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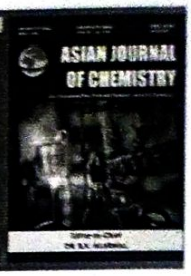

A Comparative Study of Structural, Morphological and Optical Properties of Pure and Tellurium-Doped ZnO Nanostructures

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Pure and tellurium-doped ZnO nanostructure films were prepared on microscopic glass substrates using the sol-gel method and investigated the relationship between the structural, morphological, roughness, and optical properties. The X-ray diffraction (XRD) spectra revealed that the nanostructure films have a hexagonal Wurtzite structure. The field emission scanning electron microscope (FESEM) images showed that the surface morphology of the nanostructure films was modified due to the Te dopant. The atomic force microscopy (AFM) technique was used to study the surface roughness of the pure ZnO and Te-doped ZnO deposited films. The optical properties of the nanostructure films were obtained using the ultraviolet-visible spectrophotometer. The effects of Te dopant elements on the optical characteristics and the samples' energy band gaps were calculated and discussed.

Keywords: Tellurium, ZnO, Sol-gel, Nanostructure, Bond length, AFM.

INTRODUCTION

In many optoelectronic applications, such as lasers, solar cells, light-emitting devices and detectors, wide bandgap semiconductors have been considered as the most energetic materials [1]. Zinc oxide (ZnO) is one of the mostly stable, Wurtzite hexagonal type structures, with wide direct band gaps, II-VI compound semiconductor materials. At room temperature, ZnO has a wide optical bandgap at around 3.3 eV, absorbs light in the UV range, and has a high exciton binding energy (60 meV) [2,3]. Pure ZnO nanostructured films have some limitations; pure ZnO films showing n-type conductivity, optical and electrical properties are unstable. Therefore, ZnO can not be used in pure form, thus requires doping with other appropriate materials [4,5]. Also, to develop various additional characteristics of pure ZnO, it is essential to tailor its optical, structure, and morphological properties according to the scope of new devices.

Modified ZnO nanostructures have been recently doped with chalcogen elements such as S, Se and Te [6,7]. Among these elements, tellurium is a suitable ionic dopant for increasing the bandgap of ZnO. Tellurium has the most useful and interesting characteristics, such as higher infrared transparency, non-linear optical responses and photoconductivity, all of which have potential uses in optical and electronic devices [8,9]. Undoped ZnO and Te doped ZnO nanostructures films have been prepared using various deposition methods like chemical precipitation [10], spray pyrolysis [11], pulsed laser deposition [12], hydrothermal [13], sol-gel [14], *etc*. Among these techniques, sol-gel is particularly useful due of its cheap cost, lower processing temperature, environmental friendliness, and it requires no expensive equipment [15]. The main aim of the present work is to study the pure and Te-doped ZnO nanostructure films were prepared using the sol-gel method. A study of the films was carried out to examine the modifications in ZnO structural, surface and optical properties with the doping of tellurium.

EXPERIMENTAL

Pure ZnO and 10% Te doped ZnO nanostructure films were synthesized using the sol-gel spin coating method on the microscopic glass substrates. The starting precursors used for this deposition method were zinc acetate dihydrate, tellurium tetrachloride, 2-methoxyethanol and ethanolamine. For 0.4 M solution of pure ZnO was prepared using zinc acetate dihydrate