Negative potential induced growth of surfactant-free CuO nanostructures on Al-C substrate: A dual in-line sensor for biomarkers of diabetes and oxidative stress

ABSTRACT

Identifying a non-enzymatic sensor electrocatalyst for the accurate determination of biomolecules is a paramount task. The weird morphology of the nanomaterial may exhibit the remarkable activity to enhance the sensitivity of the electrode, and hence, tuning the shape of the nanomaterials is one of the important criteria for electrochemical sensors. Thus, this study sought to fabricate a non-enzymatic sensor with different CuO morphologies by an eco-friendly and facile approach. Different surfactant-free CuO nanostructures were fabricated on the highly conductive flexible aluminum–carbide substrate for the electrochemical assessment of glucose and H2O2 in human fluids. The CuO nanostructures were initially electrodeposited at −0.1, −0.3, −0.5, and −0.7 V and then calcined in air at 120 °C for 2 h. Different CuO nanostructures with a polygonal and cactus-like morphology were observed in scanning electron microscopic images. The as-fabricated electrodes were also characterized by X-ray diffraction (XRD), X-ray photoelectron spectroscopy, and electrochemical impedance spectroscopy analysis. Texture coefficients (TC) of different CuO nanostructures were calculated from XRD analysis, and the CuO nanostructures grown at −0.5 V exhibited the highest TC with their texture along the (022) plane. The electrodes grown with different CuO nanostructures exhibited shape-dependent electrocatalytic activity against glucose and H2O2, and the cactus-like CuO nanostructures grown at −0.5 V showed superior electrochemical behavior compared to that of the other nanostructures by showing superior sensitivities of 3892.6 and 2015.7 μA mM–1 cm–2, respectively, against glucose and H2O2. In addition, the sensor grown with a cactus-like CuO nanostructure exhibited high selectivity, storage capability, and good practicability. This sensor proved to be practical by determining glucose and H2O2 levels in human fluids. It is believed that the proposed electrochemical sensor will have a strong impact in the dual in-line sensing of biomarkers in both biological and clinical fields in the near future.

Keyword: CuO nanostructures; Cactus-like nanostructures Surfactant-free nanostructures Aluminum−carbide electrode; Electrochemical sensor; Glucose