Morphological effects of electrodeposited Cu_2O thin films on enhancement of glucose sensing

Univ. of Colombo[1], Univ. of Kelaniya[2]

°Jayanetti K. D. S. Jayanetti[1], Jayasinghage L. K. Jayasingha[1], Migelhewa N. Kaumal[1], Karannagoda M. D. C. Jayathilaka[2], Mudalige S. Gunewardene[1], Dammike. P. Dissanayake[1]

E-mail: sumedhajayanetti@gmail.com

Cuprous oxide (Cu_2O) is a promising metal oxide semiconducting material used in sensing applications [1]. Performance of glucose sensing using Cu_2O thin film electrodes fabricated by electrodeposition with morphologies having microstructures of arbitrary shape, nanocubic structures and nanowires were evaluated. Microstructured n-Cu_2O films on Ti substrates were electrodeposited in an acetate bath by applying a potential of - 0.2 V (vs. Ag/AgCl) at pH 6.0 for 60 min. Nanocubic n-Cu_2O films were fabricated using template (conceived by electrodeposition of p-type Cu_2O films on Ti substrate in an acetate bath at pH 7.6 for 30 min. followed by annealing at 200ºC for 10 min.) assisted electrodeposition at pH 6.0 for 30 min. [2]. p-Cu_2O nanowires were synthesized on a Cu substrate by initially forming $Cu(OH)_2$ by applying a current density of 10 mA cm^{-2} in 3M NaOH electrolyte for 10 min. and subsequently dehydrating in a nitrogen gas atmosphere at 500ºC for 3 hrs. X-ray Diffraction (XRD) measurements of the fabricated thin films revealed that the structural properties of Cu_2O were free from impurities.

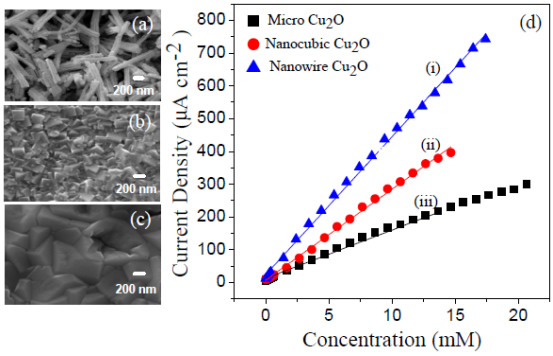

Figure 1. Film morphologies of (a) Cu_2O nanowires (b) Cu_2O nanocubes and (c) microstructured Cu_2O measured by SEM and (d) corresponding calibration curves obtained by amperometric measurements made using the three film electrodes.

Scanning Electron Microscopy images shown in the figure 1 (a) revealed that nanowires were of 100 - 200 nm in diameter with lengths exceeding 1 μm. The nanocubic films shown in figure 1 (b) had a distribution of cubic shapes with sides having a range of lengths; 150-300 nm. Electrodes were tested for glucose sensing by successive addition of glucose of known concentrations to an electrolyte consisting of 0.1 M NaOH. When the amperometric measurements were performed at 0.6 V for micro and nanocubic n-Cu_2O electrodes and at 0.5 V for p-Cu_2O nanowire electrodes, it was found that the electrodes having nanowire morphology recorded the highest sensitivity of 42.1 μA mM^{-1} cm^{-2} as shown in the figure 1 (d). Sensitivities recorded for nanocubic and microstructured n-Cu_2O electrodes were 28.4 μA mM^{-1} cm^{-2} and 16.3 μA mM^{-1} cm^{-2} respectively. The linear range of glucose sensing for nanowires, nanocubes and microstructured Cu_2O electrodes were 100 - 16,400 μM, 17 - 11,650 μM and 30 - 9,650 μM respectively. Furthermore, in the presence of commonly existing interferences such as ascorbic acid, uric acid, citric acid and NaCl that exist in blood, the current response of the electrodes were not significant. In conclusion, it can be shown that the controlling of morphology of the nanostructured Cu_2O films can lead to high sensitive detection of glucose.

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.