RESEARCH ARTICLE OPEN ACCESS

Synthesis, Characterization and Optical Properties of ZnSe Thin Films.

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ABSTRACT:
ZnSe thin films were prepared by pulsed electrodeposition technique over stainless steel substrates in galvanostatics mode from an aqueous acidic bath containing $ZnSO_4$ and SeO_2. The growth kinetics of the film was studied and the deposition parameters such as electrolyte bath concentration, deposition time, current density and pH of bath are optimized. The X-ray Diffraction (XRD) and electron dispersive spectra (EDS) analysis of the deposited film showed presence of polycrystalline nature. The surface morphology studied by Scanning Electron Microscope (SEM) shows that the deposited films are well adherent and grains are uniformly distributed over the surface of substrate.

Keywords: Electrodeposition, SEM XRD, EDS, ZnSe

Date of Submission: 23-10-2017 Date of acceptance: 04-11-2017

I. INTRODUCTION

Thin films are studied with interest due to their applications in the fields of engineering and science like semiconductor and photovoltaic devices, metallurgical coating, surface morphology testing techniques in engineering etc. Thin film technology is aggressively developing technique due to its wide scope of applications. Use of photo electrochemical solar cells causes large amount of research in thin film polycrystalline materials with acceptable efficiency.[1-4]

The wide band gap zinc selenide (ZnSe) is the promising material for optoelectronic semiconducting technology in the blue region of the visible spectrum. Interest in the use of photo electrochemical (PEC) solar cells for low-cost energy conversion has led to an extensive research in thin film semiconducting materials[5-8].Chaparro et al. [9],Dhansekaran et al. [10],Murali et al. [11],Riveros et al. [12], carried out morphological and compositionalstudy on ZnSe thin films deposited by the electrochemical bath depositiontechnique. Scanning electron microscopy, transmission electron microscopy is used for morphological characterization, These are observed promising for PEC solar energyconversion. Such polycrystalline electrodes are economically desirable in photo voltaic applications. The survey shows that very few reports are available on photoelectricproperties of ZnSe thin films. Electrochemical photovoltaic performance of

ZnSephoto electrode and its analysis has not been reported in recent years.This survey also reveals that doping of impurities increases photoelectricproperties of ZnSe thin films.Hence we have focused on ZnSe polycrystalline thin films.The structural and optical properties of electrodeposited ZnSe thin films are reported. An attempt is made to prepare ZnSe thin films through electrodeposition technique on stainless steel substrate. This helped to study the characterization like structural, surface composition, surface morphology and optical properties.

II. METHODOLOGY AND MATERIAL FORMATION FOR THIN FILM

The thin film of ZnSe was pulsed electrodeposition on stainless steel substrate. The stainless steel substrates were used as the cathode in three electrodes cell with graphite as the counter electrode and saturated calomel electrode (SCE) was the reference electrode. The electrolyte was prepared by mixing solutions of $ZnSO_4$ (0.1M) andSeO_2 (0.1M) indouble distilled aqueous bath taken in equal proportion. The pH of electrolyte solution was maintained by using dilHCl. The substrates were cleaned in double distilled water. The distance between the electrodes was 1cm kept constant during deposition. The ZnSe film was observed well deposited on substrate. The detailed study of kinetic growth of film was studied by changing pH and deposition parameters.

III. RESULTS

For the determination of exact deposition potential, the polarization curve was plotted. The films were grown at the optimized potential of

1800mV with respect to SCE and at the current density1.7 mA/cm^2 where the film was found to be uniformly thick is shown in Fig1. When the electric field was applied between the counter and working electrode, a fine ZnSe thin film formation occurred on the surface of substrate. The film formation process is time dependent. For further study, the formed films are dried and preserved in desiccators. The current density is observed varying from 0.4to 5.3 mA/cm^2. At other deposition conditions other than 1.7mA/cm^2 the thickness of film was observed less.

The PEC cell in n-ZnSe / polysulphide /C is illuminated with 200W tungsten filament lamp. The photons having energy equal to or greater than the band gap energy of ZnSe are absorbed on semiconductor and the electron-hole pairs are generated. These electron hole pairs are separated by local electric field present across the interface between semiconductor and polysulphide electrolyte. It leads to the generation of photo voltage under open circuit condition. The variation of I_{sc} and $V_{oc}$is shown in Fig 2. It has been observed that the value of I_{sc} and V_{oc} are relatively higher at deposition time 50 min and at pH 1.5 and at optimum thickness of ZnSe thin film at this condition shown in Fig 3.The grown ZnSe film deposited at optimized preparation parameters was further characterized by X-ray diffraction (XRD) pattern is shown in Fig 4.

The XRD analysis reveals that film is polycrystalline and some sharp peaks are identified at (1 1 1), (2 2 0), (3 1 1) and (3 3 1) Planes of ZnSe. The standard 'd' values and observed 'd' values for ZnSe are matching with each other which are mentioned in Table 2. The elemental analysis was performed for the optimized ZnSe film deposited using electrodeposition technique. The obtained electron dispersive spectra (EDS) show the presence of both Zn and Se, which gives the qualitative confirmation of electrodeposition of ZnSe film which is shown in Fig5. This is an agreement with the structural analysis discussed above in XRD study. This confirms the material is ZnSe.

The surface morphology of ZnSe thin film was studied by SEM. The SEM micrograph shows well adherent, smooth film surface. The surface morphology of ZnSe film prepared under optimized condition exhibits grain of uniform size about 17^{o}A spread all over the surface shown in Fig6. Atomic composition observed is given in Table3.

IV. CONCLUSION

Stoichiometric ZnSe thin film formed by electrodeposition technique was taken from acidic bath. The film was developed at optimized pH and time is polycrystalline with cubic structure and the particle sizes are found to be 17^{o}A.

ACKNOWLEDGEMENT

Author would like to thank BCUD section SavitribaiPhule Pune University for providing financial assistance to complete minor research project.

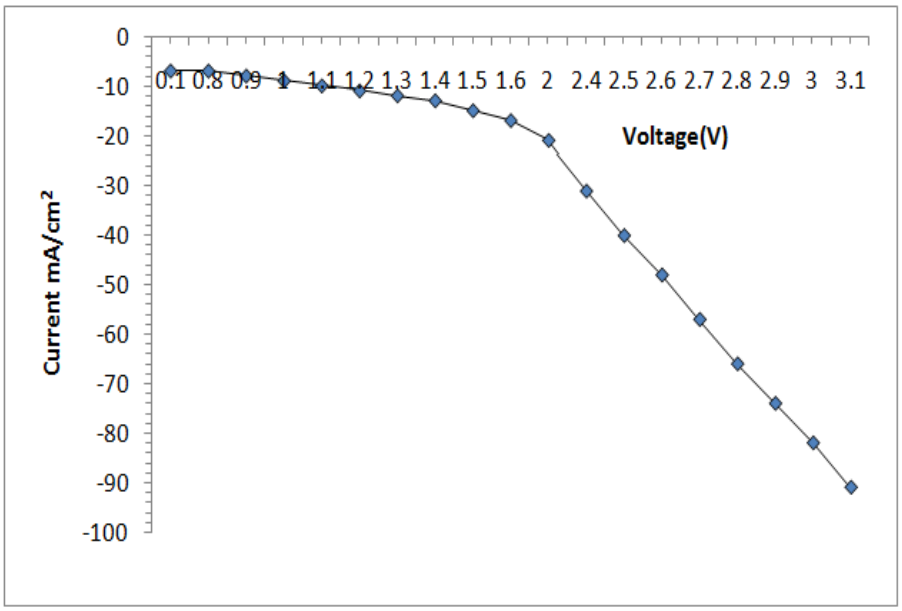

Fig 1: Optimization of deposition potential

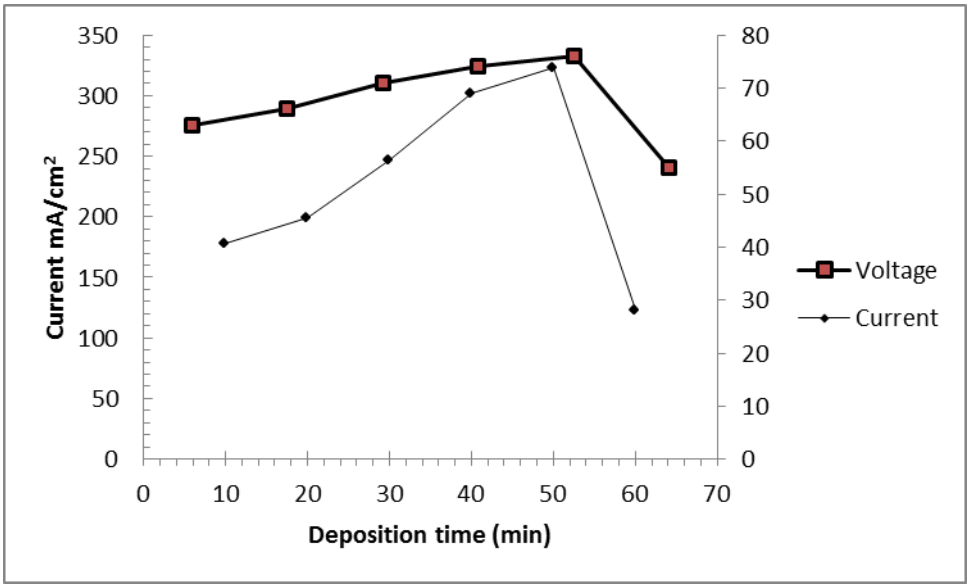

Fig 2.IscvsVoc reported for the film at pH 1.5

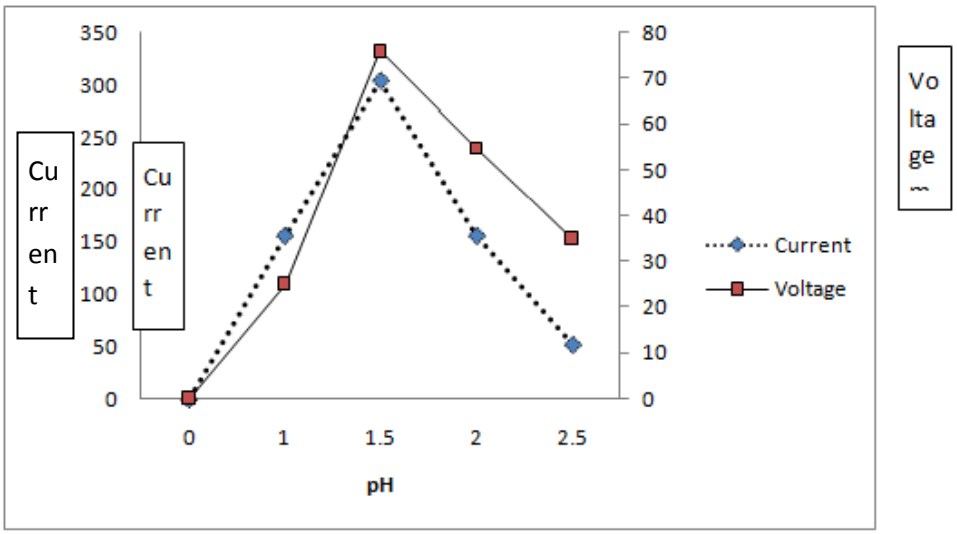

Fig 3A

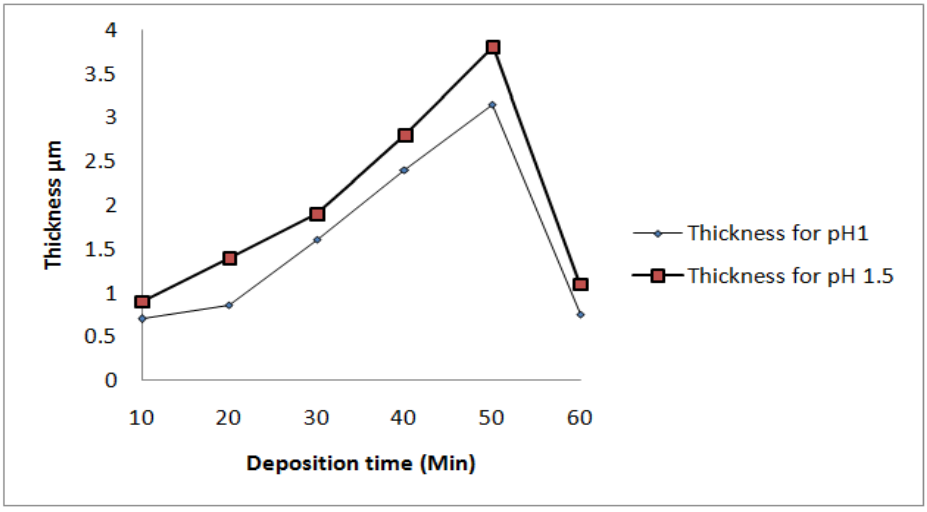

Fig 3B. Thickness of film at different pH

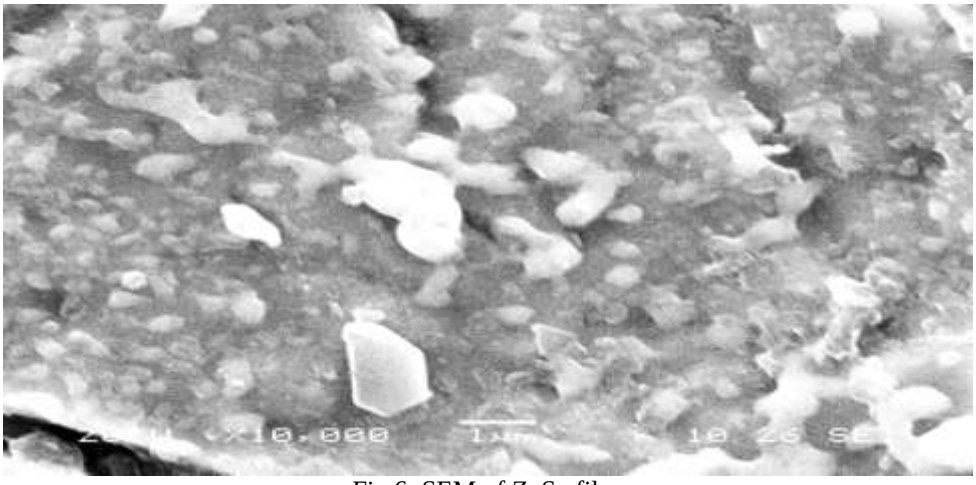

Fig 6: SEM of ZnSe film

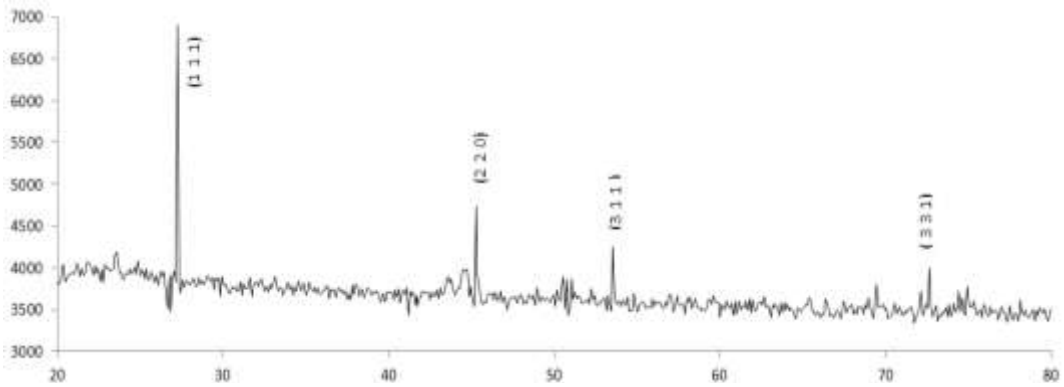

Fig 4 XRD

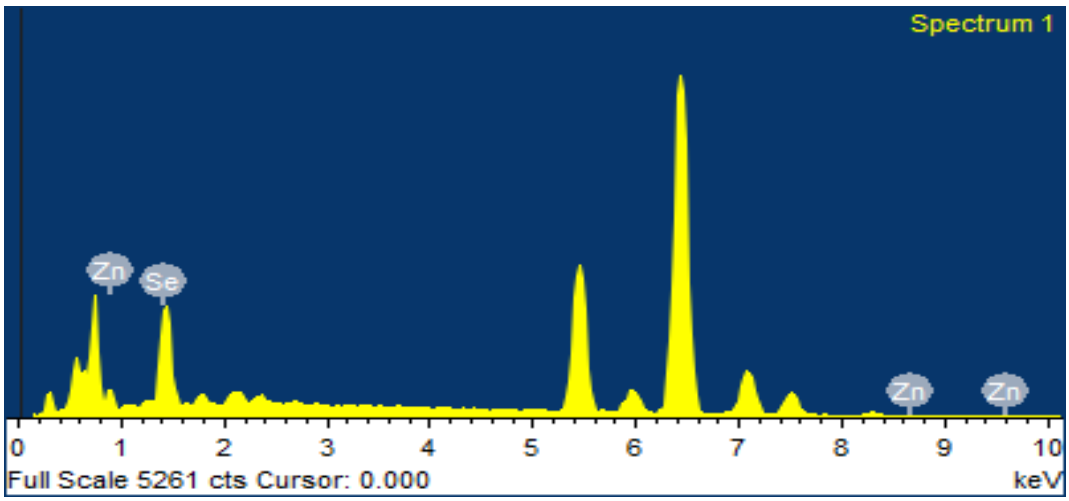

Fig 5. EDS

Table 1: Optimized parameters of ZnSe film

Sr No	Optimized Parameter	Values
1	Deposing potential	1.8V
2	Current Density	1.7mA/cm^2
3	Deposition time (min)	50
4	pH of both	1.5
5	Temperature of bath	50˚C

Table 2: Some Standard and observed values of 'd' for ZnSe film by using ASTM data

2 □	**Plane (hkl)**	**Standard 'd' A □**	**Observed 'd' A □**
27.26	1 1 1	3.27	3.17
45.20	2 2 0	2.004	2.15
53.57	3 1 1	1.708	1.800
72.63	3 3 1	1.300	1.43

Table 3: Atomic composition of Zn and Serecorded from EDS of ZnSe film

Sr No	**Element**	**Weight %**	**Atomic %**
1	Se	53.43	52.33
2	Zn	46.57	47.67
		Total = 100	100

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H. R. Kulkarni. "Synthesis, Characterization and Optical Properties of ZnSe Thin Films." International Journal of Engineering Research and Applications (IJERA) , vol. 7, no. 11, 2017, pp. 56-60.