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Influence of deposition time on optical properties of chemically deposited nickel lead sulphide thin films

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Abstract

The aim of this work is to prepare nickel lead sulphide thin films using chemical bath deposition method. The samples deposited onto microscope glass slide at the deposition times from 10 to 32 hours at room temperature. The UV-visible spectrophotometer technique studies indicate remarkable change in the absorption spectra for the films deposited in various deposition times.

Keywords: thin films, band gap, optical properties, photovoltaic cell.

INTRODUCTION:

Metal chalcogenide thin films have been studied extensively for many years by many researchers (1-20). These materials have band gap energy and light absorption coefficient very suitable to the photovoltaic conversion of solar energy (21-26). Chemical bath deposition technique is a useful method for deposition of thin films as compared to the other deposition techniques. Because of this deposition method is simple, inexpensive and environment friendly method.

In this work, nickel lead sulphide thin films have been deposited onto glass substrate. The effect of deposition time was investigated by using UV-Visible

spectrophotometer technique. The optical properties and band gap will be studied and discussed.

EXPERIMENTAL

The nickel lead sulphide films were synthesized using chemical bath deposition method on glass substrate (microscope slides). The microscope slides were cleaned before deposition by distilled water and ultrasonic cleaning with alcohol solution. In this experiment, nickel sulphate, lead nitrate and sodium thiosulphate were employed as Ni^{2+}, Pb^{2+} and sulfide sources, respectively. All the chemicals were reagent grades meanwhile deionized water (Alpha-Q Millipore) was employed as solvent. 25 mL of 0.5 M sodium thiosulfate was added into the beaker that contained 25 mL of nickel sulphate (0.5 M) and 25 mL of 0.5 M lead nitrate, respectively. Then, these beakers were mixed together for few minutes. The pH of a mixture of two solutions was adjusted to pH 1.6 by using hydrochloric acid. The ultrasonically clean glass substrate was then placed vertically inside the beaker without disturbing it. The deposition process was carried out for different deposition times (10-32 hours) at room temperature. After completion of film deposition, the glass substrate was removed from the beaker and cleaned with distilled water.

The deposited thin films were characterized for optical properties. Absorbance spectra were recorded in the range of 300-900 nm by means of Perkin Elmer UV/Vis Lambda 20 spectrophotometer. The film-coated glass substrate was placed across the sample radiation pathway while the uncoated glass substrate was put across the reference path. The absorption data will be employed in order to investigate band gap energy.

RESULTS AND DISCUSSION:

Optical absorption spectra of the nickel lead sulphide thin films prepared at various deposition times were shown in Figure 1. At first glance, all the prepared films indicate absorption value in the visible region. The figure 1a confirms a high absorption value for the films deposited for 32 hours. This is due to the growth of thick films requires quite longer times. In contrast, only a weak absorption value could be detected for the films prepared for 10 hours (Figure 1f) and 12 hours (Figure 1e). In other words, the thinnest films were obtained in very short time at room temperature.

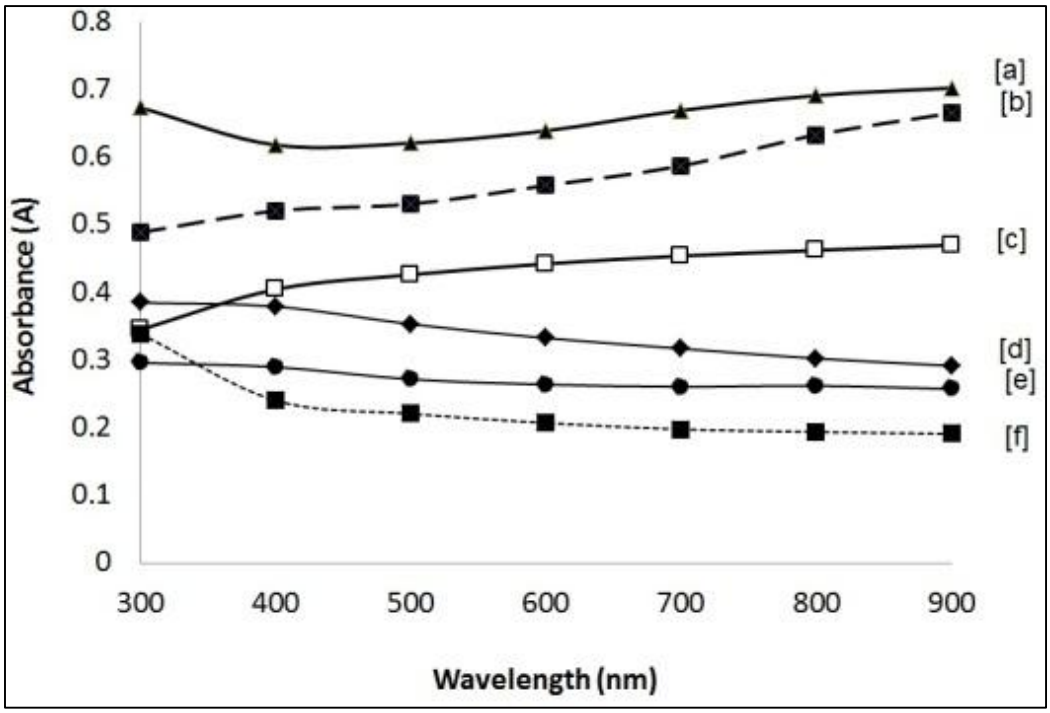

Figure 1: Optical absorption spectra of nickel lead sulphide thin films deposited at various deposition times. [a] 32 hours [b] 30 hours [c] 26 hours [d] 24 hours [e] 12 hours [f] 10 hours

In this experiment, the band gap and transition type were derived from mathematical treatment of data such as below:

$$(Ahv)^{2/n} = k(hv - E_g)$$

Where A is optical absorbance, hv is energy, h is the Planck constant, v is frequency, E_g is band gap, k is constant value, n carries the value of either 1 or 4.

The curves in the plots $(Ahv)^2$ versus hv have been extrapolated to the energy axis in order to study the band gap energy. The straight line behaviors in Figure 2 to Figure 7 represent direct transition of the band structure. Here, the band gap values show very important variations with deposition time. Thus, the band gap values obtained for different deposition periods in the range of 0.9 to 1.3 eV (Table 1).

Table 1: Band gap energy of nickel lead sulphide thin films prepared at various deposition times

Deposition time (hours)	Band gap (eV)
10	1.2
12	1.15
24	0.9
26	1.3
30	0.95
32	1.0

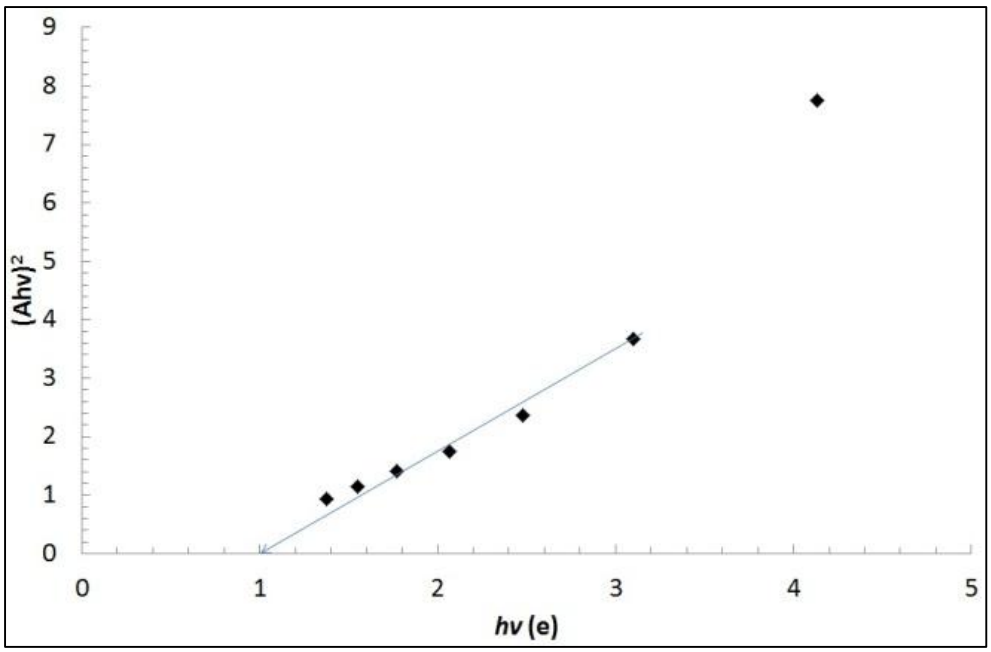

Figure 2: Band gap of nickel lead sulphide thin films deposited by chemical bath deposition with deposition time of 32 hours.

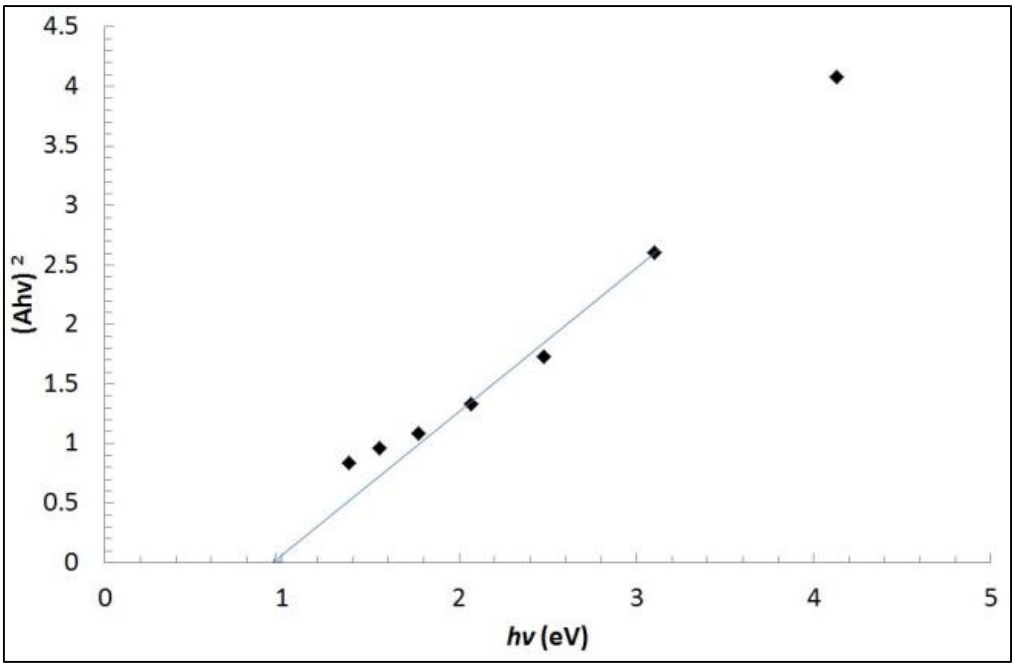

Figure 3: Band gap of nickel lead sulphide thin films deposited by chemical bath deposition with deposition time of 30 hours.

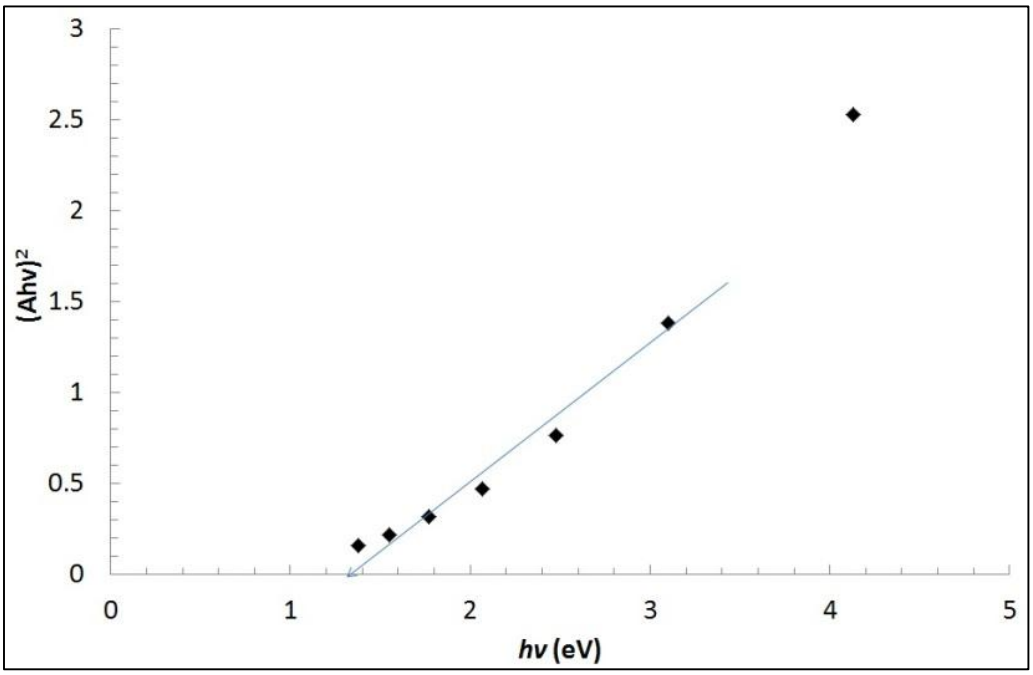

Figure 4: Band gap of nickel lead sulphide thin films deposited by chemical bath deposition with deposition time of 26 hours.

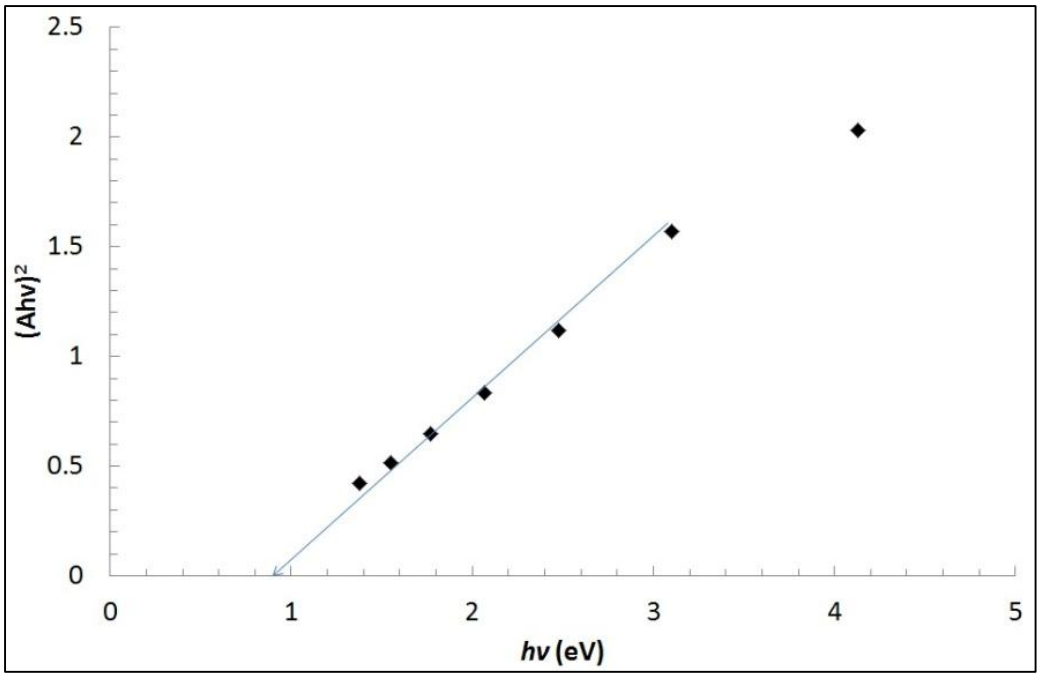

Figure 5: Band gap of nickel lead sulphide thin films deposited by chemical bath deposition with deposition time of 24 hours.

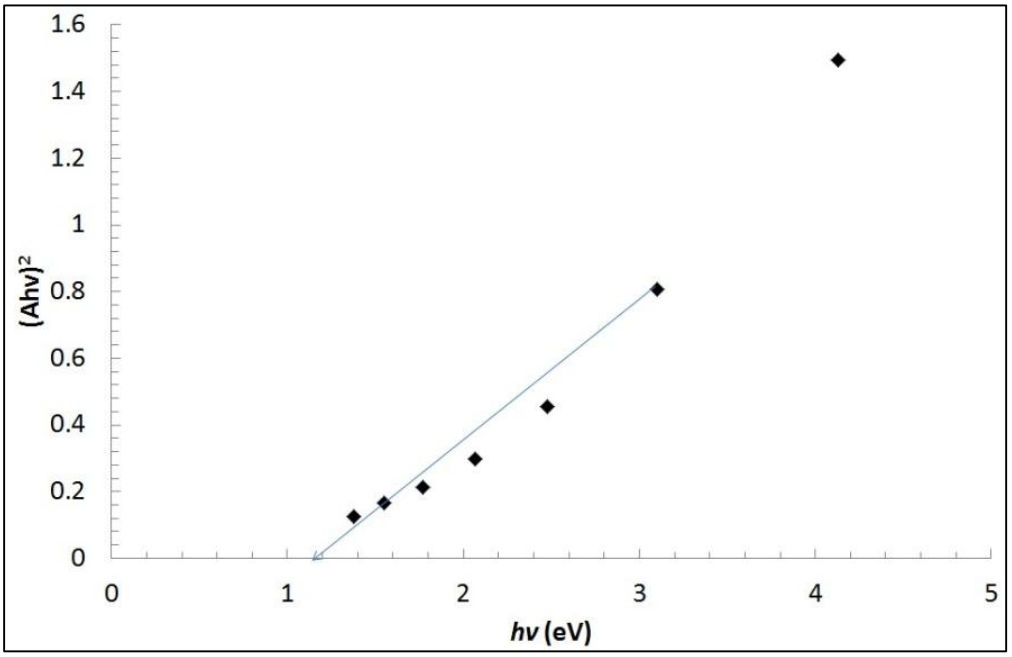

Figure 6: Band gap of nickel lead sulphide thin films deposited by chemical bath deposition with deposition time of 12 hours.

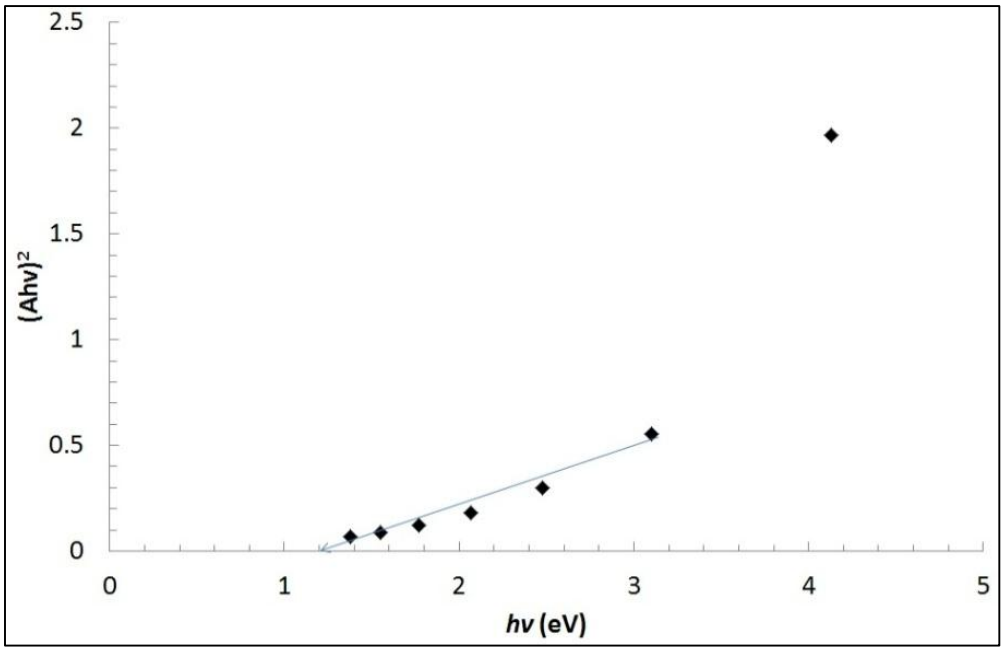

Figure 7: Band gap of nickel lead sulphide thin films deposited by chemical bath deposition with deposition time of 10 hours.

CONCLUSION

This work presents the influence of deposition time on the chemical bath deposited nickel lead sulphide thin films. The present method is simple and economic. The obtained films were characterized by using UV-visible spectrophotometer technique. The band gap values are in the range of 0.9 to 1.3 eV for the films prepared with different deposition times from 10 to 32 hours.

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