doi:10.1017/S1431927620022849
Microsc. Microanal. 26 (Suppl 2), 2020

Comparative Study of ZnO and CdS/ZnO Thin Films Deposited by Chemical Bath Deposition Technique as a Buffer Layer for Solar Cell Applications

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Nowdays, energy production has been a keystone factor in the development of new electrical devices. The consumption of energy is directly proportional with world population growth as well as the characteristics of the modern society, especially in a good quality of life. Therefore, the energy generation with resourses renewable is really important now, in other case it will affect in negative form the entire population of the world qualitatively. In the other words, the international energy scenario allows us to visualize that the use of solar energy has strong growth prospects within the area of alternative energy sources. Recently, the CdTe/CdS solar cells technology reached a high-tech level able to realize devices showing efficiencies close to 22% [1]. The production process of the thin film CdTe/CdS-based solar cells both from a technological and from a physical point of view is not so dificult. For example, in solar cells applications, Cadmium sulphide (CdS) thin films have been wide used, because it is of the most familiar semiconductors having narrow direct band gap (2.4 eV) and widely employed as a visible light photocatalyst. On the other hand, Zinc Oxide (ZnO) has a wide band gap semiconductor that is gaining widespread attention in photocatalytic applications because of its higher exciton binding energy of 60 meV, high electron mobility, break-down strength, its low cost, extraction stability and non-toxic nature. Combining Zinc Oxide (ZnO) and Cadmium sulphide (CdS) to form heterostructure have numerous importance because the subsequent product has the ability of improving their electrical, optical, physical, and chemical properties [1] and that can be shown increasing the efficiency. From the electrical point of view, the ZnO and CdS/ZnO layers can optimize the band alignment of the device. Also, these can build a sufficiently wide depletion width that minimizes tunneling and establishes a higher contact potential that allows higher open circuit voltage. Recently, a particular attention of the researches has been focused on the heterostructures involving ZnO and CdS/ZnO multilayers.The band energy structures of ZnO and CdS are suitable to stimulate the transfer of electron processes where photogenerated electron can drift from CdS to ZnO and the charge transporters become physically detached upon generations [2]. In general, ZnO and CdS/ZnO thin films have been extensively investigated as an n-type buffer layer to form thin film heterojunction solar cells with p-CdTe absorber layers. In this work, we prepared ZnO and CdS/ZnO heterostructures by simple Chemical Bath Deposition (CBD) technique, because this technique is well known to produce solar cells over a large area at a low cost and low temperature. The effect of deposition parameters of ZnO and CdS thin films developed by CBD technique were investigated in [3-5], principally, the influence of pH control of the reaction solution on the structural and optical properties of chemically deposited ZnO and CdS thin films. Different films thicknesses of ZnO and CdS/ZnO thin films were deposited onto a glass substrate. The structural surface morphology of as-deposited ZnO and CdS/ZnO thin films was characterized by SEM. The physical conditions were kept identical while growing of the samples.

In this paper, a comparative study of ZnO and CdS/ZnO thin films deposited by CBD as a buffer layer solar cell was carried out. The thin films ZnO were fabricated by CBD technique on a glass substrate for a deposition time 60 minutes with a bath temperature of 90 ºC. The Figure 1(a) shows SEM photos of the sample surface of ZnO films grown at 60 minutes time deposition using a solution with pH 11.4 at different zoom scales. The SEM image reveals that the surface looks poly-crystalline, porous and the grains are almost interconnected. In the other case, for the CdS/ZnO thin films grown at 60 minutes time deposition, using a solution with pH 11.4 and at a bath temperature of 90 ºC, one can see the SEM photos of the

samples surfaces in the figure 1b. Based on the optical transmission measurements, the square of absorption coefficient (α^2) is plotted as a function of phonon energy ($h\nu$) in figure 1c, one can see the energy band gap for ZnO and CdS/ZnO thin films, E_g = 3.3 and 3.2 eV, respectively. This may be interpreted by the decrease of the film thickness. From these studies, we are able to optimize the process in order to produce the layer suitable for optical window in solar cells. This approach could be used in improving the spectral response of CdTe-based solar cells. This work revealed that composite such as CdS/ZnO heterostructure has better photocatalytic efficiency that pure ZnO.

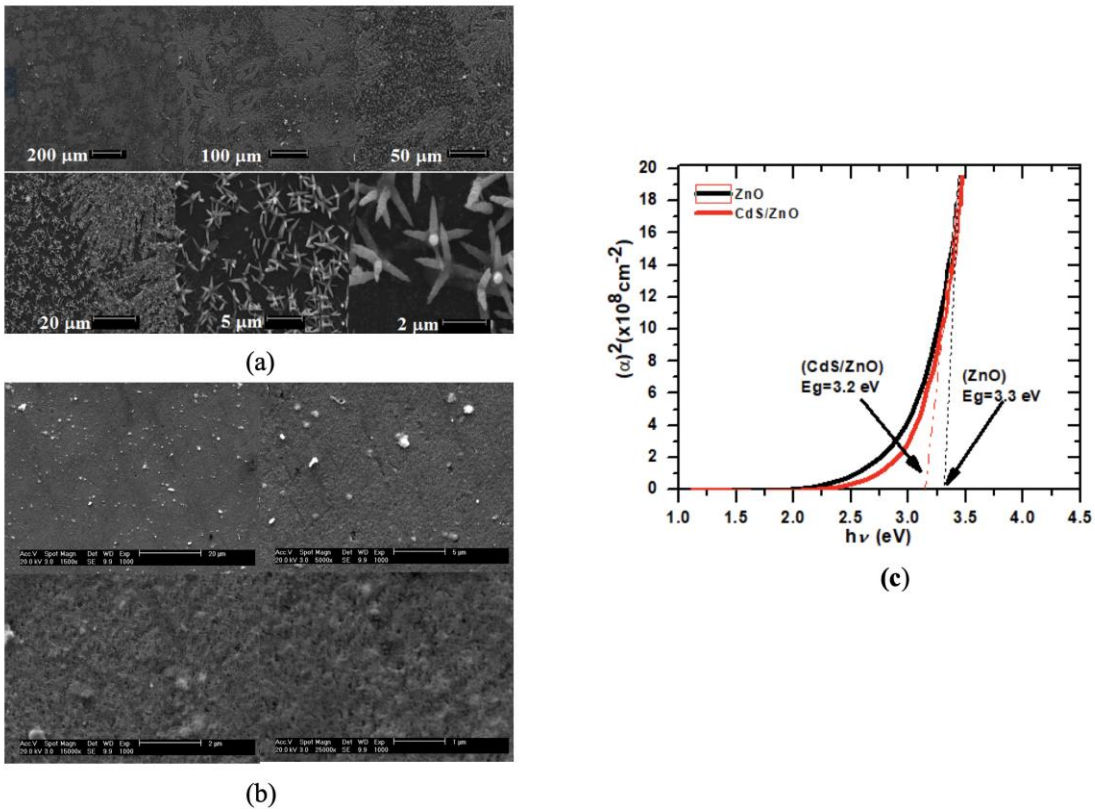

Figure 1. SEM photos of the samples surfaces of ZnO thin films (a) and CdS/ZnO thin films (b) grown at 60 minutes time deposition with a solution with pH=11.4. α^2 versus hν plot for ZnO and CdS/ZnO thin films (c).

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https://doi.org/10.1017/S1431927620022849 Published online by Cambridge University Press