Universidad Autónoma de Ciudad Juárez

Instituto de Ingeniería y Tecnología

Departamento de Ingeniería Eléctrica y Computación

Maestría en Ingeniería Eléctrica

“Desarrollo de electrodos flexibles de óxido de cobre dopados con nanopartículas por el proceso sol-gel para su aplicación en un sensor no enzimático de glucosa”

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Abstract

In recent years, the development of new materials for the creation of new devices for the quantification of biological parameters has increased. Copper oxide (CuO), due to its great abundance and optimal characteristics has been investigated in the last decades for applications in several areas, such as: solar cells, batteries, electric circuits, gas sensors and in non-enzymatic biosensors. Actually, diabetes mellitus is a disease that affects 415 million people in the world. In the last decades, research on metal oxides have been carried out for the development of sensors in the medical area, with the aim of quantifying biological parameters that are more precise, practical, reliable and economical. For this reason, in this work, flexible electrodes are manufactured based on CuO thin films with copper (Cu) and silver (Ag) nanoparticles, which were added in copper oxide precursor solutions, before the deposit of the thin films.

The thin films were manufactured by the sol-gel process assisted by the spin coating technique at low temperatures. The sol-gel process is a chemical method for the manufacture of various materials from small molecules, the spin coating technique is used for the deposit of thin homogeneous films on a substrate. Then, the CuO films with Cu and Ag nanoparticles were subjected to a thermal treatment. The chemical properties of the precursor solutions are analyzed by means of a Fourier Transform Infrared Spectroscopy (FTIR) study. The CuO films were optically and microstructurally characterized by visible ultraviolet (UV-visible) spectroscopy, scanning electron microscopy (SEM), energy dispersive X-ray fluorescence (EDS) and X-ray diffraction (XRD). Later, the manufacturing of the electrodes is presented, where they are electrically characterized by means of a current-voltage analysis. The results show that thin films when subjected to a heat treatment suffer a change in their optical and microstructural properties. Where a batochromic effect is shown, where the absorption wavelength of a substance is displaced towards larger wavelengths, and a band gap of 3.89 eV, in addition to a densification of the material and homogeneity of the elements in all the surface. The monoclinic phase of CuO and the increase in crystallite size were also demonstrated. The analysis by current-voltage shows that the value of the electrode resistivity is 2.40×10^{-2} $\Omega \cdot cm$ and a conductivity of 41.57 $S \cdot cm^{-1}$, showing that the conductivity of the material is within the reported for semiconductors. Therefore, CuO electrodes doped with Cu and Ag nanoparticles have the optical, microstructural, and electrical properties to be used in non-enzymatic glucose sensors.

Keywords: Biosensor, copper oxide, non-enzymatic, semiconductor, thin films,