sensitivity of 15.0 µA mM^{-1}.

Keywords: Hybrid polyoxometalates, Hydrogen peroxide detection, Glucose oxidase, Enzyme biosensor, Electron transfer mediator.