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Zno Thin films as an Anti-Reflection Coating on Solar Cells

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Abstract: Zno thin films are prepared by sol-gel method using zinc acetate dehydrate $[Zn(CH_3CO_2)_2 \cdot 2H_2O]$ and isopropanol. Diethanol amine is added as a stabilizer. The solution was stirred for 90min at 600°C using sol-gel. The thin films are fabricated on glass substrates at different durations at 40sec, 50sec & 60sec by adjusting the speed at 3000RPM. The films showed a bandgap of 3.49 to 3.64eV corresponding to speed and durations of spin coater.

I. INTRODUCTION

A solar cell is a device which converts the energy from sun into electrical energy. Silicon is a semiconductor optical material with relatively index. It is an ideal material for solar cells. When the light is incident on a solar cell about 35% of the incident light is reflected back. In general, the optical losses account for about 7% efficiency loss in crystalline silicon solar cells.

The anti-reflection coating on the solar cell reduces the optical losses such as reflectance and increase the efficiency. The bandgap determines the wavelength at which photovoltaics operate more efficiently. Generally we use wide bandgap semiconductor materials as an anti-reflection coating on the solar cells. In this work we will see how ZnO can be used as an anti-reflection coating on the solar cells.

II. EXPERIMENTAL DETAILS

A. Materials Required

4g Zinc acetate dehydrate, 50ml isopropanol, 4ml diethanolamine

B. Sol-gel Method

- 1) Synthesis of ZnO solution: Initially, 4 g of "Zinc acetate dehydrates" in the 50 ml of "isopropanol". Then this solution was stirred with the help of magnetic stirrer at 60°C for 30 min. After that the "diethanolamine" as a stabilizer was added in this solution and stirred the solution for 90 min at the temperature of 60°C. The clear homogeneous solution of ZnO was obtained by aging this solution for 24 h.
- 2) Coating of ZnO precursor solution on substrate: Now the glass substrate is fixed on spin coating system and its disc speed is adjusted at 3000 rotation/min. The rotation time is 30 s per sample. The drops of sol-gel solution are dropped on the glass substrate as per requirement of layers. After 30 s, the glass substrate is removed from spin coating disc and placed on the hot plate for almost 10 min to dry at 100°C. The experiment is repeated to make thin films with multilayer. The thin films are put in furnace and the temperature is raised gradually until the temperature reached 400°C. Then the furnace is switched off and each sample is left to cool down until it reaches room temperature. Then samples are taken from the furnace and now they are ready to analyze.

III. RESULTS AND DISCUSSIONS

A. Thin Film Thickness Measurement system

The thin film thickness measurement was done on glass slide coated with ZnO and the thickness of the coating is measured. The table below shows the values of thickness of the coating deposited on the glass surface at different speeds and duration.

Speed	Wavelength	Thickness
40s	408 nm	79.66 nm
50s	420 nm	84.41 nm
60s	400 nm	78.36 nm

Table 1: Thickness of Samples at different speeds.

B. UV-VIS-NIR Spectroscopy

The UV-VIS-NIR Spectroscopy was carried out on the ZnO coated glass slide and the values of the wavelength at which the absorption peak occurred has been noted. The bond gaps were also calculated for the same by using the formula. $E = hc/\lambda$ Where E =band gap, h =Planck's constant, λ =wavelength at which the absorption occurred.

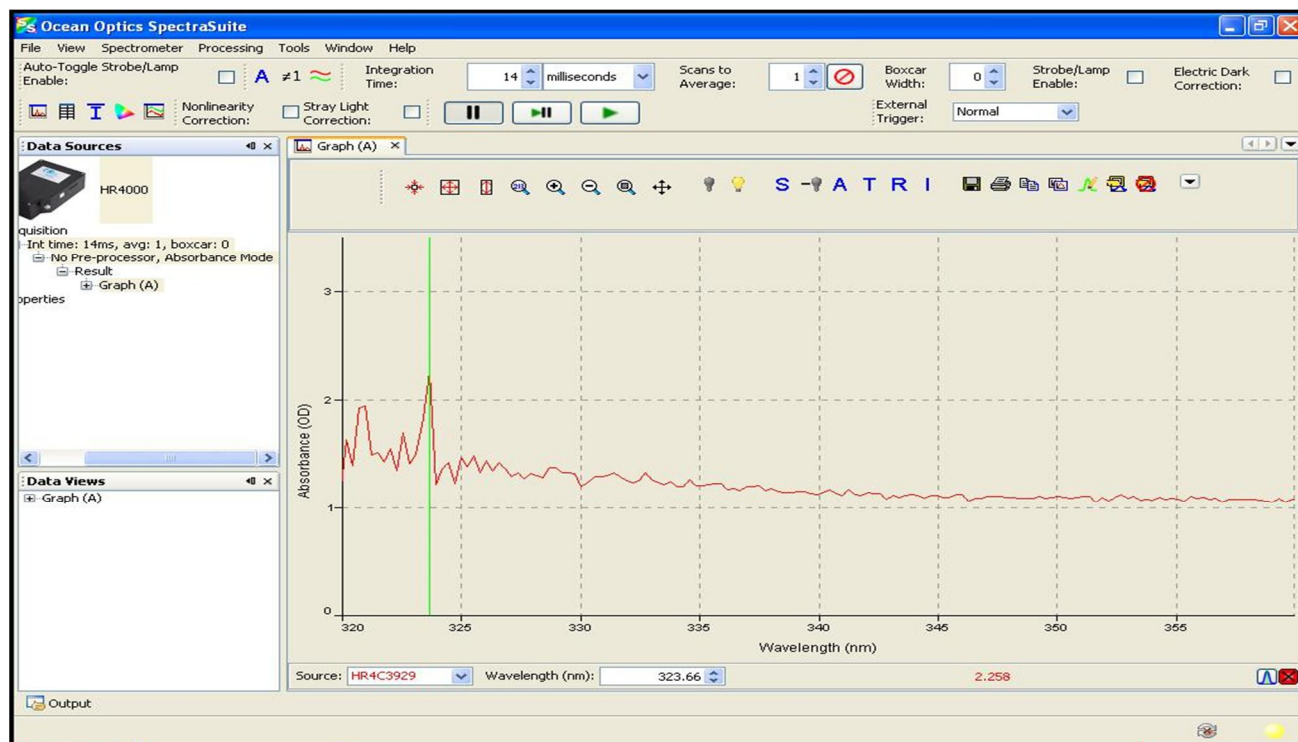


FIG 1 : graph at 60sec, 3000RPM

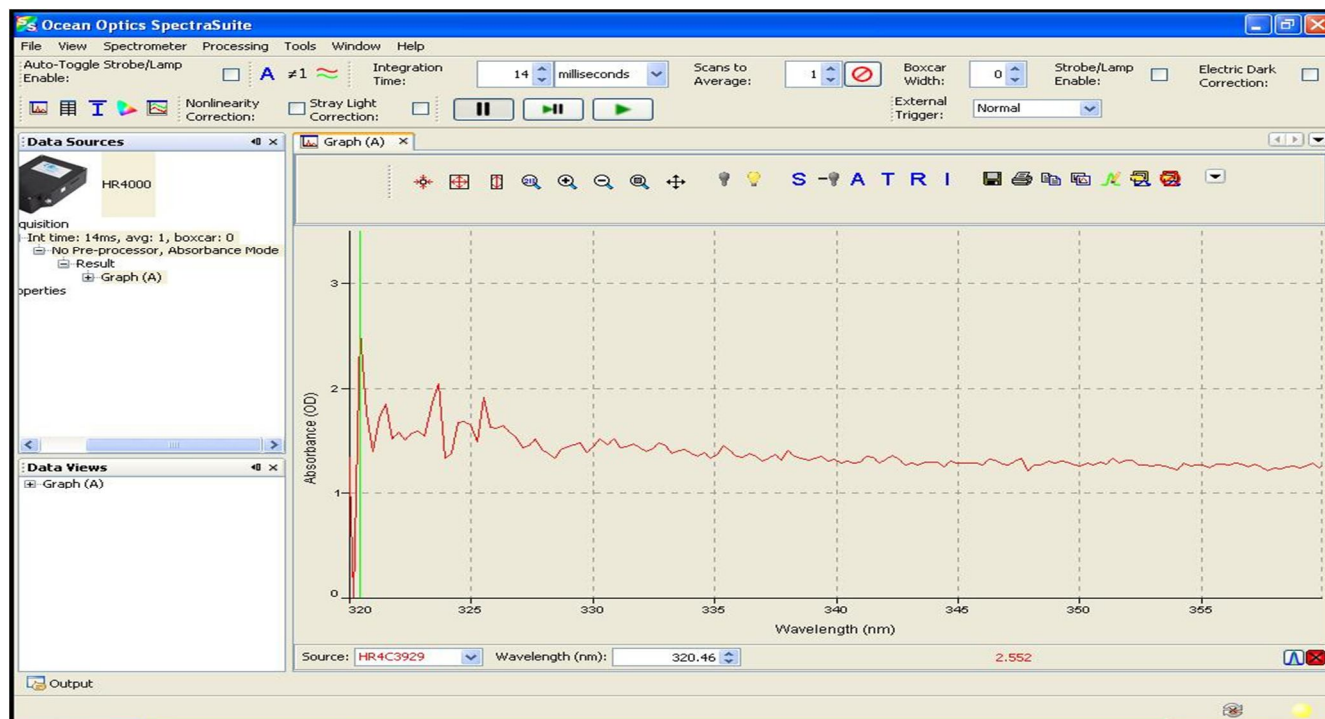


FIG 2 : graph at 50sec, 3000RPM

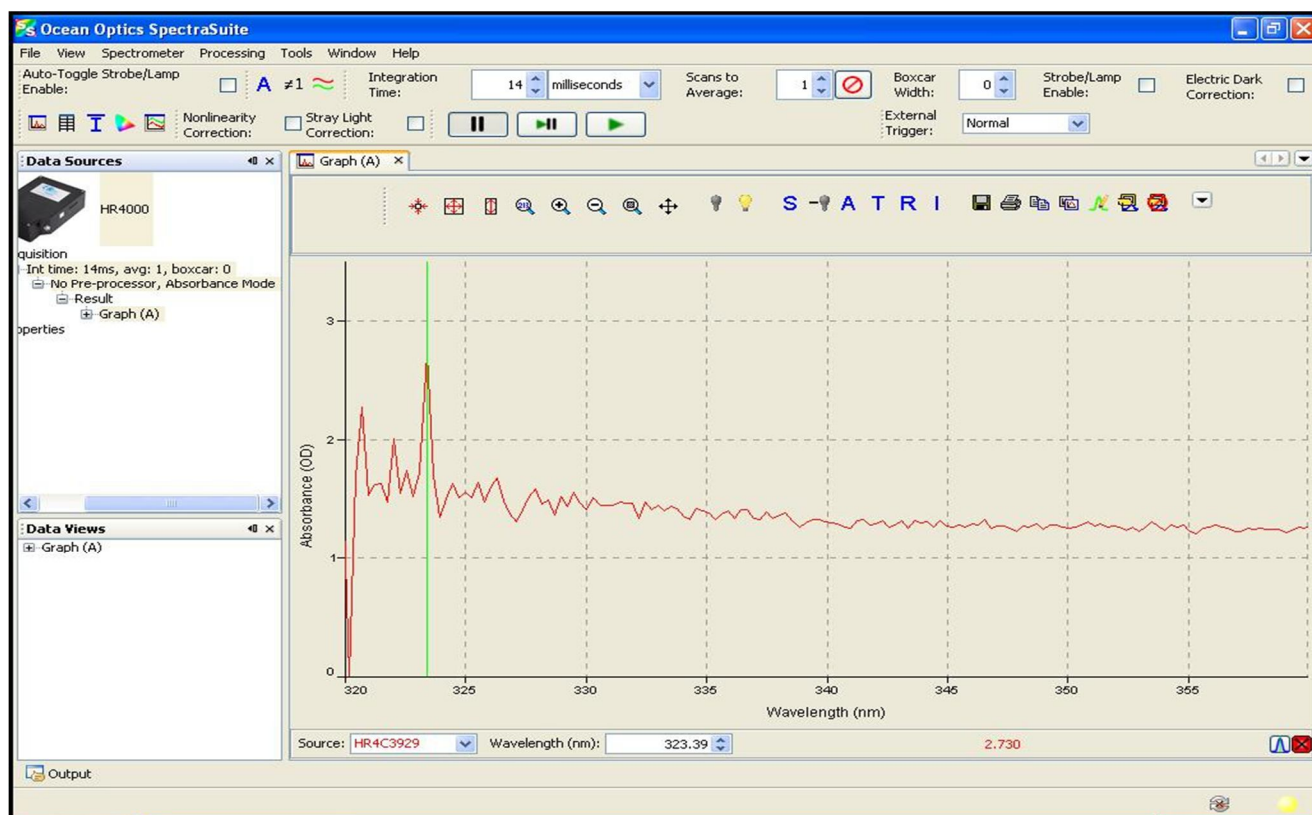
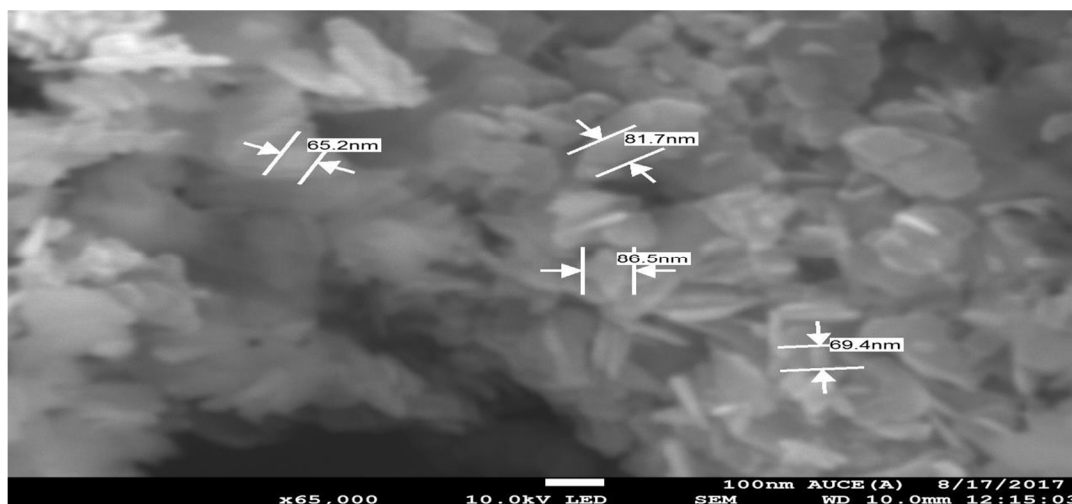


FIG 3 : graph at 40sec, 3000RPM

Duration	Wavelength	Bandgap
40s	340.79	3.645ev
50s	341.53	3.630ev
60s	354.83	3.49ev

C. FESEM Result



FESEM image of ZnO

IV. CONCLUSION

Zno thin films were fabricated by using sol-gel spin coating method at 400°C for different speeds such as 3000RPM and durations of 40sec, 50sec, 60sec. The thickness of the film is measured using thin film measurement system. The thickness was found to be in the range of 84.41 nm to 78.36 nm. The UV-VIS-NIR Spectroscopy was done and band widths were in the range of 3.41 to 3.645. The FESEM characterizations are also done. Hence we can conclude that due to the wide optical band gap and low absorption i.e high transmittance in the visible region the ZnO can be used as an anti reflection coating application for the photovoltaics.

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