

Electrochemical determination of lead & copper ions using thiolated calix[4]arene-modified screen-printed carbon electrode

ABSTRACT

This study used a thiolated calix[4]arene derivative modified on gold nanoparticles and a screen-printed carbon electrode (TC4/AuNPs/SPCE) for Pb²⁺ and Cu²⁺ determination. The surface of the modified electrode was characterised via Fourier-transform infrared spectroscopy (FTIR), field emission scanning electron microscopy (FESEM), cyclic voltammetry (CV), and electrochemical impedance spectroscopy (EIS). Differential pulse voltammetry (DPV) was used for the detection of Pb²⁺ and Cu²⁺ under optimum conditions. The limit of detection (LOD) for detecting Pb²⁺ and Cu²⁺ was 0.7982×10^{-2} ppm and 1.3358×10^{-2} ppm, respectively. Except for Zn²⁺ and Hg²⁺, the presence of competitive ions caused little effect on the current response when detecting Pb²⁺. However, all competitive ions caused a significant drop in the current response when detecting Cu²⁺, except Ca²⁺ and Mg²⁺, suggesting the sensing platform is more selective toward Pb²⁺ ions rather than copper (Cu²⁺) ions. The electrochemical sensor demonstrated good reproducibility and excellent stability with a low relative standard deviation (RSD) value in detecting lead and copper ions. Most importantly, the result obtained in the analysis of Pb²⁺ and Cu²⁺ had good recovery in river water, demonstrating the applicability of the developed sensor for real samples.

Keyword: Calixarene; Screen printed-carbon electrode (SPCE); Differential pulse voltammetry (DPV); Heavy metal; Lead (Pb²⁺); Copper (Cu²⁺)