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PHOTO CONDUCTIVITY OF ZINC OXIDE THIN FILMS OF DIFFERENT THICKNESS WITH PHOTO CURRENT AND DARK CURRENT

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ABSTRACT

In this paper, the effect of thin films thicknesses on the photoconductivity of the ZnO thin films deposited using sol-gel spin coating technique on glass substrates were tested for photo conductivity. The layer by layer method of film deposition was adopted to develop the thin films of different thickness. The thicknesses of the films resulting from the 2 to 6 repetitions of spin coating and annealing were found to be (a) 14.3 $\pm$ 0.2 nm, (b) 20.9 $\pm$ 0.3 nm, (c) 42.8 $\pm$ 0.5 nm, (d) 51.5 $\pm$ 0.4 nm, and (e) 61.7 $\pm$ 0.3 nm. Present study showed that the coatings with larger thicknesses were able to generate more photo current than the thinner coatings.

Keywords: *Zinc oxide, thin film, solar cell, photoconductivity*.

I. INTRODUCTION

Transparent conductive oxides are of great importance now a day. ZnO is also a member of transparent conductive oxides. Zinc Oxide has a large band gap (Eg=3.37 ev), large excitation energy of 60 meV and categorized as a semi-conductor material primarily used for manufacturing of LEDs, OLEDs, Liquid crystal displays, flat panel displays, front contact of thin film solar cells and many other photonic devices [1, 2]. In particular, ZnO forms a technologically important class of material, exhibiting exceptional UV attenuation characteristics: blocking 95% of all UV radiation, excellent transmittance in the long wavelength region, and outstanding antimicrobial properties [3, 4]. One area of great interest is the application of ZnO as a transparent conducting oxide. Many deposition techniques have been used to synthesize ZnO thin films, such as, sputtering, pulsed laser deposition. Physical vapor deposition [5], spray pyrolysis, evaporation and sol-gel technique [6]. Sol-Gel Spin Coating synthesis is used in our work. It is used for several reasons, low cost, easy to understand procedure, uniform film thickness and large area deposition. ZnO is non-toxic and abundantly available material [7, 8].

In this paper, the effect of thin films thicknesses on the photoconductivity of the ZnO thin films of different thickness with photo current and dark current were observed.

II. MATERIALS AND METHODS

For preparation of zinc oxide thin films, the method suggested by Shariffudin *et al*. [9] was adopted. ZnO sol was prepared using zinc acetate dehydrate ($Zn(CH_3COO)_2\cdot H_2O$, Merck) as the starting material, 2-methoxyethanol ($C_3H_8O_2$, Sigma-Aldrich) as the solvent, and monoethanolamine (MEA, C_2H_7NO, Merck) as the Sol stabilizer. The concentration of zinc acetate was 0.4 M and the molar ratio of MEA to zinc acetate was maintained at 1.0. Solution was stirred on a hot plate stirrer with applied temperature of 80^{o}C for 1 hour to yield a homogenous solution. The resultant clear solution was aged for 24 hours at room temperature. Glass slides were cut into 2×2 squares and cleaned using acetone, methanol and de-ionized water in an ultrasonic bath for 10 minutes each. The sol was dropped onto the spinning glass substrate with a rotation speed of 3000 rpm for 60 seconds. Each coating was dried at 150^{o}C for 10 minutes to remove the solvent and organic residues. The film was then annealed in air at a temperature of 500^{o}C for 30 minute each layer. The process from coating to annealing was repeated 2 to 6 times to produce different thickness of the films named as ‘a to e’. A field emission scanning electron microscopy (FE-SEM, model: JEOL JSM-7600F) as used with an accelerating voltage of 5 kV to examine the nanostructures of the films.

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The films thicknesses were measured using a surface profiler (Model: KLA-Tencor). In present study, the photo-conductivity [10] of ZnO nanostructure samples was taken using a simple photoconductive circuit (Figure 1).

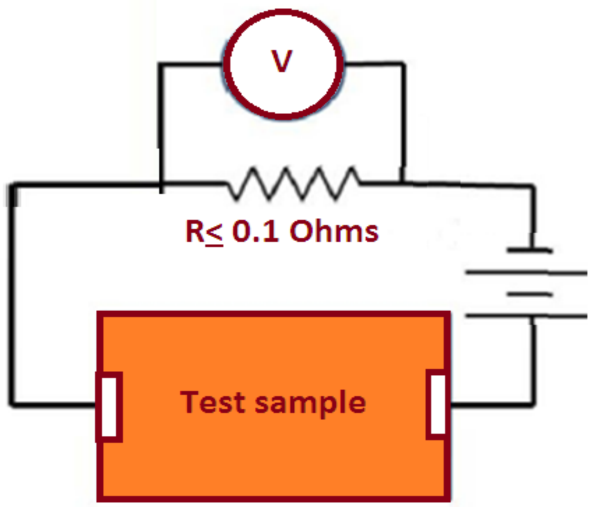

Figure 1: Photo Conductivity Test

III. RESULTS AND DISCUSSION

The thicknesses of the films resulting from the 2 to 6 repetitions of spin coating and annealing were found to be (a) 14.3 $\pm$ 0.2 nm, (b) 20.9 $\pm$ 0.3 nm, (c) 42.8 $\pm$ 0.5 nm, (d) 51.5 $\pm$ 0.4 nm, and (e) 61.7 $\pm$ 0.3 nm. The photoconductivity is an optical and electrical phenomenon in which a material becomes more electrically conductive due to the absorption of electromagnetic radiation such as visible light, ultraviolet light, infrared light, or gamma radiation. When light is absorbed by a material such as a semiconductor, the number of free electrons and electron holes changes and raises its electrical conductivity [11]. To cause excitation, the light that strikes the semiconductor must have enough energy to raise electrons across the band gap, or to excite the impurities within the band gap. When a bias voltage and a load resistor are used in series with the semiconductor, a voltage drop across the load resistors can be measured when the change in electrical conductivity of the material varies the current flowing through the circuit The variation in the output for the dark current and the photo-current was very large order (figure 2 and 3). For an initial input value of 0.01 V the variation was smaller than 0.5 mA whereas for 0.07V the variation was approximately 4Ma. This infers that the coatings with larger thicknesses were able to generate more photo current than the thinner coatings. These observations were in well agreement with previous study of T. Söderström *et al.* [12] and M. Sathya *et al.* [13, 14].

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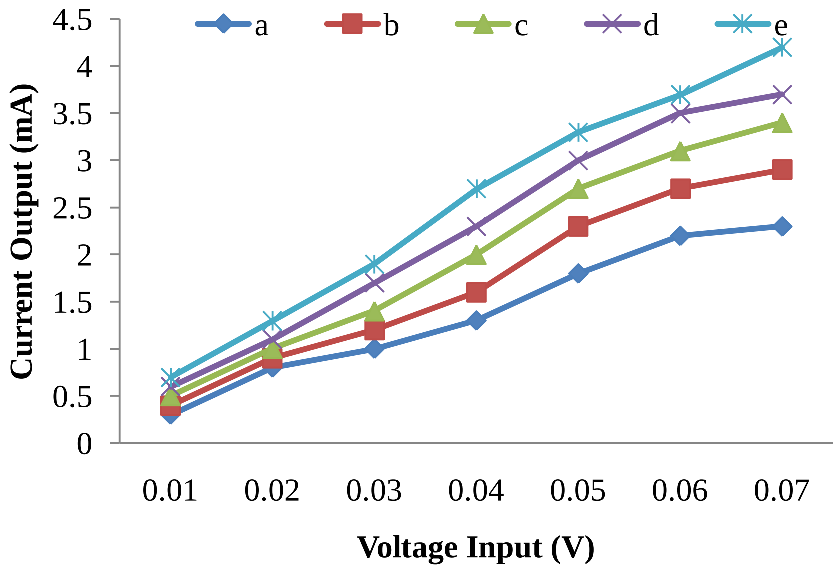

Figure 2: Photo conductivity of zinc oxide thin films of different thickness with Photo current (With Sunlight)

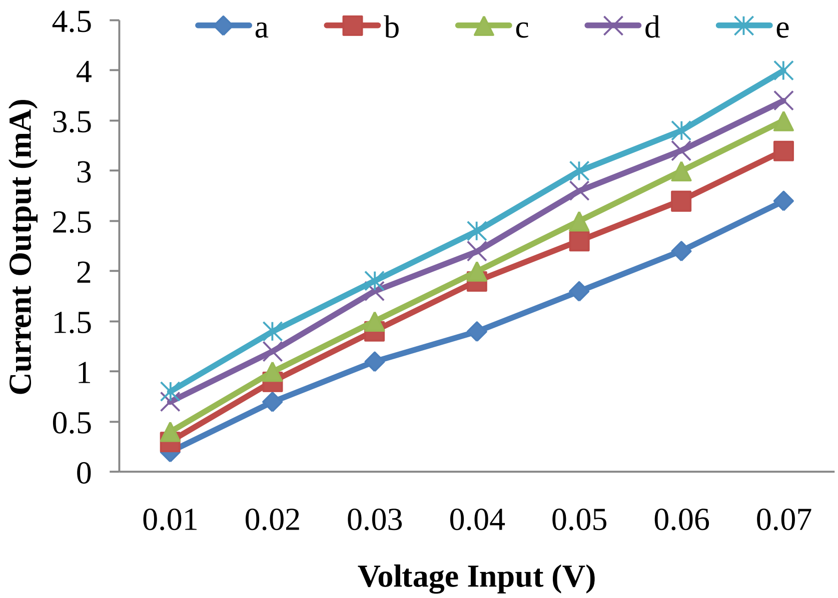

Figure 3: Photo conductivity of zinc oxide thin films of different thickness with Dark current (Without Sunlight)

IV. CONCLUSION

In this paper we observed effect of thin films thicknesses on the photoconductivity of the ZnO thin films deposited using sol-gel spin coating technique on glass substrates for solar cell applications. Study infers that the coatings with larger thicknesses were able to generate more photo current than the thinner coatings..

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REFERENCES

1. *D. C. Plain, H. Y. Yeom, and B. Yaglioglu, Flexible flat panel displays, edited by G. P. Crawford, John Wiley and Sons, Ltd, Singapore, 2005, pp. 94.*
2. *D. M. Yeul and D. S. Dhote, Int. J. Inno. Sci., Eng. Tech. 2 (11); 354-370. 2015*
3. *D. M. Yeul and D. S. Dhote, NCRISE proceeding. 2017*
4. *D. M. Yeul and D. S. Dhote, Science Park Research Journal. 2015*
5. *W. Zhang, Y. Liao, L. Li, Q. Yu, G. Wang, Y. Li, and Z. Fu, Applied Surface Science, vol. 253, pp. 2765, 2006.*
6. *S. O. Brien, L. H. K. Koh, and G. M. Crean, Thin Solid Films, vol. 516, pp. 1391-1395, 2008.*
7. *D. M. Yeul and D. S. Dhote, NCRAS proceeding. 2016.*
8. *A. Farooq and M. Kamran, International Journal of Applied Physics and Mathematics, Vol. 2, No. 6, 2012*
9. *S. S. Shariffudin, M. Salina, and S. H. Herman. Transactions On Electrical And Electronic Materials Vol. 13, No. 2, pp. 102-105, 2012.*
10. *T.-L. Phan, S. C. Yu, R. Vincent, N. H. Dan, and W. S. Shi, 2010, Journal of Luminescence, vol. 130, no. 7, pp. 1142–1146*
11. *M. H. Huang, S. Mao, and S. Mao, , Science, vol. 292, no. 5523, pp. 1897–1899. 2001.*
12. *T. Söderström et al., Proc. of SPIE Vol. 7603 PP B1-B12.2010.*
13. *M. Sathya, A. Claude, P. Govindasamy and K. Sudha. Advances in Applied Science Research, 3 (5):2591-2598. 2012.*
14. *Yeul D M. Thesis Submitted to SGBAU, 125 pp. 2017.*