EXPERIMENTAL STUDY ON THERMAL PERFORMANCE OF SOLAR ABSORBER WITH ZNO NANO STRUCTURE SELECTIVE COATING

G.Kannan[1], B.Deepak Senthilkumar[2], S.HariHaran[3], A.Karthik Raja[4], G.kavin[5]
Department of Mechanical Engineering, Nandha Engineering College, Erode, Tamilnadu, India, 638052.
Email id: gkannan11@gmail.com[1]

Abstract
Zinc oxide (ZnO) nano particles have been prepared by simple chemical method. The morphological analysis carried out on the annealed ZnO nano particles showed that the particles are nano structured in nature with grain size around 45 nm. The particles had porous in nature. The porous nature has been confirmed using XRD method. The SEM images of ZnO particles show that the particles have highly spongy structure. The band gap energy has been identified in between in the range of 2.98 to 2.69 eV. Prepared ZnO nano particles are used to coating on solar panels. The results compared the efficiency of IV characteristics of ZnO nano particles coated solar panels with non-coated solar panels. Based on this comparison of solar cells, ZnO nano particles coated solar panels confirmed higher power conversion efficiency.
Keywords: Zinc oxide, nanoparticles, temperature and solar panels.

1. Introduction

In the last three decades the most of the research are going on in the field of solar energy. Comparing all other researches, solar panel is important. From the categorization of solar panels, the nano coated solar panels having the ways of charges are separated [1]. Nano coated solar panels are hopeful cheap and environmental approachable. These solar panels are malleable more band gap semi conductor oxide are covered in the both two glass electrode [2]. The most outstanding experiential capability semiconductor material is ZnO nano particles. In this Zinc oxide solar panels are used to give a more surface area for corridor the light absorption [4].

Nowadays the ZnO nano particles research expose that it have high charge carrier mobility which can be used more exclusively for electrochemical applications [5]. In advance it can be used as photo absorber in solar panels [6]. ZnO nano particle plays a very important role as an absorber in the solar photoconductivity, since its band gap is within the range of solar spectrum [7-10].

In our research we prepared Zinc Oxide (ZnO) nano particles by solvo thermal method. The prepared nano particles are annealed at 140ºC. All samples are used to characterize with different analysis. Prepared ZnO nano particles are used to coating on solar panels. The results compared the efficiency of IV characteristics of ZnO nano particles coated solar panels with non-coated solar panels. Based on this comparison of solar cells, ZnO nano particles coated solar panels confirmed higher power conversion efficiency.

2. Experimental

Zinc acetate dehydrate was in use as a parent materials to prepare ZnO nano particles. Solvo thermal method is used. 5 grams of Zinc acetate dehydrate were mixed with 60 ml ethanol. The solution is stirred with 48 hours continuously. Then the solution of potassium hydroxide (2.5 gram) and 25ml distilled water is slowly added with the above zinc acetate solution. Now the solution is frequently stirred for 7 hours. After 7 hours the solution is perverted into semi solid form and the blue based white solution is formed. The color indicated the ZnO. And the solution is used to

dry at 50 to 70 ºC. Finally the solution is tatty to centrifuged and washed. The ZnO nano particles are annealed at 140°C.

The paste for coating was prepared using ZnO nano particles. The paste was formed by mixing of 0.6 gram of ZnO nano particles with a mixture solution (10 gram of α-terpineol, 2 gram of cellulose, and 30 ml of ethanol, which was solicited for 24 hours at 1,600 Wcm^{-2}). This paste were used as coating materials on a FTO conducting glass plate (Hartford FTO, approximately 30Ω cm^{-2}, 80 % transmittance in visible region) using the doctor blade technique. The prepared films were annealed at 140°C for 60 min.

3. Result and Discussion

3.1 XRD analysis

The structural analysis was conceded by X-ray diffraction pattern has been consider the phase of prepared ZnO nano particles. The X-ray diffraction pattern of ZnO nano particles annealed at 140ºC is shown in figure.

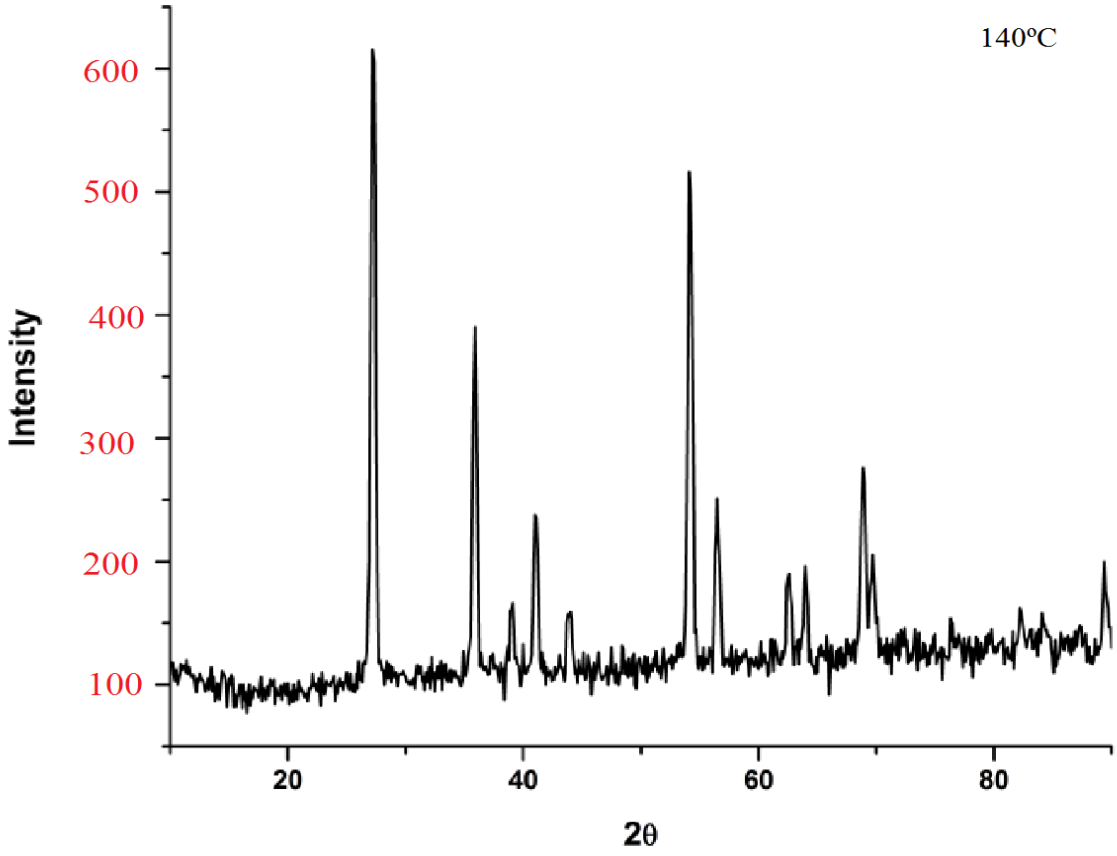

Figure 1. XRD patterns for ZnO nano particles

From this XRD analysis shows that the crystal structure made up of a accurate micro structure. In this XRD, the ZnO nano particles annealed at 140°C are shown in figure1. The characteristics peaks of observed at 2ɵ value 28.2, 36.42, 42.22, 54.12, 58.35 and 69.81 respectively. The main peaks of the 2Ɵ value of 28.2 and 54.12 also and are recognized for temperature T=140°C. In this XRD patterns synchronized with triclinic ZnO nano particles. The slow peripheral of different peaks as one go from temperature T=140°C. The results show that in the growth of nano structure model, detailed planes of the growth are magnified by the doping temperature. The oxide cell defenses are nano crystalline because the peaks are sensibly broad and difficult concentration. The average particles size is found is 45.4 nm.

Table 1: 2θ, d spacing, relative intensity and average particle size of the ZnO nano particles at 140°C.

Temperature (°C)	2θ (degree)	d - spacing (Å)	Relative intensity %	D (nm)	Average particle size (nm)
140	28.2	3.85	100	38.0	45.4
	36.42	4.56	96.3	42.6	
	42.22	5.12	96.44	37.5	
	54.12	6.18	91.94	47.6	
	58.35	6.89	93.71	50.6	
	69.81	7.46	92.1	56.3	

3.2 Morphological analysis of ZnO nano particles

The surface morphology of ZnO nano particles at 140°C is found from SEM images and is shown in figure 2. From SEM images it is observed that ZnO nano particles are like spherical shape.

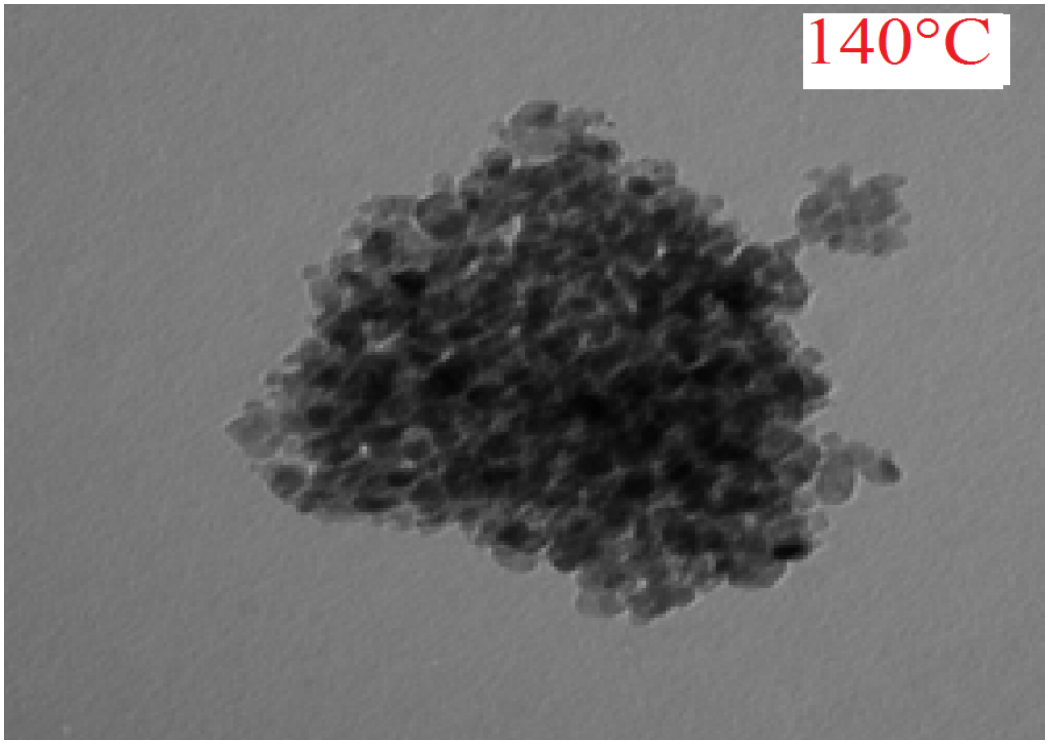

Figure 2. SEM image of ZnO nanoparticles

Figures 3 shows the scanning electron microscope (SEM) images of ZnO nano particles annealed at 140°C. The image is unlike and has a different morphology. From the image of SEM the average grain size is found as 45 nm and this is in good agreement with XRD result. The particle size increases with doping and increase in temperature. The copper element is found in small concentration which is consistent with the XRD patterns and SEM micrographs.

3.3 Optical absorption of ZnO nano particles

The optical absorption analysis of the Zinc Oxide (ZnO) nano particles were found by UV- visible spectroscopy and the results are

presented in figure. UV-Vis modify is worn to concluded the intensity of light momentary from beginning to end the sample (I), and compares it to the attentiveness of light before it passes through the sample (I0). The relation is called transmittance, and is frequently articulated as a percentage (%T). Here theoptical absorption spectra of the pure ZnO thin films calculated. The primary absorption boundary was realistic for colliding photon wave length of about 280 nm with a wideabsorption band roughly 340 nm.

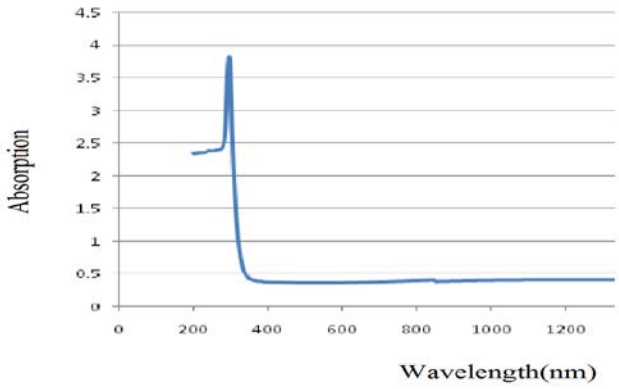

Fig 3.UV analyses for ZnO nano particles

The nano particles prepared at 250°C shows the elevated optical absorption without significant wide band transmittance. The initiation positions of light absorption for all particles were found to be nearly associated because of very change in particle size of the materials with annealing temperature as was analyzed by XRD study. However,this tiny transform of the crystalline size was reflected on the UV-Visiblespectra in the electorate of 390 nm to 360 nm wavelengths with red modifyabsorption wavelength. The results in this analysis are good conventionalitywith earlier researches. The average band gap of the ZnO thin films was found to be 2.85 eV in conformity with earlier studies.

3.4 **Comparison of solar panel with and without ZnO nano coating**

The prepared ZnO nano powders are coated with the solar panel. Then ZnO nano coating panel and without coating panel are placed in sun light and noted the current and voltage values using multi meter with different time interval. Used that values we drawn a graph IV characteristics curve. Based on this comparison of solar cells, ZnO nano particles coated solar panels confirmed higher power conversion efficiency.

S.No	TIME	WITHOUT COATING		WITH COATING	
		Current (I) Ampere	Voltage (V) Volt	Current (I) Ampere	Voltage (V) Volt
1	11.30 AM	0.02	5.28	0.04	5.50
2	12.00 PM	0.04	5.48	0.04	5.51
3	12.30 PM	0.08	5.61	0.09	5.53
4	1.00 PM	0.10	5.65	0.13	5.59
5	1.30 PM	0.16	5.67	0.19	5.62

Table 2: IV values for with and without ZnO nano coated solar panels

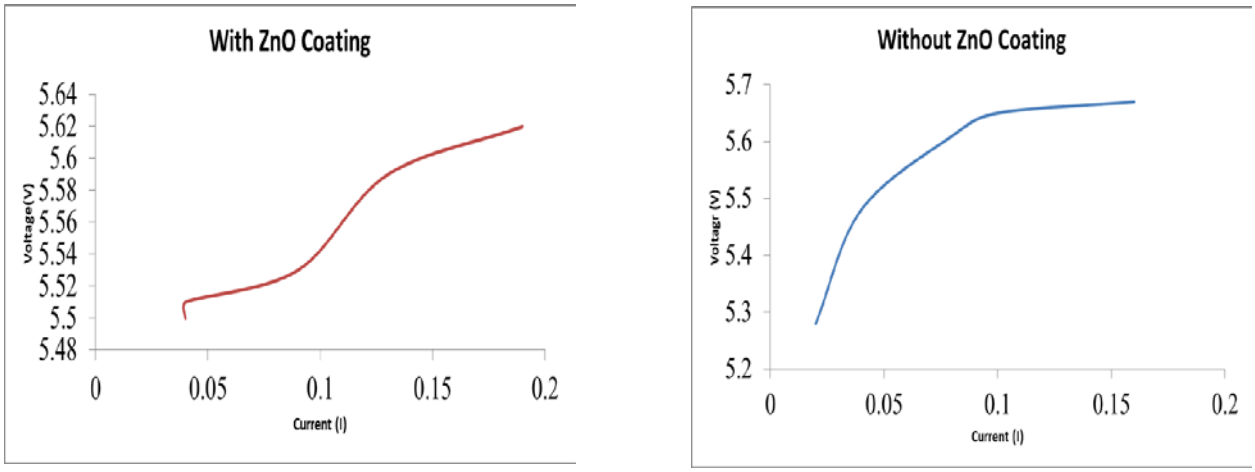

Figure 4. IV curves for with and without ZnO nano coated solar panels

7.4 Conclusion

ZnO nano particles were synthesized by using simple chemical method. From the XRD investigation we established the formation of ZnO nano particles. TEM and EDAX exposed that the surface morphology of the prepared nano particles. The optical absorption of the prepared ZnO nano particles was found the band gap is 2.85 eV. The prepared ZnO nano particles are used to coating on solar panels. We compared the efficiency of IV characteristics of ZnO nano particles coated solar panels with non-coated solar panels. Based on this comparison of solar cells, ZnO nano particles coated solar
panels confirmed higher power conversion efficiency.

References

1. Anesh, P, Vanaja, K, Jayaraj, M, "Synthesis of ZnO nano particles by hydrothermal method", Nano photnic Materials IV, Vol. 6639, pp.66390J-1-9, (2007).
2. Prabhu N, Agilan S, Muthukumarasamy N and Senthil, TS, Journal of materials science, materials in electronics, Vol.25, 5288-5295, (2014).
3. Depa Rani, T, Tamilarasan, K, Thangaraj, K, Elangov Elamurugu, . Ramamurthi ,K, Lela, S, "Structural and optical propeties of Nd doped zinc oxide thin films deposited by spray pyrolysis", Optik, Vol. 127 , pp.72–75, (2016).
4. Hossain, M, Biswas, S., Takahashi, T., Kubta, Y., Fujihima, A. "Investigation of sputter-deposited TiO_2 thin film for the fabrication of dye-sensitized solar cells", Thin Solid Films, Vol.516, pp. 7149–7154, 2008.
5. Prabhu N, Agilan S, Muthukumarasamy N and Senthil, TS, "Preparation and Characterizations of Copper doped WO_3 Nanoparticles Prepared by Solvo Thermal cum Chemical method" International journal of chemtech research, Vol.6, No.7, pp. 3487-3492, 2015.
6. Seok-Min Yong, Tsvetkov Nikolay, Byung Tae Ahn, Do Kyung Kim, "One-dimensional WO_3 nanorods as photoelectrodes for dye-sensitized solar cells", Journal of Alloys and Compounds 547 (2013) 113-117.
7. Chandra. S.R., Govindraj, A. and Rao, C.N.R., "High-sensitivity hydrocarbon sensors based on tungsten oxide nanowires". J. Mater. Chem., Vol.16, pp. 3936, (2006).
8. Kamellia N, Zolfaghar Rezvani , Rafat Pakizevand, "Synthesis of ZnO Nanoparticles and Investigation of the Ionic Template Effect on Their Size andShape", International Nano Letters, Vol. 1, No. 2, pp. 75-81, (2011).
9. Nithya, N and Rugmini Radhakrishnan, S, "Effect of Thickness on the Properties ZnO Thin Films", Advances in Applied Science Research, Vol. 3, No.6, pp.4041-4047, 2012.
10. Ravindra PS, Vineet KS, Raghvendra SY, Prashant KS, Prashant KS, Avinash CP, " Biological approach of zinc oxide nano particles formation and its characterization", Advanced Materials Letters, , Vol. **2**, No.4, pp. 313-317, (2011).