Preparation and Characterization Iron doped Zinc Selenide Thin Film by Electrodeposition

G. M. Lohar, J. V. Thombare, S. K. Shinde, U. M. Chougale, V. J. Fulari *

Thin Film Physics and Holography Laboratory,
Department of Physics,
Shivaji University, Kolhapur.416 004, Maharashtra, India
**Corresponding author Tel.: +91 231 2609224, Fax: +91 231 2690533*
E-mail address: vijayfulari@gmail.com

ABSTRACT

In the present investigation, results on preparation and characterization of iron doped zinc selenide thin film by Electrodeposition. Thin film where deposited by galvanostatically as well as potentiostatically from an aqueous solution onto stainless steel substrate and ITO (indium tin oxide). For zinc selenide, we use precursor zinc sulphate ($ZnSO_4$) and selenium dioxide (SeO_2) and ferrous sulphate ($FeSO_4$). Further the deposited films were characterized by different physico-chemical characterization such as, for structural study X-ray diffraction study was used, optical absorption study was made by UV spectrometer and it showed that the semiconductor nature of the electrodeposited zinc selenide thin film. Reflectance study was made by using Steller Net. Inc. USA Reflectometer. Zinc selenide shows band gap ~2.6 eV.

Keywords: Iron doped zinc selenide, Galvanostatically, X-ray diffraction, etc

Introduction

Binary Semiconductors are considered important technological materials because of their potential application in optoelectronics devices, solar cell IR detector and laser [1]. Zinc selenide is well known II-VI semiconductor. The band gap of zinc selenide is 2.7 eV [2]. The numbers of methods are used in the formation of ZnSe thin film, including atomic epitaxy [3] molecular beam epitaxy [4] chemical vapor deposition [5] etc. Now a day's electrodeposition has emerged as simple economical, low temperature, valuable technique, which could produce film of good quality for device application [6] that's why electrodeposition is very useful technique for deposition of metal chalcogenide such as ZnSe thin film. Already many researchers explain potentiostatically deposited ZnSe thin films [7, 8].

In the present work, we are reported galvanostatically electrodeposited ZnSe thin films on the indium doped tin oxide (ITO) and steel substrates. Then deposited thin films are characterized using X-ray diffraction spectroscopy (XRD), Uv- Vis Spectroscopy and Reflection Spectroscopy.

Experimental

All chemicals employed in this work were analytical grade. The zinc selenide (ZnSe) thin films were grown by electrodeposition technique in the electrolytic bath containing 0.25M ZnSO4, 0.001M SeO2 in an aqueous solution. The pH was adjusted between 2-2.5 by adding sulphuric acid. The films were deposited on stainless steel as well as ITO coated glass substrate by galvanostatic mode of electrodeposition by applying constant current density 70μA/cm2 for various deposition times such as 30 min, 60 min, 90 min and 120 min etc. A stainless steel substrate was used as a working electrode. The bath temperature was maintained at 65oC by using thermostat.

X-ray diffraction

XRD patterns are recorded for ZnSe and 1% Fe doped ZnSe thin film which is shown in figure 1, however, to low selenious acid concentration turn out in longer deposition time and in poor quality of thin film, the deposition time is 1.5 hour and the thickness of the thin film is about 2800 A°, therefore the intensity of the XRD pattern is very week x-ray diffraction pattern shows peak at 25.58°, 29.16°, 73.99°, 81.58° and 89.99° and it shows the hexagonal structure. The observed D values are good agreement with JCPDS card number 01-089-

2940.The particle size (D) is calculated using Scherer's formula, $$D = \frac{0.9\lambda}{\beta \cos\theta}$$

Where, β is the full width at half maxima, D is the particle size; θ is the angle between the incident and the scattered x-ray. The observed particle size was 57.51 nm.

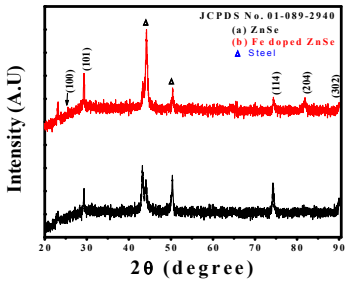

Figure 2 XRD pattern of ZnSe and Fe doped ZnSe thin film

Optical absorption

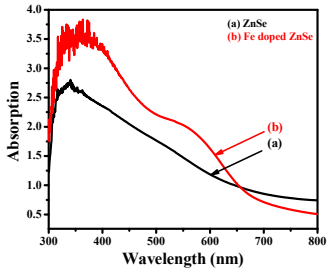

Fig 2 Absorption of ZnSe and Fe doped ZnSe thin film

The optical absorption spectra of ZnSe and Fe doped ZnSe shown in fig 2. The bulk band gap of ZnSe is 2.7eV. In case of ZnSe and Fe doped ZnSe absorption edge at 365nm and after adding of 1% Fe in ZnSe the absorption was increased and we observed absorption at 386nm. Absorption is increased because of Fe impurities in ZnSe; Fe is responsible for increase the conductivity and absorption.

Reflectance

The reflectance spectra of the electrosynthesized ZnSe thin film were recorded in the spectral region 300 - 850 nm which is shown in figure 3. Fe doped ZnSe thin film shows more reflection than the as it it is ZnSe thin film. The diffused reflectance spectra will increase some light scattering effect and this light scattering effect is responsible for high photocurrent that's why study of reflectance spectra is important. Electrodeposited ZnSe thin film shows the 18 % reflectance and after Fe doping it shows the 28 % reflectance.

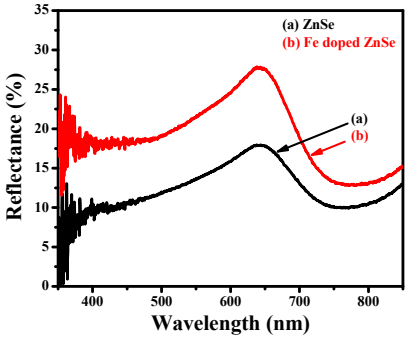

Fig 3 reflectance of ZnSe and Fe doped ZnSe thin film

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