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# The Influence of pH Buffer as Agent Reaction Moderator in the Growth of CdS/ZnS Films by CBD Technique for Solar Cell Applications

F. Vázquez-Monroy[1], A. García-Barrientos[2], J.L. Bernal[3], J. Plaza-Castillo[4], H. Romero-Trejo[2] and R. Ramírez-Bon[5]

[1.] Renewable Energy Department, Universidad Tecnológica Tula-Tepeji, Hidalgo, México.
[2.] Electronics Department, Universidad Autónoma del Estado de Hidalgo, Hidalgo, México.
[3.] Mechanics Department, Universidad Politécnica de Pachuca, Hidalgo, México.
[4.] Physics Department, Universidad del Atlántico, Barranquilla, Colombia
[5.] CINVESTAV-IPN Unidad Querétaro, Querétaro, México.

Thin films of II–VI semiconductors are important for their applications in solid-state solar cells, optical coatings, optoelectronic devices, and light emitting diodes [1]. Cadmium sulphide (CdS) 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 layer optimizes the band alignment of the device [1,2] and builds a sufficiently wide depletion width that minimizes tunneling and establishes a higher contact potential that allows higher open circuit voltage [2]. Recently, particular attention of the research has been focused on the heterostructures involving CdS/ZnS multilayers [3–6]. 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, efforts have been made by many research groups over the world [5-7]. The effect of deposition parameters of CdS/ZnS thin films developed by CBD technique was investigated in this paper, principally, the influence of pH control of the reaction solution on the structural and optical properties of chemically deposited CdS/ZnS films. Different films thicknesses of CdS/ZnS were deposited onto a glass substrate. The structural surface morphology of as-deposited CdS/ZnS thin films was characterized by SEM, XRD, profilometer, and ultraviolet–visible spectroscopy. The physical conditions were kept identical while growing the samples. The investigation of the effect of the synthesis method on the change the ammonium hydroxide by buffer pH-11.4 contributed in increases the growth kinetics, resulting in thicker films.

The CdS/ZnS thin films were fabricated by CBD technique on a glass substrate for different deposition times (15, 30, 45 and 60 minutes) at a bath temperature of 90 ºC. The diffractogram of an as-deposited CBD-CdS/ZnS sample is shown in figure 1(a). The typical XRD pattern shows lines that correspond to the reflection mixture (002) of the greenockita (hexagonal) and (111) of the hawleyite (cubic) peak (1), showing in general that the preferential orientation of the film is along the (002) and (111) direction, other XRD pattern corresponds to the reflection of (220) of the hawleyite (cubic) peak (2), and (201) of the hawleyite (cubic) peak (3). We can also observe that these peaks are quite broad, which is indicative of nanosize particle. The transmittance at the high-energy region extends up to 300 nm as is shown in the figure 1(b). The SEM photos (see figure 1(c)) show the surfaces of CdS/ZnS films grown at 60 minutes deposition time and to different solution pH, A:11.4, B:11.8, C:12.6 and D:13, with thickness from 123, 102, 89 and 55 nm, and with the resistivity from 5.12, 4.18, 3.9, and 2.4 x $10^5$ Ω-cm, respectively. Based on the optical transmission measurements, the square of absorption coefficient ($\alpha^2$) is plotted as a function of phonon energy ($h\nu$) in figure 1 (d). At 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 [5]. Finally, these studies

show that the pH contributes noticeably to the growth and to the structure of deposited 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.

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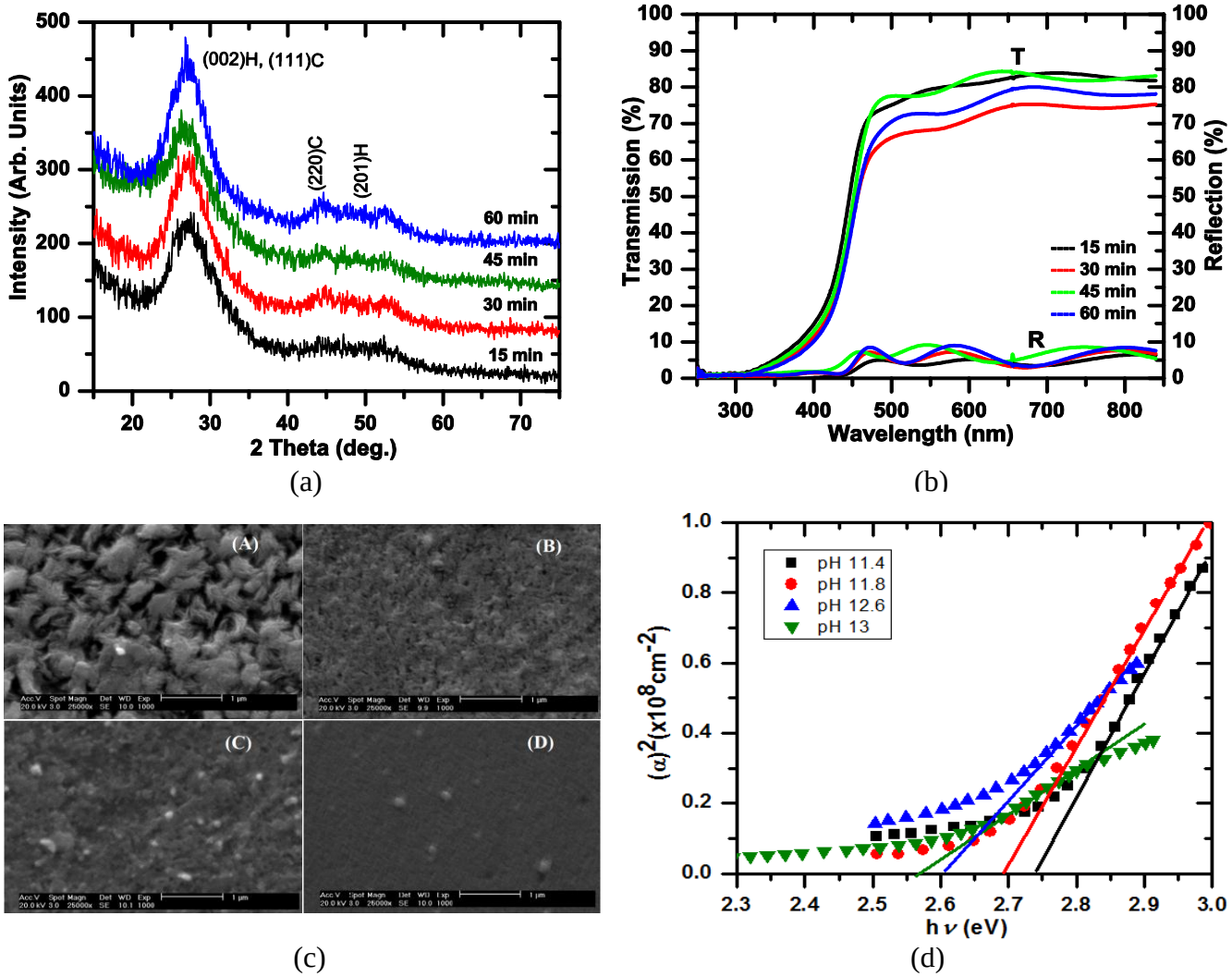


**Figure 1.** X-ray spectrum of a typical CBD-CdS/ZnS sample (a). The transmittance at the high-energy region extends up to 300 nm (b). SEM photos of the samples surfaces of Cd/ZnS films grown at 60 minutes time deposition and to different solution pH, A:11.4, B:11.8, C:12.6 and D:13 (c). $\alpha^2$ versus h$\nu$ plot of CdS/ZnS films (d).

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