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Electrocatalytic activity of nanocubic and microcrystalline Cu_2O electrodes for glucose oxidation

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Nanostructured metaloxides have been extensively explored as sensors with high sensitivity, fast response, and good stability for the determination of glucose by electrochemical oxidation. This study reports the fabrication of nanocubic Cu_2O and microcrystalline Cu_2O films on Ti substrates using a pH controlled acetate bath, their characterization and performance as an electrochemical glucose sensor. Electro deposition of Cu_2O films was accomplished in an aqueous acetate bath (0.1 M sodium acetate and 0.01 M cupric acetate at pH=6). Conditions were optimized to obtain *p*-type Cu_2O nanocubes having well defined edges with dimensions around 300 nm. These films changed their conductivity to *n*-type upon annealing (200°C, 1h). These were then used as templates to grow thicker *n*-type films with an agglomeration of a large number of nanocubic Cu_2O crystals. Resulting films were used as electrodes for amperometric determination of glucose. Topographical properties of the deposited films were analyzed by scanning electron microscopy (SEM), which revealed the presence of a well defined nanocubic structure. The electrocatalytic activity for glucose oxidation of these films was compared with that of the microcrystalline Cu_2O films having grains of arbitrary shapes. The structure and the phase purity of the Cu_2O films were characterized by X-ray diffraction (XRD) and no impurities were detected. Impedance measurements were used to determine the type of the conductivity of the films. Cyclic voltammograms of the Cu_2O electrodes were obtained in 0.1 M NaOH solution. A clear peak for the oxidation of glucose was observed in the case of nanocubic material. No such clear glucose oxidation peak was observed for microcrystalline material. Chronoamperometry was utilized to ascertain the effect of working potential on the electrocatalytic oxidation of glucose over nanocubic and microstructure Cu_2O electrodes. Successive addition of 0.1 mM glucose at the applied potentials ranging from 0.2 V to 0.6 V showed that the maximum current is obtained at 0.5 V. However, a wider linear detection limit was observed at 0.6 V which is 2 µM to 20 µM. The nanocubic electrode showed a sensitivity of 2937 $\mu AmM^{-1}cm^{-2}$ whereas the microcrystalline electrode showed a sensitivity of 1882 $\mu AmM^{-1}cm^{-2}$.

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