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Growth And Characterization Of Pbse Thin Films By Chemical Bath Deposition Technique

Dr. Harishchandra K. Sadekar
Department of Physics, Arts, Commerce and Science College, Sonai, India (MS)-414105

Abstract

Lead selenide (PbSe) thin films were deposited on amorphous glass substrates through Chemical Bath technique at the bath temperature 80° C. The deposition parameters were optimized to obtain good quality thin films. Structural, surface morphology and optical properties of thin films were characterized by X-ray diffraction, scanning electron microscopy and UV-VIS spectrophotometer respectively. X-ray diffraction data showed that the films were polycrystalline and cubic in structure. SEM micrograph showed that the uniform deposition of PbSe on glass substrates with regular shaped grains. Optical absorption study showed that the high absorption in the visible region and the optical band gap value was determined to be 1.2 eV.

Keywords: Chemical bath deposition; Structural properties; Optical properties.

1. Introduction

PbSe is a IV–VI narrow direct band gap semiconductor. It exhibits the cubic structure with face centered phase and space group. It exhibits strong quantum size effects below Bohr radius of 46 nm. High conversion efficiency if we use as a Absorber. PbSe, due to its narrow band gap, used to produce photoresistors, photodetectors, solar cell and photo emitters in the IR range. The PbSe thin films attract attention of many researchers because they are cheap, abundant and they posses semiconducting properties.

Variety of methods have been employed in the fabrication of high quality PbSe thin films such as electrochemical deposition [1], magnetron-sputtering [2], successive ionic layer adsorption and reaction (SILAR) [3], molecular beam epitaxy (MBE) [4], thermally evaporation [5], chemical bath deposition (CBD) [6-8] etc. CBD is advantageous technique because it is low cost, low temperature operated and no costly instrumentations are required. In this technique, substrates are immersed in an alkaline solution containing the chalcogenide source, the metal ion, added base and complexing agent. Furthermore, in CBD controlled chemical reactions play important role during the deposition of thin film and the rate of deposition can be controlled by adjusting the parameters like bath temperature, pH of solution, stirring rate, immersion time and relative concentration of solutions in the bath. This paper reports the structural, optical, and surface morphological properties of PbSe thin films.

2. Experimental

PbSe thin films were deposited on commercially available glass slides with a size of 75 mm × 25 mm × 2 mm by chemical bath deposition technique. Substrates were cleaned by using chromic acid, soap solution and deionized water. Chemicals used for the deposition were lead acetate, sodium hydroxide, and sodium selenosulphate. A solution of sodium selenosulphate was prepared by refluxing 100 ml of 0.4M sodium sulphite with selenium powder for about 8 hours. All chemicals are used AR grade.

Reaction bath contains 10 ml 0.4 $Pb(CH3COO)_2$, 10 ml freshly prepared solution of Na_2SeSo_3 in 100 ml beaker and the rest distilled water to make the volume to 50 ml. pH of solution was adjusted to 10 by 0.5 M sodium hydroxide. Well cleaned glass substrates were then immersed vertically into the deposition bath against the wall of the beaker containing the reaction mixture. The deposition was allowed to proceed at 80° C bath temperature for different time durations. After deposition, the glass microslides were taken out from the bath, washed with de-ionized water and was dried in air. Then films were characterized by XRD, SEM and optical by Spectrophotometer.

3. Results and discussions

3.1 X-Ray Diffraction

The structure of the film was studied by X-ray diffraction analysis. Figure 1 shows X-ray diffraction pattern of as-deposited PbSe thin film. The XRD pattern indicates that the film is polycrystalline in nature. The obtained peaks (111), (200), (220), (311), and (222) were compared with JCPDS diffraction patterns of JCPDS card 01-077-0245. The observed peaks indicate the formation of face centered cubic in nature. Crystallite size is determined by Scherrer formula [9] using FWHM. It is found to be near 43 nm.

$$B(2\theta) = \frac{0.94\lambda}{L\cos\theta} \quad (1)$$

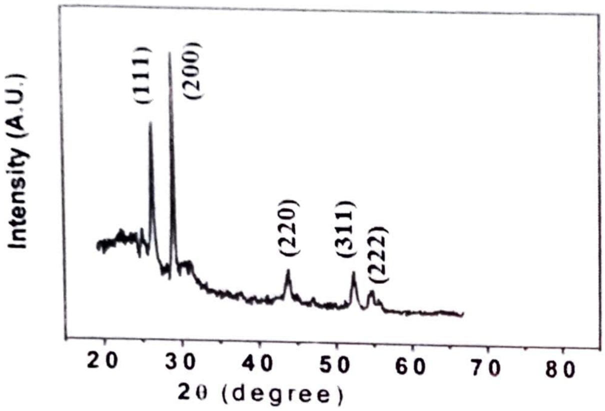

Figure 1: XRD pattern of PbSe thin film

3.2 Scanning Electron Microscopy (SEM)

Figure 2 shows the scanning electron microscopy micrograph of as-deposited PbSe thin film. It can be observed that the PbSe thin films are uniform and cover the substrate surface well. From the micrograph it is clear that the films were composed of a compact structure having single type of small densely packed micro crystals. The grains are cubic in shape and of almost similar size, which were uniformly distributed over a smooth homogeneous background.

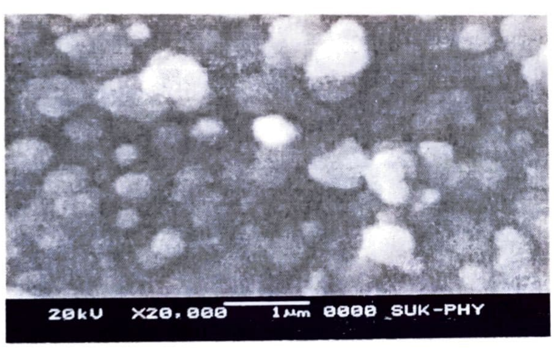

Figure 2: SEM image of PbSe thin film

3.3 Optical Study

Determination of the optical band gap is based on the photon induced electronic transition between the conduction band and the valance band. The relation between the absorption coefficient α and the incident photon energy (hν) can be written as [9],

(3)

where 'A' is constant, n= ½ for direct allowed transition, 'Eg' is optical band gap of the material. Figure 3 shows the plot of (αhν)2 against (hν) for PbSe thin film derived from the optical spectra. Extrapolating the straight-line portion of the plot of $(\alpha h\nu)^2$ vs (hν) for zero absorption coefficient value gives the band gap, which is found to be 1.2 eV at room temperature (RT).

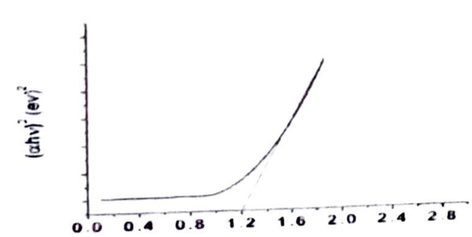

Figure 3: Plot of $(\alpha h\nu)^2$ versus hν PbSe thin film

4. Conclusion

Thin films of PbSe have been successfully deposited by chemical bath deposition technique. Polycrystalline face centered cubic nature was predicted from X-ray diffraction studies. Scanning electron microscopy study revealed uniform deposition on glass substrates. Optical study revealed that the energy bandgap is predicted as 1.2 eV.

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References

[1] Liana Anicai, Ion Sin, et al, Applied Surface Science, **475**(2019), 803-812.
[2] WenrancFeng, Jiali Song, et al, Physica E: Low-dimensional Systems and Nanostructures, **102**(2018), 153-159
[3] K.C.Preetha, T.L.Remadevi, Materials Science in Semiconductor Processing, **39**(2015), 178-187
[4] S.Chusnutdinow, M.Szot, et al, Journal of Crystal Growth, **507**(2019), 10-15.
[5] WenranFeng, HaiZhou, FeiChen, Vacuum, **114**(2015), 82-85
[6] WenranFeng[a]JialiSong, Journal of Alloys and Compounds, **770**(2019), 649-654
[7] Sharmistha Anwar, Shahid Anwar, Barada, Kanta Mishra, Materials Science in Semiconductor Processing, **40**(2015), 910-916.
[8] Fekadu Gashaw Hone, Francis Kofi Ampong, Materials Chemistry and Physics, **183**(2016), 320-325
[9] Md. Tanweer Ashraf, Numan A. Salah, et al, Thin Solid Films, 612 (2016) 109–115.