Electrochemical modification of nanocubic \( p\text{-Cu}_2O \) electrodes for enhanced non-enzymatic glucose sensing

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Glucose sensing has applications in food industry, clinical diagnostics and medicine. \( \text{Cu}_2O \) is a promising platform for the development of stable, reliable and highly sensitive electrodes for sensor applications. Recent work on nanocubic \( p\text{-Cu}_2O \) thin film electrodes has shown high sensitivity, linearity and stability in the detection of glucose \([1]\). In this study, a non-enzymatic nanocubic \( \text{Cu}_2O \) thin film sensor was fabricated by potentiostatic electrodeposition on a \( \text{Cu} \) substrate by applying \(-0.2\) \( \text{V} \) with respect to \( \text{Ag}/\text{AgCl} \) electrode in a bath containing \( 0.01 \text{ M} \) cupric acetate and \( 0.1 \text{ M} \) sodium acetate. The pH of the bath was adjusted using sodium hydroxide \([2]\). The obtained nanocubic structured \( \text{Cu}_2O \) electrodes were modified by applying a more negative potential of \(-0.7\) \( \text{V} \) for different time durations in a bath containing \( 0.1 \text{ M} \) sodium sulphate and \( 0.01 \text{ M} \) copper sulphate. The film morphology (nanocubic crystals with sizes \( \sim100–200\) \( \text{nm} \)) and the conductivity type were confirmed by scanning electron microscopy (SEM) and spectral response measurements respectively. Spectral response measurements showed that the as deposited nanocubic structured thin films gave rise to a negative photocurrent, exhibiting \( p\text{-type} \) conductivity. Electrochemical performance of the sensor for glucose detection was investigated by Cyclic Voltammetry and Chronoamperometry.

Amperometric measurements were carried out at \(+0.4\) \( \text{V} \) in a \( 0.1 \text{ M} \) \( \text{NaOH} \) electrolyte with continuous stirring. As shown in figure 1, measurements showed that the modified nanocubic electrodes (that were fabricated by applying a potential of \(-0.7\) \( \text{V} \) for \( 90\) \( \text{s} \)) performed better than the unmodified nanocubic electrodes with a longer linear range (0.069 M - 8.3 mM), and a sensitivity (46.52 ± 0.67) \( \mu\text{A} \text{M}^{-1} \text{cm}^2 \) respectively. The detection limit was 29.8 \( \mu\text{M} \) and the sensor responded quickly (3s) to glucose. Linear range, sensitivity and detection limit for unmodified electrode were 0.1 M - 7.62 mM, 33.07 ± 0.86 \( \mu\text{A} \text{M}^{-1} \text{cm}^2 \) and 86 \( \mu\text{M} \) respectively. Furthermore, the electrode exhibited good reproducibility and high catalytic activity. No significant poisoning from commonly interfering species such as ascorbic acid, citric acid, NaCl and urea existing in blood was observed.

![Figure 1. Amperometric response measurements of (i) modified electrode and (ii) unmodified electrode at +0.4 V with the successive addition of 0.1 mM and 1 mM glucose into the 0.1 M NaOH electrolyte. Inset: Calibration curve of the corresponding amperometric response.](image)

These nanocubic \( \text{Cu}_2O \) electrodes provide a good platform for the fabrication of efficient surfactant free non-enzymatic glucose sensors.

References
