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Surfactant assisted synthesis of CuO nanostructures for nonenzymatic glucose sensor

A.S. Patil [a], R.T. Patil [b], Vijay J. Fulari [b,*]

[a] Rajarshi Chhatrapati Shahu College, Kolhapur, India
[b] Holography and Materials Research Laboratory, Department of Physics, Shivaji University, Kolhapur-416 004, (MH), India

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ABSTRACT

In the present work, CuO thin films are synthesized using the chemical bath deposition method and examined their electrochemical properties for non-enzymatic glucose sensors. Surfactants such as Triton X-100, cetyltrimethyl ammonium bromide (CTAB) and polyethylene glycol (PEG) are used to study their effect on structural, morphological electrochemical properties of CuO thin films. The crystallinity and morphology of CuO thin films was determined using an X-ray diffractometer (XRD) and a Field Emission Scanning Electron Microscope (FE-SEM). The prepared CuO thin films exhibit a monoclinic phase with bundles of nanosheets. The CuO thin films prepared using different surfactants exhibits different morphology. The electrochemical properties are studied by cyclic voltammetry and chronoamperometry. The prepared CuO thin films serve as an active material for nonenzymatic glucose sensor with a favorable response. The CuO thin films prepared with triton X-100 shows high sensitivity 2025 $\mu AmM^{-1}cm^{-2}$ at a potential of + 0.6 V with response time (~5s), linear range 3 µm to 3 mM. The selectivity of prepared CuO thin films with different surfactants towards interfering species ascorbic acid is studied. All the CuO thin films show a greater response to glucose than ascorbic acid.

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1. Introduction

On account, the significance of dependable and quick monitoring of glucose levels for medical care and controlling diabetes, the improvement of more sensitive and particular glucose sensors have attracted much consideration [1–5]. Several nanostructured metals (Pd, Pt, Cu, Ni, Au,) [6–10] and their alloys (Pt-Au, Pt-Pb, Ni-Pd Au-Cu, Cu-Ni, Au-Cu) [11–15] have been used to boost the sensitivity of glucose sensors. But, electrodes developed using metallic nanoparticles experience stability problems or expensiveness due to the use of noble metals [16,17]. On the contrary, metal oxides (Co_3O_4, Cu_2O NiO, CuO, MnO_2,) based sensors have been developed for the detection of glucose which does not contain any enzyme because of their higher stability and low expensiveness [18–22]. The use of CuO is significantly advantageous for glucose sensors because it is non-hazardous. Also, constituents of CuO are plentifully available in nature [23].

The nanostructures of CuO have a higher surface area and the ability to promote reactions occurring due to electron transfer at a lower potential. Hence, CuO provides greater attention to the improvement of the nonenzymatic glucose sensor. The physicochemical properties of the material are affected by its shape, size, and morphology thus significant efforts have been taken to synthesize different CuO nanostructures for example nanospheres [24], nanowires [25], nanoflowers [26], which can advance the performance of glucose sensor. In recent times, nanostructures of CuO such as nanosheets [27], nanowalls [28], and nanobelts [29] have been developed on CuO foils for glucose sensing. But, CuO thin films developed on stainless steel substrate have been rarely reported. Furthermore, the synthesis of these nanostructures is a relatively difficult and time consuming process. As a result, a simpler method to synthesize nanostructures of CuO films with higher catalytic activity for glucose detection is still required. CuO nanostructures like seeds, tubes, wires, belts, [30–32] leaves, rods, platelets, and needles [33] are synthesized using various deposition techniques. Among these various methods, CBD has been attracted to more consideration because of its simplicity. In the CBD technique, chemical reactions are easily carried out in an open con-

* Corresponding author.
E-mail address: vijayfulari@gmail.com (V.J. Fulari).

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