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Analysis of Optical Energy Band Gap of Aluminium Zinc Sulphide(Al2ZnS4)Ternary Thin Films Grown by Solution Growth Technique Kingdom

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Abstract

Background: Aluminium Zinc Sulphide (Al_2ZnS_4) Ternary Thin Films were successfully grown on the substrates by Solution Growth Technique (SGT). The sources of Aluminium, Zinc and Sulphur ions are Aluminium Chloride, Zinc Sulphate, ethylenediamine tetraacetic acide (EDTA), concentrated ammonia solution and thiourea. The films were annealed at 300˚C for 2 hours and characterized by UV-VIS-NIR Spectrophotometer in the wavelength range of 300nm-1000nm to determine the optical properties of the films. The optical transmittance was obtained directly by the Spectrophotometer. Other optical properties were determined by theoretical calculations. The average energy band gaps of the films grown at two different temperatures are 3.63 and 3.77eV for different dip times. The other optical properties have been reported. From the results, the wide direct energy band gap exhibited by the films reveals that the films are suitable materials as window layer in solar cells fabrication.The high transmittance exhibited by the films reveal that the films are promising material for the construction of roofs and walls poultry houses. This will provide the needed heat required for warming of young chicks and has the potential to reduce the cost of energy consumption associated with the use of electric bulbs, stoves and lambs which will produce the needed heat to warm young birds.

Methods: The ternary thin films of Aluminium Zinc Sulphide (Al_2ZnS_4) were deposited using solution growth technique. Prior the deposition, glass substrates (slides) degreased in trioxonitrate (V) acid for 24 hours, washed with detergent, rinsed in de-ionized water and dried in air. The purpose of degreasing the surfaces is to provide nucleation centers for the growth of the films, thereby yielding adhesive uniformity grown films. The films were grown in different concentrations 0.1M, 0.3M and 0.5M; at different temperatures 300K and 333K for different dip times 2 hours and 24 hours. The chemical bath for the deposition of Al_2ZnS_4 contains 16mls of 0.1M of $AlCl_3$, 16mls of 0.1M of $ZnSO_4$, 10mls of 0.1M of EDTA, 16mls of 0.1M of $CS(NH_2)_2$ and 10mls of concentrated aqueous ammonia (NH_3) in a 100ml beaker. The same volume of mls of solution was used for the deposition of films at the concentrations of 0.3M and 0.5M respectively. The mixture was stirred with magnetic stirrer for the uniformity of the solution. EDTA and ammonia solution were used as a complexing agents which slow down the in order to eliminate spontaneous precipitation. The substrates were dipped into the reaction baths vertically with help of the perforated synthetic foam. The substrates were allowed to remain in the bath for different dip times 2 hours and 24 hours. The films were washed in de-ionized water and dried in air after each deposition. After the deposition, the films were annealed at temperature of 300oC for 2 hours and characterized for optical transmittance using UV-VIS-NIR Spectrophotometer.

Results: Consumption indicators in Ukraine decreased from 11.5358 DID in 2013 to 10.0884DID in 2015 and increased from 11.0792 DID in 2016 to 12.4731 DID in 2018.

The consumption in the United Kingdom has decreased from 18.2765 DID in 2013 to 16.2636 DID in 2018, despite a slight increase in 2014 (18.5068 DID).

Throughout the study period, antibiotics were consumed more in the United Kingdom than in Ukraine. The largest difference in antibacterial for systemic use consumption between the two countries was recorded in 2015 (1.8 times).

Conclusion: New ternary thin of Aluminium Zinc Sulphide grown have been successfully deposited on glass substrate using solution growth technique. The optical characterization was examined using UV-VIS-NIR Spectrophotometer. The result reveals that the wide energy band gap exhibited by the films make them suitable photovoltaic and optoelectronic applications

Keywords: Zinc Sulphide; aluminium

Introduction

The new ternary thin films of Al2ZnS4 are one of the essential ternary compounds for optoelectronic device applications. The deposition and study of the properties of ternary chalcognide compounds and their application in solar cells, light emitting diode and other optical devices has increased in recent years (Ortega- Lopez etal; 2003).Ternary compounds are recommended as suitable materials for window layer in solar cells (Woon-Jo and Gye-Choon, 2003). Ternary compounds have been deposited by advanced technological methods but a simple and low cost solution growth technique improves much better. Solution growth technique is an interesting technique which produces high quality semiconductor thin films (Wang etal; 1999). This technique has been employed in producing emerging materials for solar cells, protective coatings, solar thermal control in buildings which was adopted by industries (Chopora etal; 1985, Nnabuchi, 2005, and Ezema etal; 2009). It is also the technique for depositing many films at a single run.

Methods

The ternary thin films of Aluminium Zinc Sulphide (Al2ZnS4) were deposited using solution growth technique. Prior the deposition, glass substrates (slides) degreased in trioxonitrate (V) acid for 24 hours, washed with detergent, rinsed in de-ionized water and dried in air. The purpose of degreasing the surfaces is to provide nucleation centers for the growth of the films, thereby yielding adhesive uniformity grown films. The films were grown in different concentrations 0.1M, 0.3M and 0.5M; at different temperatures 300K and 333K for different dip times 2 hours and 24 hours. The chemical bath for the deposition of Al2ZnS4 contains 16mls of 0.1M of AlCl3, 16mls of 0.1M of ZnSO4, 10mls of 0.1M of EDTA, 16mls of 0.1M of CS(NH2)2 and 10mls of concentrated aqueous ammonia (NH3) in a 100ml beaker. The same volume of mls of solution was used for the deposition of films at the concentrations of 0.3M and 0.5M respectively. The mixture was stirred with magnetic stirrer for the uniformity of the solution. EDTA and ammonia solution were used as a complexing agents which slow down the in order to eliminate spontaneous precipitation. The substrates were dipped into the reaction baths vertically with help of the perforated synthetic foam. The substrates were allowed to remain in the bath for different dip times 2 hours and 24 hours. The films were washed in de-ionized water and dried in air after each deposition. After the deposition, the films were annealed at temperature of 300oC for 2 hours and characterized for optical transmittance using UV-VIS-NIR Spectrophotometer

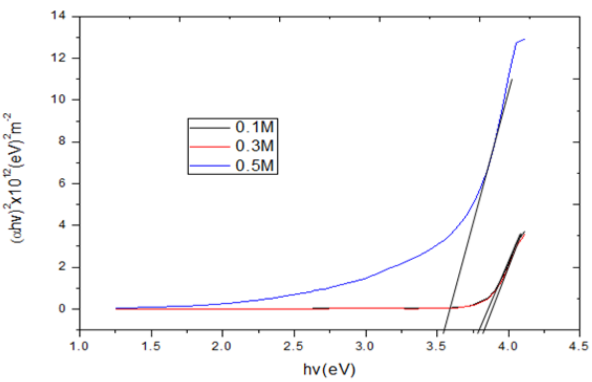

Figure 1: The dynamics of AB consumption based on number of DDDs per 1000 inhabitants per day (DID) during the examined 6-year period in UA and UK.

FIGURE 2: Plots of (αhv)2 as a Function of Photon Energy at Different Concentrations at 333K

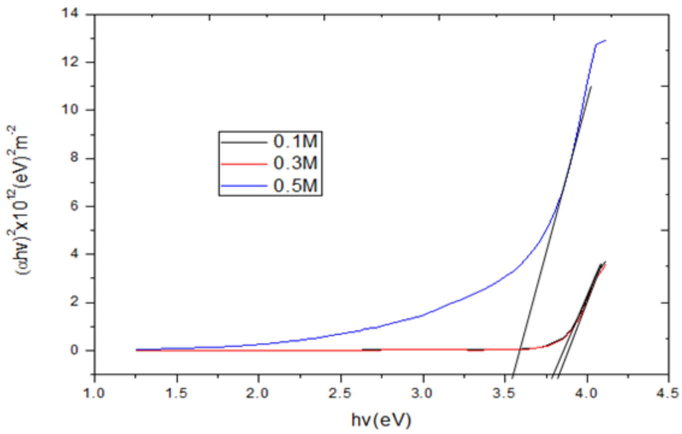

Fig.2: Plots of (αhv)2 as a Function of Photon Energy at Different Concentrations at 333K

Discussion

Figure 1. shows the plots of (αhv)2 as a function of hv for the determination of band gap of Al2ZnS4 thin films deposited at 300K. The direct energy band gap values are 3.80eV, 3.70eV and 3.40eV for 0.1M, 0.3M and 0.5M respectively. Clearly, a band gap narrowing can be observed with increase in concentration. The determination of band gap of Al2ZnS4 thin films at 333K was achieved by plotting the graph of (αhv)2 as a function of hv at different concentration (Fig. 2). As observed in fig.2, the band gap vary in the same manner, decreasing from 3.85eV for 0.1M to 3.80eV for 0.3M and 3.65eV for 0.5M. These band gap values are higher compared to that of Uhuegbu (2007) for CuZnS and FeZnS thin films. However, they are in agreement with that of Kumar, Sharma, Gaur and Sharma (2008), Shinde, Ahirrao and Patil (2011), Igweoke, Augustine, Idenyi, Okorie and Anyaegbunam, (2018) for binary ZnS thin films. The wide direct band gap exhibited by these films make them good as window layers in heterojunction solar cells (Petkov, Todorov, Kozhuharova, Tcky, Cernoskova and Ewen, 2006; Agbo, 2011). Therefore, Al2ZnS4 thin films deposited and characterized may be used as alternative for possible incorporation in CIGS solar cells.

CONCLUSION

New ternary thin of Aluminium Zinc Sulphide grown have been successfully deposited on glass substrate using solution growth technique. The optical characterization was examined using UV-VIS-NIR Spectrophotometer. The result reveals that the wide energy band gap exhibited by the films make them suitable photovoltaic and optoelectronic applications.

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