Advance Physics Letter

Optical Properties of Chemical Bath Deposited $Pb(OH)_2$Thin Film

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Abstract:-Lead hydrooxide thin films were deposited on glass slide from aqueous solution of $Pb(NO_3)_2$and NaOH by chemical bath deposition method .The films of various thicknesses have been obtained by varying the concentration(1M- 0.01M) of aqueous solution of TEA used as complexing agent (Tri Ethanolamine).Structural, optical properties and surface morphology of the deposited thin film have been studied by XRD, U.V spectrophotometer (Varian) and binocular research microscope vision 2000. The optical band gap of the $Pb((OH)_2$ thin film was found in the range of 2.59 to 3.38ev.

I. INTRODUCTION:-

Lead and leadcompounds, as important industrial materials have wide applications. Such as in building construction, lead acid batteries, bullets weights and shot, part of solder, fusible, alloys glass industry and pigment. Lead hydroxide also has wide applications, such as staining and absorbance. The synthesis of $Pb(OH)_2$nanostructureshas rarely been reported probably because the stable presence of simple hydroxide $Pb(OH)_2$ in the solid state is doubtful.[1-22]

In recent times, several techniques have been adopted for thin film deposition such as Sol-gel,[4] ionized Cluster Beam Deposition,[5] dc reactive magnetron, sputtering,[6] pulse laser deposition,[7]chemical bath deposition[8-16] spray pyrolysis,[17] plasma-enhanced chemical vapor deposition [18-23], Solid stat reaction method[24-34], Combustion[35-45]etc. Many of these methods are expensive and require high vacuum and controlled formation condition.

Another advantage of the CBD method over other method is that the film can be deposited at different shapes and size of substrates.

II. SYNTHESIS:-

In our experiment the $Pb(OH)_2$ thin films were prepared by chemical bath technique at room temperature(28^{o}C).The reaction bath is composed by $Pb(NO_3)_2$, NaOH and TEA(tri ethanolamine) used as complexing agent. For deposition of the film, commercial quality glass microscope slides of dimension 16mm x 26mm x 1mm are used. Prior to use, these glass slides were soaked in aqua regia, a mixture of concentrated HCl and HNO_3 in the ratio of 3:1. They were removed after 24 hours and washed thoroughly in cold detergent solution, rinsed intriple distilled water and drip dried in air. The properly degreased and cleaned substrate surface has the advantage of producing highly adhesive and uniform film.

The substrate was immersed vertically at the centre of reaction bath in such a way that it should not touch the walls of the beaker. Only one concentration of Pb $(NO_3)_2$ (0.04M) and of NaOH (0.08M) were used in this method. Tri ethanolamine was used either directly or as aqueous solution with varying concentration of TEA to prepare various samples.

At the end of the dip period, the films are washed and drip-dried in hot air oven at 50^{o}C.[14]The optical absorbance, transmittance, and reflectance of the film were studied in the spectral range of 285-1000nm using UV spectrophotometer (Varian). Surface morphology observed by binocular research microscope vision 2000.Thickness is calculated by the formula.

$t=m/A*\rho$ Where m = mass, A = area, ρ = densityReaction mechanics is as follow [12, 13]

$$Pb(NO_3)_2 + 2NaOH \longrightarrow Pb(OH)_2 + 2NaNO_3$$

$$Pb(NO_3)_2 + TEA \rightarrow Pb(TEA)^{2+} + 2NO_3^-$$

$$Pb(TEA)^{2+} \longrightarrow Pb^{2+} + TEA$$

$$NaOH + OH^- \longrightarrow Na^+ + 2OH^-$$

$$\rightarrow Pb^{2+} + 2OH^- \quad Pb(OH)_2$$

In directUse of TEA (sample192) the color of the film was white but when we decrease the concentration of TEA in aqueous solution the whiteness of the deposition film slightly decreases, and their band gap also increases. In sample192 (2.8ml of direct solution of TEA) we obtain band gap 2.4eV [12] and transmittance between 25-35%. In sample 284 we used 8ml of 1mole aqueous solution of TEA, we obtain band gap 2.57 eV and transmittance between 40- 50%. In sample 326 and

330we used 8ml of 0.1and 0.01 mole aqueous solution of TEA respectively, we obtain band gap 2.98&3.38eV respectively, and transmittance between 50-80%.Higher concentration of TEA will increases the reaction rate, band gap decreases and vice verse. our previous paper also reported this type of results[19,20]. The deposition parameters and thickness of the film are shown in table -1

Sample No.	Avg. thickness	Period of deposition	Band gap
	μm	(hrs)	eV
192	0.642	24	2.4
284	0.547	24	2.57
326	0.294	36	2.98
330	0.251	36	3.38

Table-1: deposition parameter and thickness of $Pb(OH)_2$ thin film

Figure 1and Figure 2, show the optical transmittance, reflectance, and absorption curve of deposited $Pb(OH)_2$ film of two thicknesses (0.294 μm,.251 μm). Figure 1 show that transmittance increases with decreasing concentration of the TEA and with decreasing thickness. Higher transmittance is observed in IR region. This indicates that film is a good material for warming applications in low temperate regions;it could be used as window glazing to create warmth in the house .It could also be very useful in Agriculture especially creating warmth for chickenin a poultry farm. On the other hand reflectance decreases rapidly with increase in wavelength falling from about 20%near UV region to about 12%near the infrared region.The band gap of the metallic oxide was determined by plotting $(\alpha hv)^2$ as a function of hv, and extrapolating the linear portion of the curve to $(\alpha hv)^2=0$ as shown in Figure-(3).The value obtained for the optical band gap is 2.89 and 3.38 eV.[5]

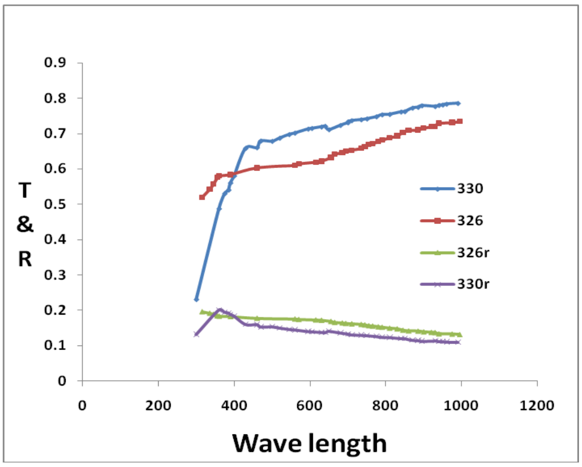

Fig.1. Transmittance &Reflectance as a Function of wave length

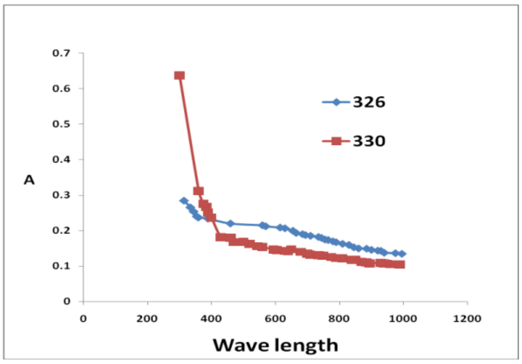

Fig.2. Absorbance as a function of wave length

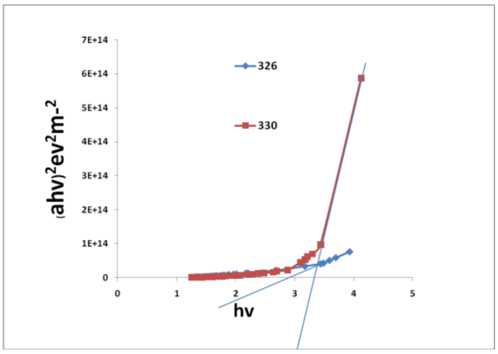

Fig.3. Plots of $(\alpha hv)^2$ ev^2m^{-2} against hv

Islam and Podder reported [21]. The absorption coefficient can be calculated by $\alpha= A/d$,

Where A is the optical absorbance and d is thickness of the film. The extinction coefficient can be obtain from the relation $= \alpha\lambda/4\pi$.

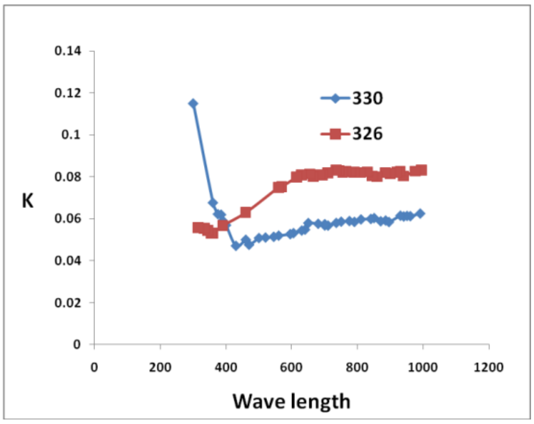

Fig.4. variation of extinction coefficient as a function of wave length

The refractive index (n) and extinction coefficient (K) value provide the optical properties of the film. The variation of extinction coefficient with wave length is shown in Figure (4). It is observed that the extinction coefficient decreases with the increase of the thickness of the film. The rise and fall in the extinction coefficient is directly related to the absorption of light. [19] From Figure 4 it is clear that K decreases rapidly with increasing wavelength from 300 to 400 and after that value of K gradually increases.

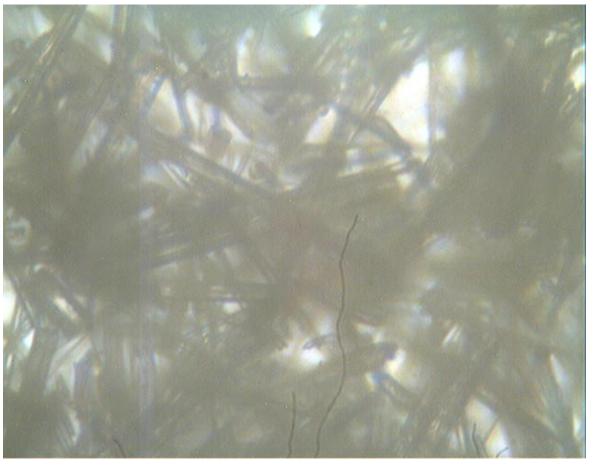

Fig.5.Sample 326

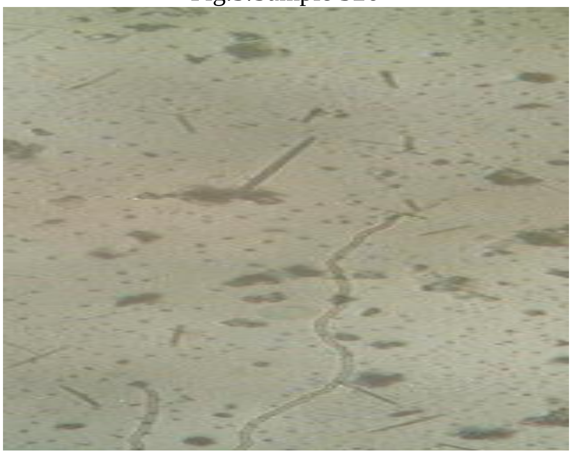

Fig .6. Sample330

To identify the crystal structure of the film, we performed XRD analysis. The XRD patterns were recorded with a D8 advance X-ray diffractometer using a Cu K_a radiation source (λ=1.54056 Å). Figure shows XRD pattern in the range of 20°<2θ<80°, most of the diffractin peaks can be assigned to $Pb(OH)_2$ according to re[1,2]and file(00-0030607) the assigned indices in the XRD pattern.This suggest that the crystal structure of $pb(OH)_2$ is hexagonal.

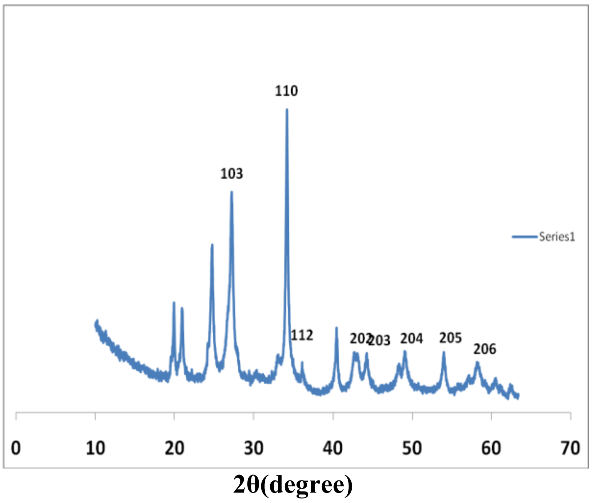

Fig .7.X-ray Diffraction Pattern For $Pb(OH)_2$ Film

The grain size is caculated by debye scherrar's formula [2]

$$D=0.9\lambda/\beta Cos\theta$$

We found that the size of partical are in the nano range 10.49 to 25.76nm.

CONCLUSION:-

$Pb(OH)_2$ films have been successfully prepared by CBD method using $Pb(NO_3)_2$and NaOH with TEA as complexing agent as well as alkali. Presence of alkali gives rod like morphology.. The film shows high transmittance in the visible/near infrared regions of electromagnetic spectrum. Refractive index is (2-2.68). Value of the real part of dielectric constant is 4-6.8.From XRD data we identify that structure of $Pb(OH)_2$ is hexagonal and size of particle is in the nano range.

REFRENCE

[1] Cheng J, Zou X, SONG W, Cao Metal 2010 chin phys let. 27, No5,057302

[2] Cheng J Zou X, Wang Metal 2005, Xiaoping Zou,xpzou 2005 @gmail .com

[3] Lead hydroxide from Wikipedia, the encyclopedia Jump to navigation search

[4] -Bao, D, Gu H and Kuang A 1988 J Thin Solid films. 312:37-39 "

[5] Whangbo S, Jang H, Kim S, Cho M et al Journal of the Korean physical society,37no 4(2000) 456-460

[6] SubramanyamT.K,Naidu B.S ,Uthanna S, 2000 Cyst Res Tectnol. 5:1193-1202.

[7] Sun X.W. Kwok H.S. 1999 Journal of Appl. Phys 86(1999)408-411.

[8] Ezema F.I.and Okeke C.e.2002 GJST.3 (2) (90-109).

[9] Eya D.D.O. Ekpunob A.J and Okeke C.e.2006 Academic Open Internet journal 17, ISSN 1311-4360

[10] Ezema F.I.Azogwa P.U 2003 The Pacific Journal of Science and Technology, 5 No1(spring)

[11] Ezema F.I Ekwealor A.B.C, OSUJi R.U. 2007 Journal of opto electronics and Advanced material 19 Number6. P 1898-1903

[12] Eya D.D.O. Ekpunob A.J and and Okeke C.E.2005 Academic Open Internet journal, Volume 14

[13] P.B.Taunk R.Das, D.P.Bisen Materials Sciencein Semiconductor Processing32(2015)49–54

[14] .B.Taunk R.Das, D.P.Bisen Raunak Kumar Tamrakar,Superlattices and Microstructures

[13] Eya D.D.O. Ekpunob A.J and and Okeke C.E.2005 The Pacific Journal of Science and Technology 6 Number1,(spring)

[14] Eze,F.C.andOkeke C.E. 1997 material Chemistry and physics ,47:31-36

[15] Tanusevski A2003 semicond. Sci Technol.18:501-505.

[16] Cao B and cal W, 2008 J. Phys Chem. C 112,680-68

[17] Santan Get al 1999 Superficies Y vacio. 9:300-320

[18] Kim y, jin. And Hyeong-j1999 mat lett 41 159-153.

[19] P.B.Taunk R.Das, D.P.Bisen Materials Sciencein SemiconductorProcessing32(2015)49–54

[20] .B.Taunk R.Das, D.P.Bisen Raunak Kumar Tamrakar,Super lattices and Microstructures, 2015doi:10.1016/j.spmi.2015.09.039

[21] Islam M.R, Podder J. 2008 Cryst. Res Technol 44, no. 3 286-292

[22] Eya D.D.O,A.J. Ekpunobi, and C.E. Okeke. **2005**. The Pacific Journal of Science and Technology 7 Number2.

[23] R TAMRAKAR, DP BISEN, N BRAHME, CS ROBINSON, Journal of Pure Applied and Industrial Physics Vol 2 (3A), 286-402

[24] RK Tamrakar, DP Bisen, N Brahme, CS Robinson, Recent Research in Science and Technology 4 (8), 2012.

[25] RK Tamrakar, DP Bisen, American Institute of Physics Conference Series 1536, 273-274

[26] R Tamrakar, V Dubey, SN Swamy, R Tiwari, SVN Pammi, ...Research on Chemical Intermediates 39 (8), 3919-3923 RK Tamrakar Research on Chemical Intermediates 39 (9), 4239-4245

[27] Raunak Kumar Tamrakar, D. P. Bisen, N. Bramhe, Kanchan Upadyay, Journal of Luminescence and Applications 1 (1), 23-29

[28] RK Tamrakar, DP Bisen, N Brahme, Research on Chemical Intermediates 40 (5), 1771-1779

[29] Raunak Kumar Tamrakar, D. P. Bisen, Ishwer Prasad Sahu, N Bramhe, Advance Physics Letter 1 (1), 1-5

[30] Raunak Kumar Tamrakar, D. P. Bisen, Ishwer Prasad Sahu, N Bramhe, Advance Physics Letter 1 (1), 6-9

[31] RK Tamrakar, DP Bisen, N Brahme, Journal of Radiation Research and Applied Sciences 7 (4), 550-559

[32] RK Tamrakar, DP Bisen, N Brahme Journal of Radiation Research and Applied Sciences 7 (4), 550-559

[33] RK Tamrakar, DP Bisen, K Upadhyay, IP Sahu, N Brahme, Journal of Optics, 1-9, 2015.

[34] RK Tamrakar, DP Bisen, K Upadhyay, N Bramhe, Superlattices and Microstructures 81, 34-48

[35] Ishwar Prasad Sahu and kanchan Upadhyay Raunak Kumar Tamrakar, D.P. Bisen, International Journal of Luminescence and Applications, 5(2),2015, 242-244.

[36] RK Tamrakar, DP Bisen, N Brahme, IP Sahu, K Upadhyay, Optik-International Journal for Light and Electron Optics 126 (20), 2654-2658

[37] Raunak Kumar Tamrakar, IP Sahu, CS Robinson, DP Bisen, Kunal Uplop, Journal of Taibah University for Science, 2015

[38] Raunak Kumar Tamrakar, DP Bisen, Ishwar Prasad Sahu, Kanchan Upadhyay,

[39] RK Tamrakar, DP Bisen, IP Sahu, N Brahme, Journal of Radiation Research and Applied Sciences 7 (4), 417-429

[40] RK Tamrakar, DP Bisen, N Bramhe - Luminescence, 2014.

[41] RK Tamrakar, DP Bisen, N Brahme, Infrared Physics & Technology 68, 92–97, 2015.

[42] K Upadhyay, RK Tamrakar, V Dubey, Superlattices and Microstructures 78, 116–124

[43] IP Sahu, DP Bisen, N Brahme, RK Tamrakar, Journal of Materials Science: Materials in Electronics, 1-12

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