Cu/Cu$_2$O Nanocomposites for Sensitive Detection of Hydrogen Peroxide

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Abstract:
In this work, Cu/Cu$_2$O nanocomposites were prepared by potential oscillation. The composition and morphology of Cu/Cu$_2$O nanocomposites were characterized by X-ray diffraction, scanning electron microscopy, energy-dispersive spectroscopy and X-ray photoelectron spectroscopy. The Cu/Cu$_2$O/FTO electrode showed super electrocatalytic activity for hydrogen peroxide (H$_2$O$_2$) oxidation because of the synergistic effects of Cu and Cu$_2$O. The electrocatalytic performance of Cu/Cu$_2$O/FTO was evaluated by linear sweep voltammetry and amperometry. Electrochemical studies showed that the developed biosensor exhibited a wide linear range of 0.2–2000 μM with detection limit of 0.04 μM ($S/N = 3$). The proposed sensor was successfully applied for the determination of H$_2$O$_2$ in milk, indicating a promising platform for the practical applications.

Key words: potential oscillation, Cu/Cu$_2$O nanohybrid, H$_2$O$_2$ oxidation, amperometry.

Introduction
Hydrogen peroxide (H$_2$O$_2$) has been widely used in the field of textile, medicine, food, environmental degradation, and chemical industries because of the strong oxidizing and reducing properties [1]. Due to health concerns, the FDA regulation limits residual H$_2$O$_2$ in finished food packages [2]. The accurate determination of H$_2$O$_2$ is essential.

Preparation of Cu/Cu$_2$O/FTO
The electrochemical deposition of Cu/Cu$_2$O and Cu$_2$O film onto the cleaned FTO substrates followed previous work by Cheng [3]. The electrolyte solution contains 3 M lactic acid and 0.3 M cupric sulfate. The pH of the electrolyte solution was adjusted by 5 M sodium hydroxide. The Cu/Cu$_2$O/FTO and Cu$_2$O/FTO electrodes were electrochemically deposited at −0.4 mA/cm$^2$ at room temperature.

FE-SEM characterization
Fig. 1 and the inset show morphology of the Cu/Cu$_2$O nanocomposites at low and high magnification, respectively. The film was composed of nanoparticles with diameters of about 50 nm.

Electrochemical property
In order to study the electrocatalytic activity of bare FTO, Cu$_2$O/FTO and Cu/Cu$_2$O/FTO electrode toward H$_2$O$_2$ oxidation, linear sweep voltammetry (LSV) was obtained in 0.1 M NaOH containing 0.5 mM H$_2$O$_2$. As shown in Fig. 2, the biggest peak current density was obtained for Cu/Cu$_2$O/FTO electrode, indicating that the addition of Cu could improve the electrocatalytic activity of Cu$_2$O towards H$_2$O$_2$.
The amperometric responses curves of Cu/Cu$_2$O/FTO electrode with different concentrations of H$_2$O$_2$ were shown in Fig. 3. The result showed that the Cu/Cu$_2$O/FTO electrode exhibited excellent electrocatalytic property towards H$_2$O$_2$ oxidation over a linear range of 0.2–2000 μM (Fig. 3B) with detection limit of 0.04 μM. The non-enzyme biosensors had been successfully applied to the detection of milk sample with pleasant recovery.

**Conclusion**

We synthesized Cu/Cu$_2$O nanohybrid via potential oscillation. The Cu/Cu$_2$O/FTO electrode could be used for quantitative determination of H$_2$O$_2$ with good sensitivity.

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**References**

