CHEMICALLY DEPOSITED EUX THIN FILMS: A MORPHOLOGICAL STUDY

BETKAR M M

Shri Kumarswami Mahavidyalaya, Ausa, Dist. Latur (MS), India- 413515.
Email: betkarmm@rediffmail.com

Abstract - The Europium chalcogenide (EuX) thin films have been deposited bare glass substrates by chemically with spray pyrolysis technique at different substrate temperatures, in aqueous medium. The films synthesized were studied morphologically. The effect of substrate temperature on morphological properties has been investigated. The XRD studies reveal that, the films are polycrystalline in nature and the deposited material was europium sulphide. The SEM analysis conforms the formation of small grains on overall substrate.

Keywords - EuX,Spray Pyrolysis, SEM, EDAX

I. INTRODUCTION

Europium sulphide (EuS) is having ferromagnetic semiconducting property. The europium chalcogenide series exhibits a simple rocksalt structure. Out of those, the oxide, sulphide, and selenide are of ferromagnetic nature. The magnetic and electronic properties of europium chalcogenides Eus, EuO and EuSe have been studied with more attention. Particularly its ferromagnetic property has been found in some divalent europium compounds. The europium chalcogenide materials initiate a simple crystal and magnetic structure and those are fit for their research studies. [1-4]

The morphological of europiumsulphide (EuX) in particular Europium SulphideEuS, chemically spray deposited. A number of methods of the film deposition, such as electro-deposition (ELD), vacuum evaporation (VE), chemical bath deposition (CBD), chemical vapour deposition (CVD), spray pyrolysis (SP) etc are practiced frequently . These techniques has major influence on morphological, structural and optical properties of synthesized thin films. In particular, the surface morphology of the films varies with the precursor concentrations, volume ratio also with deposition time. [5-6]

In the present work, europium sulphideEuS thin films are deposited by chemically spray pyrolysis deposition. Spray pyrolysis is a non vacuum and low cost technique, and it can be optimized for a wide control on morphological properties of thin films. The films are studied by Scanning Electron Microscope technique, EDAX. The results of synthesized films characteristics are outlined.

II. DETAILS EXPERIMENTAL

The EuX thin films, (in particular europium sulphide) EuS thin films were deposited onto bare glass substrates. The medium of precursor was aqueous as deionised water, comprising europium (III) chloride hexahdydrate EuCl3 and thioacetamide CH3CS.NH2, each of 0.01 M and in proportion 1:4. Aqueous solutions of EuCl3 and CH3CS.NH2, were used as the sources of Eu and S, respectively. The EuCl3 and CH3CS.NH2, solutions were mixed for 55 min, well mixed with magnetic stirrer at the rate 450 rotations per min. The glass substrates were cleaned with dilute hydrochloric acid, standard laboratory detergent Labonate, and ultrasonically cleaned with double distilled hot water for 15 min. The deposition of the film was carried out at increasing temperatures as 548 K, 573 K, 598 K and 623 K. The deposition was carried out with spray pyrolysis technique (Model No. Holmark HO-TH-04). The other parameters; carrier air pressure (30 psi), substrate to nozzle distance (15 cm), spray duration (2 min) and precursor quantity (1 ml per min) were kept constant throughout the experiment. Before deposition process the substrates were dried well. The carrier gas was air. All the chemicals used were of analytical reagent grade (99% purity).

2.2. Thermal Fatigue Test

The thermal fatigue test was done in a thermal cyclic furnace. The specimens were tested at 600^0C highest temperature. Heating and cooling time were kept as 10 minutes. When the samples were cooled to the ambient temperature, they were taken out, dried and put into the high temperature furnace again, repeating the same process. More than 90% of the cracked regions of the surface of TBC systems were adapted as the criterion for the failure of the coating. The weight changes of the samples were measured to a precision of 0.5 mg by an analytical balance. Three number of specimens were tested and average was considered for analysis.

III. RESULTS AND DISCUSSION

3.1. Morphological Characterization

Following Fig.1shows SEM images of EuS thin films deposited at substrate temperature 573 K, analysed on Electron Microscope SEM Model: Quanta 200 ESEM System, manufactured by Icon Analytical Equipment Pvt. Ltd, Mumbai. The 12000

× magnified micrograph of sample, indicates the uniform film deposition and continuous coverage of the substrate surface with small circular nanoparticles. The microgram revels the uniform and well deposition. As a result these films grow by spray pyrolysis technique of experimental precursor leads to a perfect flat surface of the films.[7,8]

The Fig.2 displays EDAX pattern of synthesized EuS thin film deposited at deposition 573 K. The pattern covers the peaks of Eu and S with varying intensity. This conforms the deposition of Eu and S. The elemental composition was analysed for Eu with weight 95.29% at 81.00% and that of for S was wt. 4.71% at 19.00%. The net intensities for Eu and S was 13.40 and 2.42 respectively.

The Fig.3 shows the XRD pattern. The XRD different peaks in the diffractogram were listed and the corresponding values of interplanar spacing 'd' were calculated. The 'd' values are compared with the standard one.[9,10] The diffraction peaks of EuS films are originated at 2θ values of 25.780, 29.920 and 42.460 corresponding to the hkl planes (111), (200) and (220) respectively. The sharp XRD peaks indicate well crystallized EuS thin films. This conforms the polycrystalline nature of EuS films as simple cubic structure. The optimized temperature for deposition of good quality EuS thin films is found to be 573 K. The height of (111) peak in X-ray diffraction pattern for EuS thin films deposited at temperature 573 K has found more sharper and FWHM data conforms the improvement of crystallite at temperature 573 K. X-ray diffraction patterns of EuS thin films is evaluated using FWHM data and Debye-Scherrer formula for the calculation of the crystallite size of EuS films synthesized at substrate temperatures 548 K, 573 K, 598 K and 623 K. Fig. 4 displays the variation of crystallite size of EuS thin films with substrate deposition temperatures 548 K, 573 K, 598 K and 623 K is shown in. It is observed from Figure 4, that the crystallite size increases with substrate temperature and the films deposited above temperature 573 K are maximum crystalline, as compared to those deposited below the temperature 573 K.

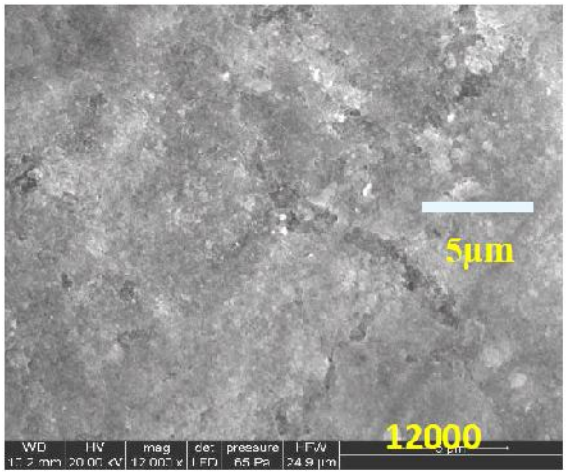


Fig.1. SEM photograph of EuS thin film at 573 K

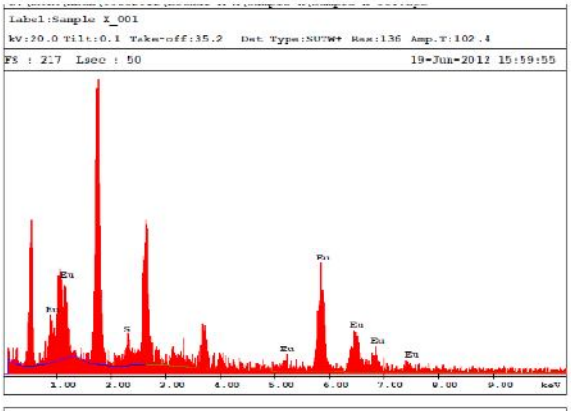


Fig.2. EDAX pattern of EuS thin film at 573 K.

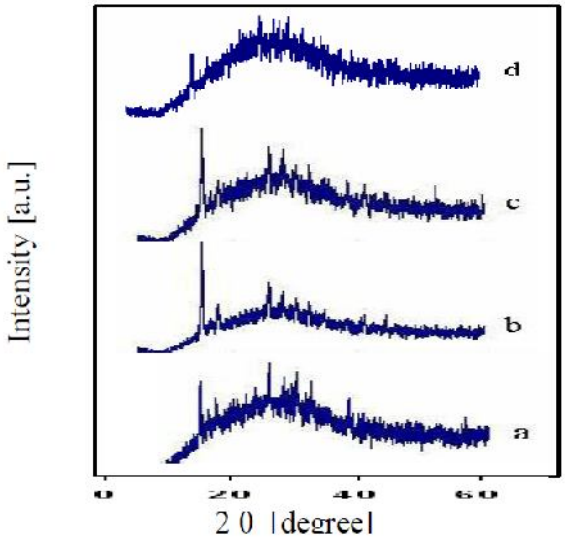


Fig.3. XRD patterns of EuS thin films deposited at substrate temperatures: (a)548 K, (b) 573 K,(c) 598 K and (d) 523 K

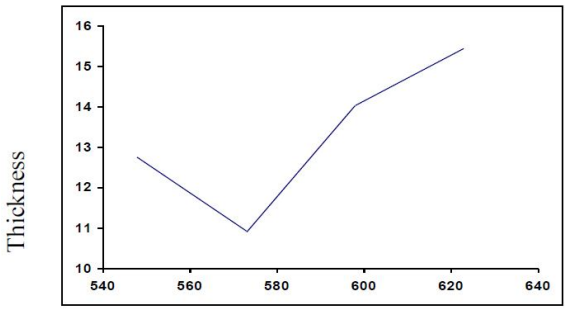


Fig.4 Variation of film thickness with substrate temperature

CONCLUSIONS

Spray pyrolysis technique was successfully employed to deposit EUX particularly EuS thin films on transparent glass substrates for increasing temperatures 548 K, 573 K, 598 K and 623 K. The XRD study of the films conforms cubic structure of EuS. Structural parameters like crystallite size, thickness are also calculated and found to depend upon varying temperatures. The average sizes of the grains are found to be 6.475 A, which confirm the

formation of well-crystallized EuS films The crystallinity of the films increased with increasing temperature from 548 K to 623 K. It shows that, the optimized EuS thin film has highly crystallized.

ACKNOWLEDGMENTS

Author is thankful to S.R.T. M. University recognized, Physics Research Centre, Mahatma Gandhi College, Ahmedpur, Dist. Latur, for providing research facility on Spray Deposited Thin Films.

REFERENCES

[1] S Ariponnammal, S Chandrasekaran, "Theoretical Study on the Electrical Properties of Some Semiconducting Rare Earth Chalcogenides Sm1-xEuxS and Sm1-xYbxS Under Pressure",
[2] Journal of Nano-and Electronic , vol. 3 no.1, pp.529-531,2011.
[3] Camenzind, Adrian, Reto Strobel, and Sotiris E Pratsinis, "Cubic or monoclinic Y2O3:Eu3+ nanoparticles by one step flame spray pyrolysis",Chemical Physics Letters, vol. 415 no.4-6,pp193-197, 2005.
[4] Dosev, D, B Guo, and I Kennedy, "Photoluminescence of Eu3+: Y2O3 as an indication of crystal structure and particle size in nanoparticles synthesized by flame spray pyrolysis", Journal of Aerosol Science, vol. 37, no.3, pp402-412,2006.
[5] Xiaoxin, L I U, J I N Zhengguo, Zhao Juan, and B U Shaojing,"Three-Dimensional Array of Highly Oriented Crystalline ZnO Microtubes", RARE METALS , vol. 23, no. 1, pp 93-97,2011.
[6] Gaikwad, N. , Bhosale C., "Electrodeposition of EuSe thin films onto different substrates", Materials Chemistry and Physics, vol.76, no.2, pp198-203,2002.
[7] M.M. Betkar , G.D. Bagde, "EFFECT OF COMPLEXING AGENT ON SPRAY DEPOSITED EuS THIN FILMS", Materials Physics and Mechanics, vol. 14, pp137-144, 2012.
[8] M MBetkar, G D Bagde, "Structural and optical properties of spray deposited CdSe thin films", Materials Physics and Mechanics, vol. 14, no.1, pp. 74-77, 2012.
[9] Regulacio, Michelle D, Konrad Bussmann, Brad Lewis, and Sarah L Stoll,"Magnetic Properties of Lanthanide Chalcogenide Semiconducting Nanoparticle", Journal of the American Chemical Society, vol. 128, no.34, pp11173-11179, 2006 .
[10] Dutta, Sreetama"Role of Defects in Tailoring Structural, Electrical and Optical Properties of ZnO", Progress in Materials Science, vol.54,pp89-136, 2009.
[11] Nadir F. Habubi, Ziad M. Abood, Ahmed N. Algamel, "Molar concentration Effects on the Optical and Structural Properties of nanostructural SnO2 Thin Films",International Letters of Chemistry, Physics and Astronomy, Vol. 65, pp 80-90,2016.

★★★