Electrochemical modification of nanocubic *p*-Cu_2O electrodes for enhanced non-enzymatic glucose sensing

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Glucose sensing has applications in food industry, clinical diagnostics and medicine. Cu_2O is a promising platform for the development of stable, reliable and highly sensitive electrodes for sensor applications. Recent work on nanocubic p-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 Cu2O thin film sensor was fabricated by potentiostatic electrodeposition on a Cu substrate by applying - 0.2 V with respect to Ag/AgCl electrode in a bath containing 0.01 M cupric acetate and 0.1 M sodium acetate. The pH of the bath was adjusted using sodium hydroxide [2]. The obtained nanocubic structured Cu_2O electrodes were modified by applying a more negative potential of -0.7 V for different time durations in a bath containing 0.1 M sodium sulphate and 0.01 M copper sulphate. The film morphology (nanocubic crystals with sizes ~100–200 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-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 V in a 0.1 M 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 V for 90 s) performed better than the unmodified nanocubic electrodes with a longer linear range (0.069 mM - 8.3 mM), and a sensitivity (46.52 ± 0.67) μA mM^{-1} cm^{-2} respectively. The detection limit was 29.8 μM and the sensor responded quickly (3s) to glucose. Linear range, sensitivity and detection limit for unmodified electrode were 0.1 mM - 7.62 mM, 33.07 ± 0.86 μA mM^{-1} cm^{-2} and 86 μM 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.

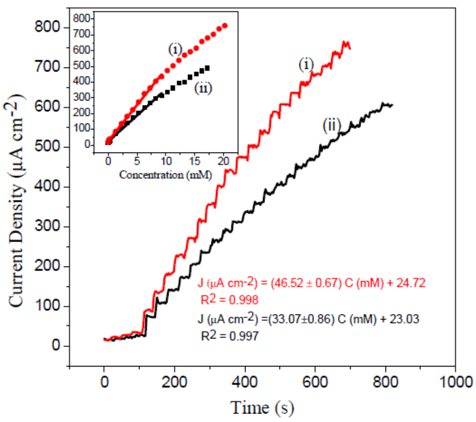

Figure 1. Amperometric response measurements of (i) modified electrode and (ii) unmodified electrode at +0.4 V with the successive addition of 0.1 mM and 1 mM glucose into the 0.1 M NaOH electrolyte. Inset: Calibration curve of the corresponding amperometric response.

These nanocubic Cu_2O electrodes provide a good platform for the fabrication of efficient surfactant free non-enzymatic glucose sensors.

References

[1]. J.L.K. Jayasingha et al., Physics Status Solidi A, DOI 10.1002/pssa.201700135 (2017)

[2]. J.L.K. Jayasingha et al., Physics Status Solidi B, DOI 10.1002/pssb.201600333 (2017) 254.