Available online www.jocpr.com

Journal of Chemical and Pharmaceutical Research, 2015, 7(9):50-55

Research Article

ISSN : 0975-7384
CODEN(USA) : JCPRC5

UV-Visible studies of chemical bath deposited $Ni_3Pb_2S_2$ films

Ho S. M.

Faculty of Science, Technology, Engineering and Mathematics, INTI International University, Putra Nilai, Negeri Sembilan, Malaysia

ABSTRACT

$Ni_3Pb_2S_2$ thin films have been prepared under various deposition times. The films were characterized using UV-Visible spectrophotometer. The obtained results indicated that the strong absorption in the visible regions. On the other hand, it is seen that the band gap was increased from 1.1 to 1.4 eV as the deposition time was reduced from 55 to 25 minutes.

Keywords: Band gap, thin films, optical properties, chemical bath deposition.

INTRODUCTION

In recent years, interest in the optical properties of thin films has considerably increased by the worldwide researchers [1-5]. As a result, an abundant of literature has appeared on the optical properties of thin films by using UV-Visible spectrophotometer. Then, the obtained absorption spectra could be used to determine the band gap of films. The measurement of the band gap is an important in the nanomaterial, semiconductor and solar industries. For example, the best photovoltaic materials consisted of binary, ternary and quaternary thin films that have band gap values ranging from 1-1.6 eV (see Table 1) according to literature survey.

In this work, I report on the chemical bath deposition of $Ni_3Pb_2S_2$ thin films from acidic solutions. At the same time, I also reported the effect of deposition time on the optical properties of the films. The chemical bath deposition method has chosen due to many advantages such as simple, economical and low temperature deposition as pointed out by many researches [19-24].

EXPERIMENTAL SECTION

In this study, $Ni_3Pb_2S_2$ thin films were prepared from the aqueous solutions. The chemicals such as nickel (II) sulfate, lead (II) nitrate, sodium thiosulfate and tartaric acid were used as received. In all experiments, the tartaric acid was used to complex the lead and nickel ions. Solutions were prepared using water purified by Millipore Alpha-Q water purification system. The substrate used for the deposition of thin films was microscope glass slides. The substrate cleaning process was discussed elsewhere[25].For the preparation of $Ni_3Pb_2S_2$ films, 20 mL of 0.1M sodium thiosulfate was placed into separate beakers which contained 20 mL of 0.1 M of nickel (II) sulfate and 20 mL of 0.1 M lead (II) nitrate, respectively. Then, 20 mL of 0.1M tartaric acid was added into the components of a mixture under continuous stirring. Thin films were deposited on the glass slides at 65 °C, pH 1.5 and various deposition times ranging from 25 to 55 minutes. It was placed vertically to the bottom of the beaker during the deposition process. After complete deposition, the substrate with the films was taken out, and dried in air. Optical absorption study was carried out using the Perkin Elmer UV/Vis Lambda 20 Spectrophotometer.

RESULTS AND DISCUSSION

There has been growing interest in the investigation of the optical properties of thin films by means of UV-Visible spectrophotometer. These compounds have opened a new area in the field of electronic and optoelectronic applications. In this study, measurement of band gap could be carried out using absorption spectra. During the experiment, the film-coated glass substrate was placed across the sample radiation pathway while the uncoated glass substrate was put across the reference path. Then, the absorption data were used for the determination of the band gap energy as indicated in Equation 1.

$$A = \frac{[k(hv - E_g)^{n/2}]}{hv} \quad (1)$$

Where v is the frequency, h is the Planck's constant, k equals a constant while n carries the value of either 1 or 4. The value of n is 1 and 4 for the direct transition and indirect transition, respectively. It is clear from absorption spectra that the strong response at longer wavelengths for all the samples reflects these materials are suitable in the solar cell applications. The films prepared in 55 and 25 minutes, show the highest and the lowest responses behavior, respectively as shown in Figure 1. In other words, it can be seen that the absorption characteristic of the films increases with the increase the deposition time. It is mainly could be attributed to the sufficient materials deposited onto the substrate at longer deposition time.

Figure 2a-2d show the variation of $(Ahv)^2$ with photon energy. The band gaps of the films were deduced from the curves and are listed in Table 2. It is very clear that when the deposition time was increased from 25 to 55 minutes, the band gap value was decreased from 1.4 to 1.1 eV. It means that the properties of thin films mainly depend on the various deposition conditions such as deposition time.

Table 1: Band gap energy of various thin films

Thin films	Band gap
$SnSe_2$[6]	1.59
PbS [7]	1.35
CoS [8]	1.13
SnS [9]	1.5
CdTe [10]	1.45
PbSe [11]	1.3
PbTe [12]	1.58
PbMnS [13]	1.5
CdMnS [14]	1.45
Cu_4SnS_4[15]	1.56
$CuInSe_2$[16]	1.04
Ag_2ZnSnS_4[17]	1.2
Cu_2ZnSnS_4[18]	1.5

Table 2: The values of band gap energy for the prepared $Ni_3Pb_2S_2$ thin films

Deposition time (minutes)	Band gap (eV)
55	1.1
45	1.15
35	1.2
25	1.4

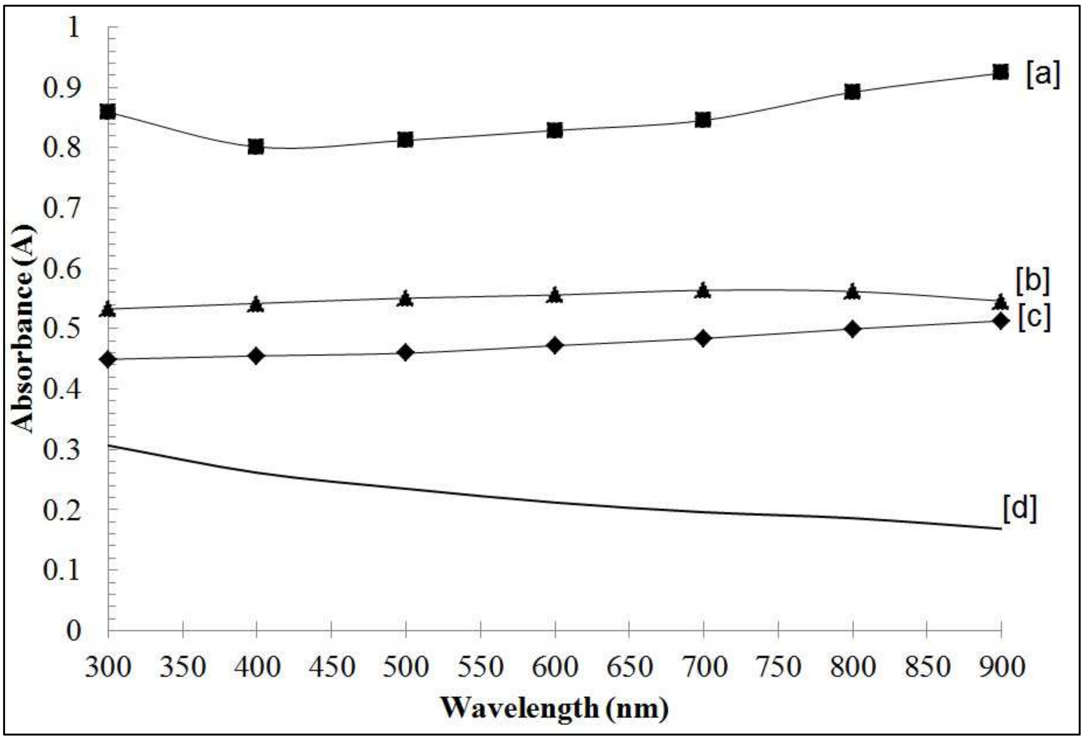
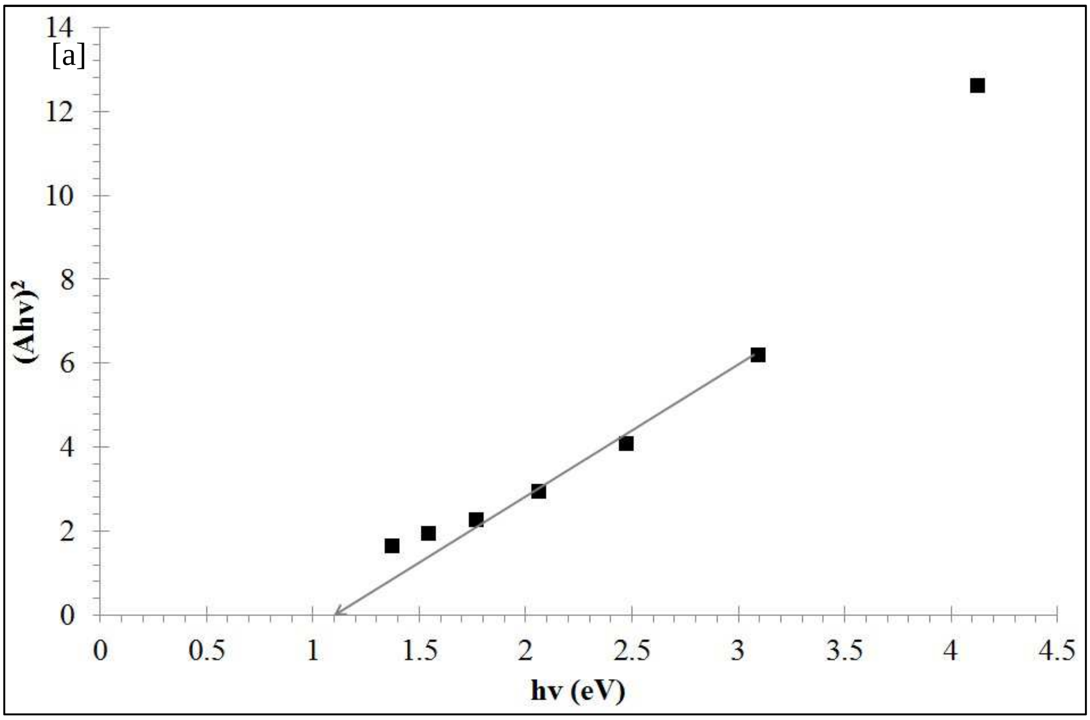
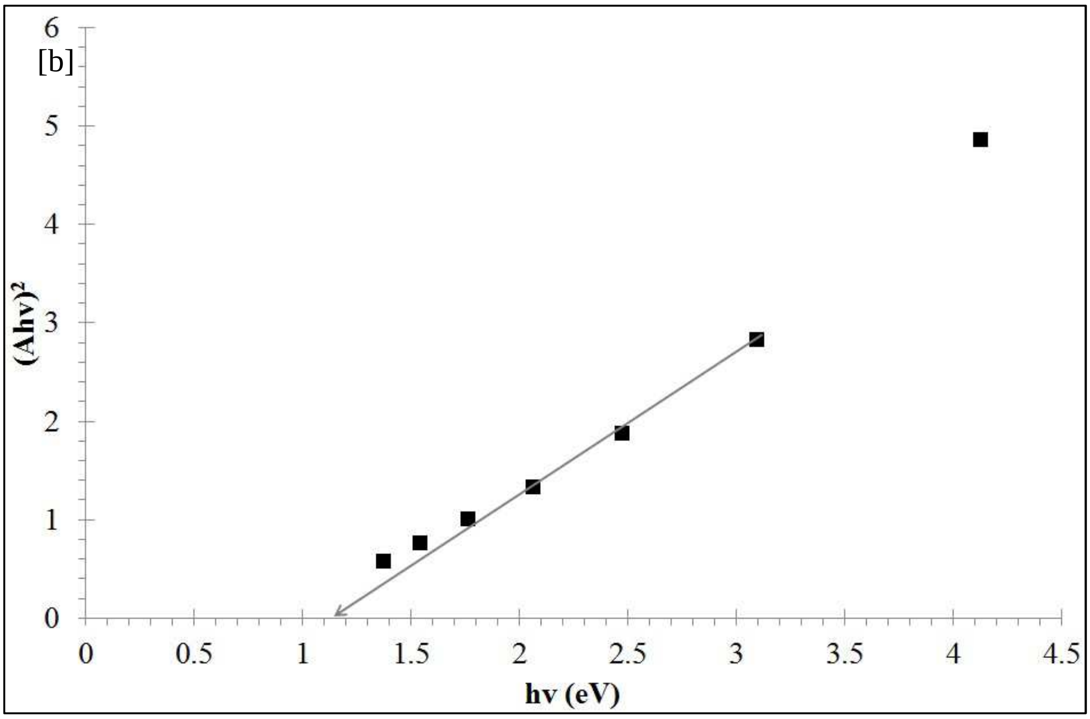
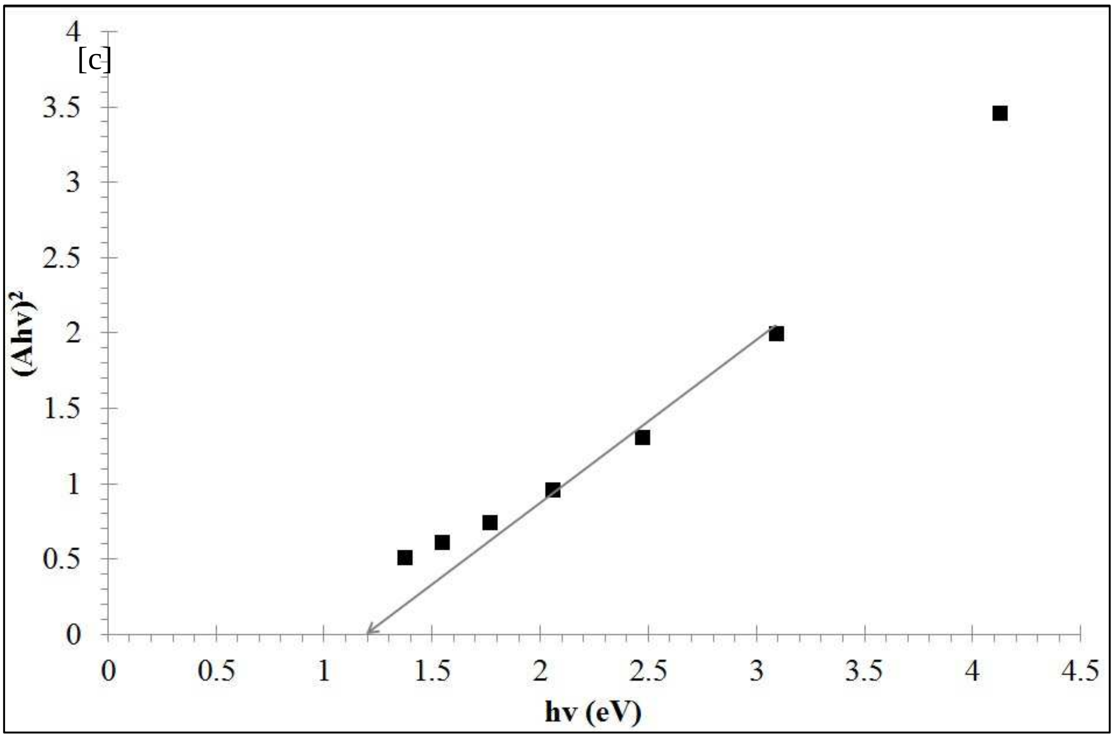


Figure 1: Optical absorbance versus wavelength of the $Ni_3Pb_2S_2$ thin films prepared under various deposition times [a] 55 [b] 45 [c] 35 [d] 25 minutes




[b]
(Ahv)²
hv (eV)
0
1
2
3
4
5
6
0.5
1.5
2.5
3.5
4.5


[c]
(Ahv)²
hv (eV)
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5

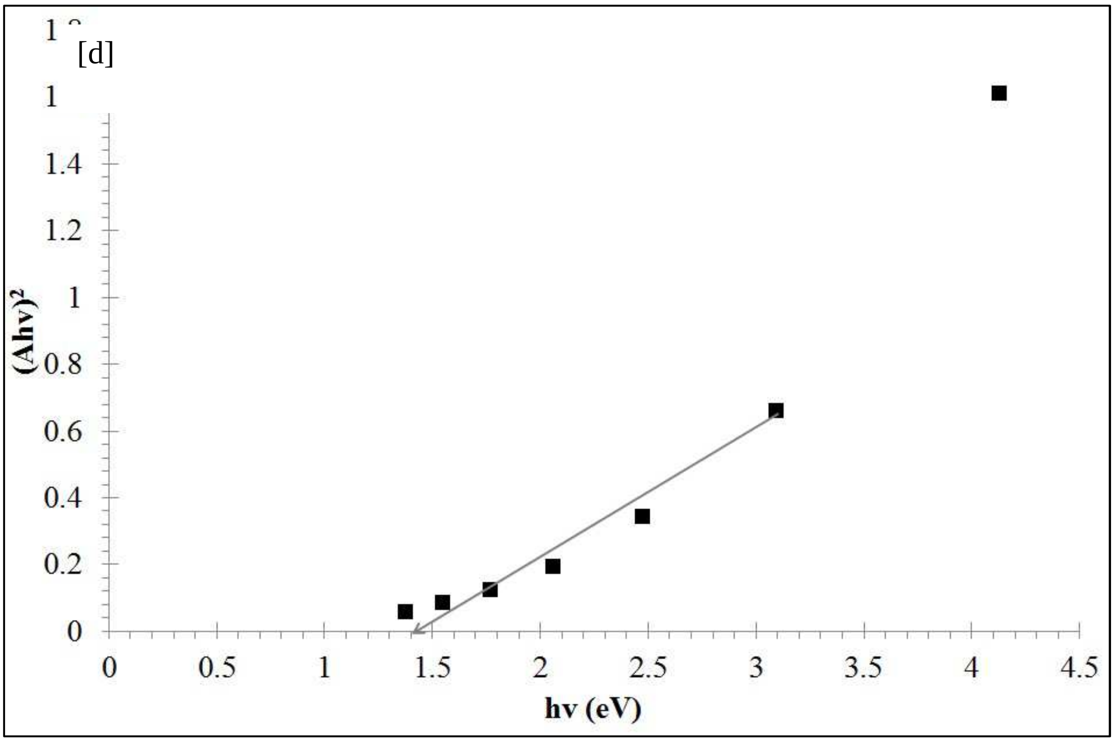


Figure 2: Plots of (Ahv)^2 versus hv for the $Ni_3Pb_2S_2$ thin films prepared under various deposition times. [a] 55 [b] 45 [c] 35 [d] 25 minutes

CONCLUSION

$Ni_3Pb_2S_2$ thin films could be deposited on glass slides that were immersed in solutions containing metal complex ions. The optical properties of thin films prepared under various deposition times have been reported. The band gap values in the range between 1.1 and 1.4 eV.

Acknowledgement
This research work was supported by INTI International University under INTI Research Grant: INT-FOSTEM-05-02-2014.

REFERENCES

[1] CD Lokhande;SHPawar,*Solid State Commun*.,**1982**, 44, 1137-1139.
[2] B Krishnan;AArato;E Cardenas;TKS Roy;GA Castillo, *Appl. Surf. Sci.*,**2008**, 254, 3200-3206.
[3] S Seghaier;N Kamoun;R Brini;AB Amara,*Mater. Chem. Phys.*,**2006**, 97, 71-80.
[4] IA Ezenwa;NA Okereke;NJ Egwunyenga,*Int. J. Sci. Technol.*, **2012**,2, 101-106.
[5] S Mahanty;D Basak;F Rueda;M Leon, *J. Electron. Mater.*,**1999**, 28, 559-562.
[6] D Martinez-Escobar; M Ramachandran; ASanchez-Juarez;JSN Rios,*Thin Solid Films*, **2013**, 535, 390-393.
[7] SM Ho; K Anuar; WT Tan,*World Mech.*, **2014**, 1, 1-6.
[8] ST Mane;SS Kamble; LP Deshmukha,*Mater. Lett.*,**2011**, 65, 2639-2641.
[9] K Anuar; SM Ho; S Atan; HJelas; NSaravanan,*Oriental J. Chem.*, **2011**, 27, 1375-1381.
[10] G Laxman; RA Yelameli; KR Sheela,*J. Mod. Phys.*,**2012**, 3, 1870-1877.
[11] K Anuar; SM Ho; N Saravanan,*Turk. J. Sci. Technol.*,**2011**, 6, 17-23.
[12] K Lakshmanan;S Ramakrishnan,*Adv. Cond. Matter Phys.*, **2012**,http://dx.doi.org/10.1155/2012/763209.
[13] RK Joshi; P Kumar;HK Sehgal;AKanjilal,*J. Electrochem. Soc.*, **2006**, 153, C707-C712.
[14] CI Oriaku;FI Ezema; JC Osuwa,*Pacific J. Sci. Technol.*, **2008**, 10, 413-416.
[15] K Anuar; N Saravanan; KZulkefly; S Atan; WT Tan; SM Ho,*Bull. Chem. Soc. Ethiop.*,**2010**, 24, 259-266.
[16] RH Bari; LA Patil; PPPatil,*Bull. Mater. Sci.*,**2006**, 29, 529-534.
[17] LY Yeh; KW Cheng,*Thin Solid Films*,**2014**, 558, 289-293.
[18] EP Subramaniam;G Rajesh; N Muthukumarasamy;M Thambidurai; V Asokan;D Velauthapillai,*Indian J. Pure Appl. Phys.*,**2014**, 52, 620-624.
[19] WL Liu;CS Yang;SH Hsieh;WJ Chen; CL Fern,*Appl. Surf. Sci.*,**2013**, 264, 213-218.
[20] KAnuar; SM Ho; WT Tan; Kelvin;NSaravanan,*Eur. J. Appl. Sci.*,**2011**, 3, 75-80.
[21] H Khallaf; IOOladeji; L Chow, *Thin Solid Films*, **2008**, 516, 5967-5973.

[22] K Anuar; SM Ho; JH Mohd; NSaravanan. *Int. J. Pharm. Life Sci.*,**2011**, 2, 1190-1194.
[23] K Girija;S Thirumalairajan; SM Mohan;J Chandrasekaran,*Iraqi J. Appl. Phys. Lett.*, **2009**, 2, 21-24.
[24] K Anuar; SM Ho,*Int. J. Chem. Res.*,**2010**, 1, 1-5.
[25] SM Ho,*Eur. J. Sci. Res.*,**2014**, 125, 475-480.