

Probing the electrochemical behaviour of SWCNT–cobalt nanoparticles and their electrocatalytic activities towards the detection of nitrite at acidic and physiological pH conditions

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ABSTRACT

The electrochemical decoration of edge plane pyrolytic graphite electrode (EPPGE) with cobalt and cobalt oxide nanoparticles integrated with and without single-walled carbon nanotubes (SWCNTs) is described. Successful modification of the electrodes was confirmed by field emission scanning electron microscopy (FESEM), AFM and EDX techniques. The electron transfer behaviour of the modified electrodes was investigated in $[\text{Fe}(\text{CN})_6]^{3-/4-}$ redox probe using cyclic voltammetry (CV) and electrochemical impedance spectroscopy (EIS) and discussed. The study showed that cobalt nanoparticles modified electrodes exhibit faster electron transfer behaviour than their oxides. The catalytic rate constant (K) obtained at the EPPGE–SWCNT–Co for nitrite at pH 7.4 and 3.0 are approximately the same ($\sim 3 \times 10^4 \text{ cm}^3 \text{ mol}^{-1} \text{ s}^{-1}$) while the limits of detection ($\text{LoD} = 3.31/\text{m}$) are in the μM order. From the adsorption stripping voltammetry, the electrochemical adsorption equilibrium constant γ was estimated as $(13.0 \pm 0.1) \times 10^3 \text{ M}^{-1}$ at pH 7.4 and $(56.7 \pm 0.1) \times 10^3 \text{ M}^{-1}$ at pH 3.0 while the free energy change (ΔG°) due to the adsorption was estimated as -6.36 and $-10.00 \text{ kJ mol}^{-1}$ for nitrite at pH 7.4 and 3.0, respectively.