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Acetylsalicylic acid assisted hydrothermal growth of NiO, CuO and Co_3O_4 nanostructures and their application in the electro-catalytic determination of nalbuphine hydrochloride

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Abstract

This study describes the hydrothermal synthesis of NiO, CuO and Co_3O_4 nanostructures using acetylsalicylic acid (ASA) as a growth-controlling/directing agent. The as-synthesised nanostructures were shown to possess unique structural features and distinct morphologies, portraying the efficiency of ASA as a suitable growth modifier. The formed metal oxide nanostructures, when used for electrode modification purposes, exhibited excellent electro-catalytic capabilities against the oxidation of nelbuphine hydrochloride (NAL) in aqueous buffer solution. The modified electrodes exhibited distinct electrochemical characteristics, with CuO-based electrodes exhibiting a superior signal sensitivity and lower over-potential value compared to the NiO and Co_3O_4 nanostructures. The study further explores variation in the observed electro-catalytic oxidation signal referenced to the distinct morphologies of the metal oxides nanostructures. The CuO-based electrode was selected for the sensitive quantification of NAL in aqueous solution over the linear range 0.001-2.25 µM. The electrode demonstrated excellent working linearity, with signal sensitivity achieved down to 1×10^{-4} µM. Moreover, the successful quantification of NAL in complex matrices, such as human urine and clinical waste water, further reflected the analytical capability of the proposed sensor.

Keywords: Acetylsalicylic acid; Electro-catalytic oxidation; Nalbuphine hydrochloride; Pharmaceutical drug; Drug template; Nanostructures; Electrochemical sensors