1548
doi:10.1017/S143192761800822X

Microsc. Microanal. 24 (Suppl 1), 2018

Comparative Study of CdS and CdS/ZnS Thin Films Deposited by CBD as a Buffer Layer Solar Cell

A. García-Barrientos[1], H. Gomez-Pozos[2], E. Villicaña-Ortiz[3] and L. Cruz-Netro[4]

[1.] Faculty of Science, Universidad Autónoma de San Luis Potosi, SLP, México.
[2.] Electronics Department, Universidad Autónoma del Estado de Hidalgo, Hidalgo, México.
[3.] Departamento de Ingeniería de la Energía, Universidad de Ingeniería y Tecnología, Lima, Peru
[4.] Ingeniería Industrial, Universidad Politécnica de Altamira, México

Cadmium sulphide (CdS) and Cadmium sulphide/Zinc sulfide (CdS/ZnS) thin films have been extensively investigated as an *n*-type buffer layer to form thin film heterojunction solar cells with *p*-CdTe absorber layers. The buffer layer affects the electrical properties of the junction and protects it from chemical reactions. From the electronic point of view, the CdS and CdS/ZnS layers can optimize the band alignment of the device [1 and 2]. Also, these can build a sufficiently wide depletion width that minimizes tunneling and establishes a higher contact potential that allows higher open circuit voltage [2]. Recently, a particular attention of the researches has been focused on the heterostructures involving CdS and CdS/ZnS multilayers [3]. Because of its band gap, it could be an excellent window layer in CdTe thin film solar cells. Since Chemical Bath Deposition (CBD) is known to produce solar cells over a large area at a low cost and low temperature. The effect of deposition parameters of CdS and CdS/ZnS thin films developed by CBD technique were investigated in [4 and 5], principally, the influence of pH control of the reaction solution on the structural and optical properties of chemically deposited CdS and CdS/ZnS thin films. Different films thicknesses of CdS and CdS/ZnS thin films were deposited onto a glass substrate. The structural surface morphology of as-deposited CdS and CdS/ZnS thin films was characterized by SEM. The physical conditions were kept identical while growing of the samples. The investigation of the effect of the synthesis method on the change the ammonium hydroxide by buffer pH (from 10.1 - 13) contributed in increases the growth kinetics, resulting in thicker films.

In this paper, a comparative study of CdS and CdS/ZnS thin films deposited by CBD as a buffer layer solar cell was carried out. The CdS and CdS/ZnS thin films were fabricated by CBD technique on a glass substrate for a deposition time of 60 minutes at a bath temperature of 90 ºC. These thin films were synthesized by chemical bath deposition using acid as a complexing agent with pH values between 10.1 to 11.3 for the CdS thin films and for the CdS/ZnS thin films with pH values between 11.4 to 13, these can be seen in the Figures 1a and 1b, respectively. The SEM photos (see figure 1a) show the surfaces of CdS films grown at 60 minutes deposition time and to different solution pH values. Based on the optical transmission measurements, the square of absorption coefficient (α^2) is plotted as a function of phonon energy (hν) in figure 1c, one can see the energy band gap, *E*g, values 2.38, 2.58 and 2.44 eV for pH values, 10.1, 10.6 and 11.3, respectively. In the other case, for the CdS/ZnS thin films grown at 60 minutes time deposition, one can see the SEM photos of the samples surfaces in the figure 1c. Also, we found different energy band gaps for different pH values; for pH=11.4, *E*g equals 2.74 eV and at pH=11.8, *E*g equals 2.7 eV, these values are pretty similar of the literature [6]. Finally, these studies show that the pH contributes noticeably to the growth and to the structure of deposited CdS and CdS/ZnS multilayer films. 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. For the case of CdS thin films, it is better to use acid as a complexing agent with pH value equal to 10.6 and for the case of CdS/ZnS thin films, it is better use with pH value equal to 11.4. This approach could be used in improving the spectral response of CdTe-based solar cells. A higher band gap was observed for CdS/ZnS, it indicates that there is clear short-wavelength advantages in current collection with the potential of increasing short-circuit current density for Cd/ZnS compared to CdS.

[1] Jongmin Kim, et al., *Appl. Phys. Lett.*, vol. 102, no. 18, 183901, 2013.
[2] M.A. Contreras, *Thin Solid Films*, vol. 204, 403-404 pp., 2002.
[3] T. Ben Nasr, et al., *Thin Solid Films*, vol. 500, 4-8 pp., 2006.
[4] F.Vázquez-Monroy, et al. *Metallogr. Microstruct. Anal.*, vol. 5, No. 62, 2016
[5] F. Vázquez-Monroy, et al., *Microsc. Microanal.*, vol. 21, 295-296 pp., 2015
[6] Arreola-Jardón G., et al., *Thin Solid Films*, vol. 519, 517-520 pp., 2010

The authors acknowledge funding from the CONACYT-Mexico, research projects grant numbers 169062 and 204419.

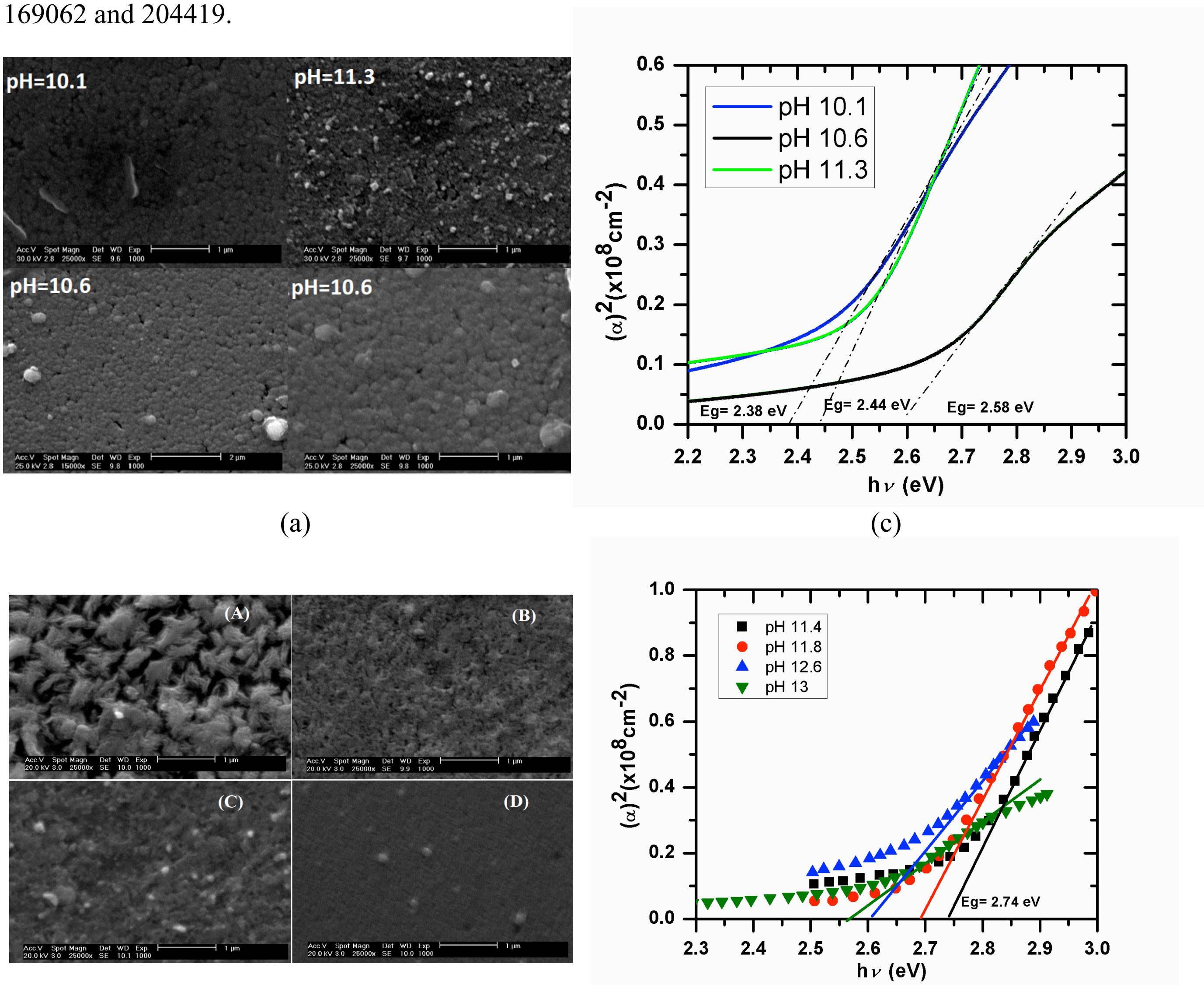

Figure 1. SEM photos of the samples surfaces of CdS thin films (a) and Cd/ZnS thin films (b) grown at 60 minutes time deposition to different solution pH, A:11.4, B:11.8, C:12.6 and D:13. α^2 versus hν plot for CdS thin films (c) and for CdS/ZnS thin films (d).