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Chemical Bath Deposition Method for Synthesized Nano crystalline Pb S thin films

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Abstract- Nano crystalline PBS thin films were prepared by chemical bath deposition (CBD) method by varying synthesis temperatures. The influence of the synthesis temperature of lead acetates on the structure and morphological properties of PBS nanostructures were investigated respectively. The X-ray diffraction (XRD) patterns of the PbS nanostructures correspond to the various planes of a single phase cubic PbS. It was observed that decrease in the synthesis temperature resulted into extra diffraction peaks due to the presence of the impurity phases. The morphological properties of the films are determined by scanning electron microscopy.

Keywords: - Nano crystalline PbS , Chemical bath deposit, XRD, SEM, Thin Film, Chemical bath deposition.

I. INTRODUCTION

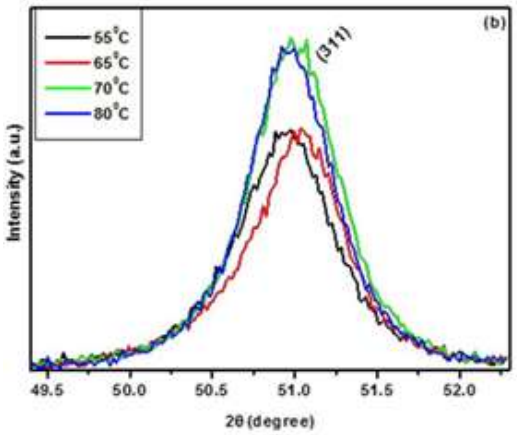
In recent years, the development of the semiconductor nanostructured materials has grown very rapidly[1]. This is due to their wide application in the area of solar cells, optoelectronic devices, photoconductors, sensor and infrared detector devices[2]. Consequently, the synthesis of PbS Nano crystals with different morphologies and the corresponding effects on material properties is of great importance in the field of light emitting diodes, infrared-related applications. We have selected the CBD method owing to its many advantages such as low cost, large area production and capable of yielding good quality thin films. The aim of this paper is to investigate the effect of synthesis temperature and molar concentration of lead acetate on the structure, morphology and optical properties of PbS nanoparticles prepared by CBD method.

II. EXPERIMENTAL DETAILS

Nano crystalline PbS thin films were deposited on glass substrates by CBD method. The substrates were very carefully cleaned using an oxidant mixture ($K_2Cr_2O_7$: H_2SO_4 -1:10, HNO_3, 1% EDTA) and were then thoroughly rinsed with distilled water before deposition. The cleaning of the substrate is of crucial importance for the quality of the film formation. The deposition bath contains a mixture of matrix solution and thiourea. The chemical bath solution was prepared as follows: 60 ml of lead acetate, thiourea, sodium hydroxide and along with 2% of PVA solution. The amount of solutions of lead acetate, thiourea and PVA was held constant at ratio of 1:1:1. Each mixture was continuous stirred for 10 minutes by varying the synthesizing temperature at 55, 65, 70 and 80^{0}C respectively. The pH of the solution was maintained at around 10.5 by slowly adding NaOH solution drop by drop. The substrates were kept in the solution for 26 h for deposition of PbS. After deposition of the films, substrate were taken out and thoroughly washed in doubly distilled water and then dried in air. Structural characteristics of the films were determined by X-ray diffraction (XRD) method using Philips X-pert pro diffractometer (PW 1830) at room temperature with CuKα radiation. Grain size of the films was also determined by scanning electron microscopy (SEM) at different magnifications.

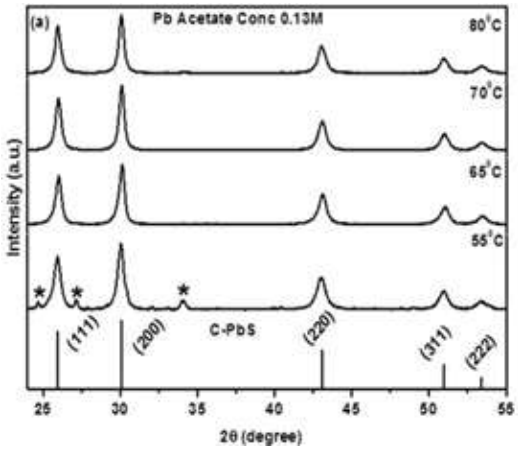
III. RESULTS & DISCUSSIONS

3.1 XRD studies

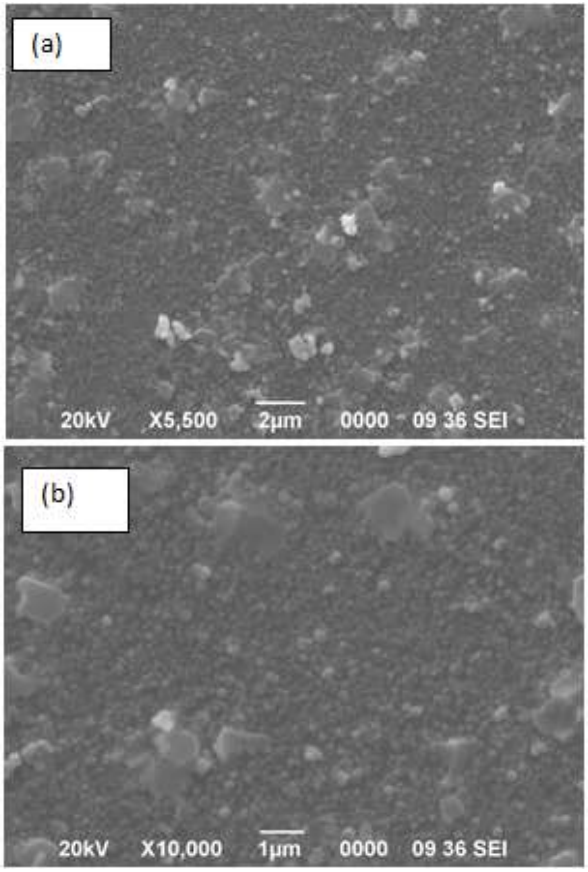


All XRD patterns show four intense peaks at around 2θ=25.99, 30.11, 43.09 and 51.03^0. All these peaks corresponding to the cubic phase of PbS which

matched with the standard JCPDS card no. (05-0592). The PbS prepared at 550c shows extra peaks which are unreacted lead acetate oxide hydrate due to the low synthesizing temperature. However, as the bath temperature is increased from 65 to 85^{0}c, the extra peaks disapperared and the intensity of the peaks as in fig 1(a). This improved intensity with sharper peaks indicates a higher crystallinity of the material.



Given Figure 1(a) shows X-ray diffraction patterns of PbS synthesized at different bath temperature as indicated (55, 65, 70 and 80^{0}c).



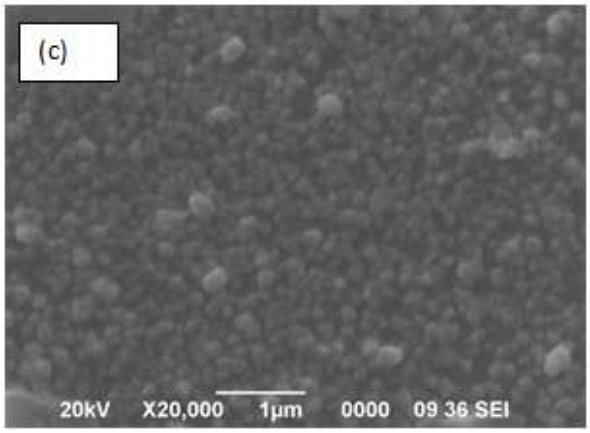


Figure 2 The SEM micrograph of PbS synthesized at the various temperatures but at constant molar concentration of lead acetate: (A) 65^{0}C (B) 70^{0}C and (C) 80^{0}C

Given Figure 2(a), (b), (c) show surface morphologies of PbS synthesized at various temperature. All the samples were taken at 20 KeV with a 0.05 nm field of view. Karami et al [2] have reported that by increasing the synthesized temperature there was no influence on particle size and morphology. But we observed that particle size decreased slightly with the increase in synthesized temperature. With the increase in synthesized temperature, the parcicle becomes unsymmetrical. From the micrograph it is observed that grain sizes are not of much uniformity.

IV. CONCLUSIONS

Nano crystalline PbS thin films with constant molar concentration of the solutions have been prepared and synthesized. The size of the PbS Nano crystals in the deposited film is affected by the temperature of the bath solutions. XRD showed that the structure of the material obtained was cubic for the variation of synthesized temperature.

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