doi:10.1017/S1431927617010984
Microsc. Microanal. 23 (Suppl 1), 2017

The Influence of pH Control of the Reaction Solution in the Growth of ZnO Films by CBD Technique for Solar Cell Applications

F. Vázquez-M.[1], A. García-Barrientos[2], J. L. Bernal[3], R. Ambrosio[4], R. Balderas[2] and R. Ramírez-Bon[5]

[1.] Renewable Energy Department, Universidad Tecnológica Tula-Tepeji, Hidalgo, Mexico.
[2.] Faculty of Science, Universidad Autónoma de San Luis Potosí, San Luis Potosí, Mexico.
[3.] Department of Mechanical Engineering, Instituto Tecnológico de Orizaba, Veracruz, Mexico
[4.] Faculty of Electronincs, Benemérita Universidad Autónoma de Puebla, Mexico
[5.] CINVESTAV-IPN Unidad Querétaro, Querétaro, Mexico

The fabrication and characterization of ZnO thin films is very important nowadays, because it is in the group II–VI metal oxide semiconductor with a wide direct band gap [1]. Electrical and optical characteristics of ZnO films are pretty similar like GaN, ZnS, and compound semiconductors, and also because this material has different applications such as solid state light sources and detectors in the blue and UV spectral range [2-3]. For applications in electronics and optics field, ZnO has interesting properties such as magnetic, piezoelectric, semiconductor. It has a high electrical conductivity and a high optical gain at ambient temperature. In consequence by these properties, thin films ZnO has found numerous potential applications in fields such as, light emitting diodes, most gas sensors, solar cells. Specially, actual solar cells have limitations in terms of energy conversion efficiency. In this context, there is the necessity to develop a material that should possess inherent properties like large band gap, higher electron mobility, higher breakdown field strength, high chemical stability, low dielectric constant and high luminous transmittance [2-3]. ZnO has emerged as one of the most promising compound for such applications. The fabrication of thin films ZnO can be carried out with different techniques, such as vapor-liquid-solid growth, chemical vapor deposition, electrochemical deposition, and chemical bath deposition (CBD). The last one method has drawn more attention than other thin film deposition techniques, because it is a low-cost manufacturing process, non-toxic, and simple coating process [4]. The effect of deposition parameters of thin films ZnO 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 ZnO films. Different films thicknesses of thin films ZnO were deposited onto a glass substrate. The structural surface morphology of as-deposited ZnO 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 from 11.4 to 13 contributed in increases the growth kinetics, resulting in thicker films.

The thin films ZnO were fabricated by CBD technique on a glass substrate for different deposition times (30, 45 and 60 minutes) at a bath temperature of 90 ºC. The diffractogram of an as-deposited CBD-ZnO sample is shown in figure 1(a). All the diffraction peaks in the pattern is well matched with the available Joint Committee on Powder Diffraction Standards for bulk ZnO (JCPDS 36-1451) reported data [5]. Additionally, higher intensity and narrower spectral width of ZnO peaks in the spectrum affirmed that the obtained products have good crystallinity. Figure 1(b) shows the variation of $(\alpha)^2$ with $h\nu$, which is a straight line, indicating the direct transition. The energy is obtained by extrapolating the linear part of the curve at $\alpha = 0$. The band gap energy is found to be 3.3 eV for a ph=11.4, and 3.2 eV for a ph=13, these values are pretty similar of the literature. The Figure 1(c) shows SEM photos of the samples surfaces 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. The agglomeration of small crystallites to form spindle, dumb bell and cuboidal shaped particles and fused clusters are also seen in surface morphology of this film that may provide novel platform for photovoltaic applications. Finally, these studies show that the pH contributes noticeably to the growth and to the structure of deposited ZnO 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.

References:

[1] Dewei Chu *et al*, Phys. Status Solidi A **206(4)** (2009), p. 718.

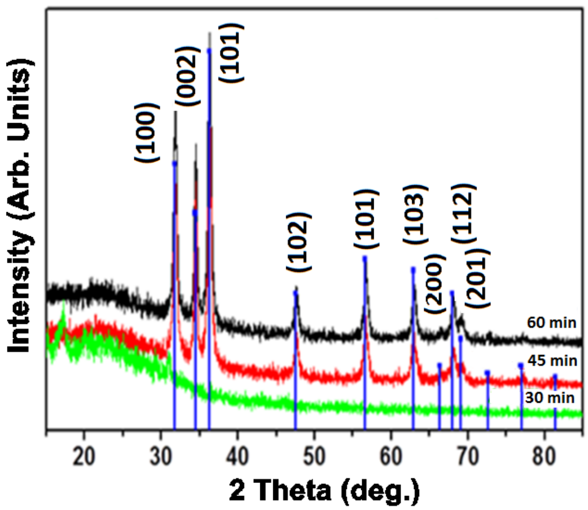
[2] G. Amin *et al*, Journal of Nanomaterials **2011** (2011), Article ID 269692, 2011

[3] D. Polsongkram *et al*, Physica B **403** (2008), p. 3713.

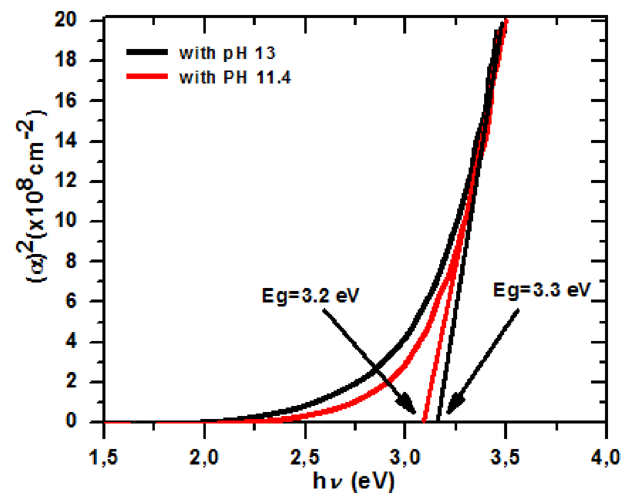
[4] Rizwan Wahab *et al*, Materials Transactions **50(8)** (2009), p. 2092.

[5] Rayees A. Zargar *et al*, Optik **126** (2015), p. 4171.

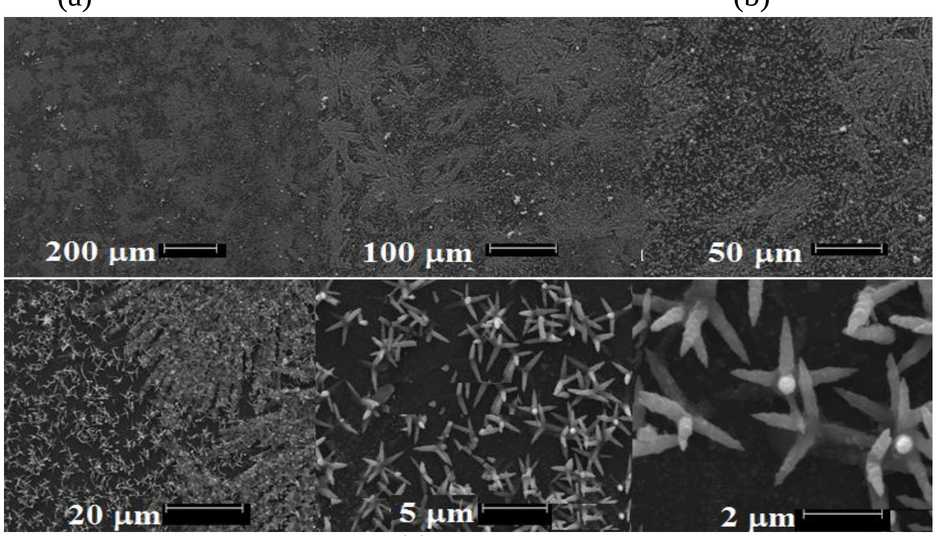
[6] The authors acknowledge funding from the CONACYT-Mexico, research projects grant numbers 169062 and 204419 and PRODEP-Mexico.



(a)



(b)



(c)

Figure 1. (a) X-ray spectrum of a typical CBD-ZnO sample. (b) α^2 versus *hν* plot of ZnO films. (c) SEM photos of the samples surfaces of ZnO films grown at 60 minutes time deposition with a solution pH = 11.4 at different zoom scales.

https://doi.org/10.1017/S1431927617010984 Published online by Cambridge University Press