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OPTICAL PROPERTIES OF InS THIN FILMS PREPARED BY SPRAY PYROLYSIS TECHNIQUE

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Abstract : Indium sulphide (InS) thin films have been synthesized by spray pyrolysis technique at 300°C temperature by spraying aqueous solutions of $InCl_3$ and thio urea. Thickness of as deposited thin films were measured by weighing method and found in the range of 0.4840 µm, 0.4734µm and 0.4578 µm. Indium sulphide has recently attracted much attention due to its potential in optical sensors as photo conducting material and in photovoltaic applications as a wide gap material. The optical measurement showed films had a maximum transmittance of 68 % in the visible region. Energy band gap varied in the range 2.54 eV, 2.42 eV and 2.34 eV .The optical parameters of the films have been determined using conventional transmission and reflection spectra. The optical study that included the absorption and transmission spectra in the spectrum wavelength ranges 380-998 nm demonstrated that the value of absorption coefficient was $10^{-5}m^{-1}$.

***IndexTerms* – InS, chemical spray pyrolysis, thin films, optical properties.**

INTRODUCTION

In recent years, there has been increasing interest in III-IV semiconductor materials for their potential applications in opto-electronic, photovoltaic industries and photo electrochemical solar cell devices.[1-2] . Indium sulphide is one of the prominent wide band gap semiconductors that have an attractive fundamental property suitable for device applications, particularly for photovoltaic cell [3]. The optical properties of Indium sulphide (In_2S_3) thin films depend on their synthesis process and on their composition. It can be found in literature that its band gap varies from 2.0[4] to 2.4[5-6]. Indium sulphide thin films can be used as effective nontoxic substitute for cadmium sulphide (CdS) in copper indium gallium selenide (CIGS) based solar cell [7-9]. Indium sulphide thin films have high transmittance in the visible spectrum [10-11].Therefore, they have been used as buffer layer in photovoltaic structures [12-14] They have also been used as an absorber layer in nanostructure solar cell [15-17] . And obtain more environment friendly photovoltaic technology [18]. Using an In_2S_3 layer replaces the toxic cadmium, besides the optical properties of the buffer layer are improved because this material has a band gap wider than the one of CdS [19].The indium sulphide can be binary base materials to be a suitable substitute for the deposition of semiconductor compound such as $CuInS_2$, a popular absorber material in hetero-junction solar cell device structures [20-21] .

EXPERIMENTAL

Chemical spray pyrolysis (CSP) is a simple, low cost technique in which the deposition parameter can be easily varied. In the present work, spray solution were mixtures of indium chloride ($InCl_3$) and thio urea .The solution was sprayed on glass substrates at substrate temperature 300°C. using fixed volume at all rates is 30 ml. These films were yellowish in color. The In/S ratio in the solution was varied by varying the molar concentration of $InCl_3$ and thio urea. Thickness of the as deposited films were measured by using the weighing method and found to be in the range of 0.4840µm, 0.4734µm and 0.4578µm .Optical properties were studied using a UV-VIS spectrophotometer [3].

RESULT AND DISCUSSION

The optical absorption of indium sulphide thin films with concentration was measured within the wavelength range of 380-998 nm. As shown in the Fig.(1) ,the spectra of indium sulphide thin films presented the strong absorption in the ultra –violet range[2].Fig.(2) shows the optical transmittance curves as function of the wavelength. The films present a high transmittance in the visible wavelength range .The absorption coefficient (α) was determined by the following equation:

$$\alpha = 1/t \ln (1/T)$$

Where T is transmittance and t is the film thickness .The absorption coefficient was found in the order of $10^{-5}m^{-1}$[21]. Fig.(4) shows the $(\alpha h\upsilon)^2$ versus photon energy plots, which were used to calculate optical band gap values of sprayed indium sulphide films .For an allowed direct band gap, the absorption coefficient can be related to the photon energy($h\upsilon$) by

$$(\alpha h\upsilon) = A (h\upsilon - Eg)^{1/2}$$

Where A is a constant, Eg is the optical band gap .The interception of $(\alpha h\upsilon)^2$ versus photon energy plots gives the optical band gap values of indium sulphide thin films and values of optical band gap found to be 2.54 eV, 2.42 eV and 2.34 eV [22].

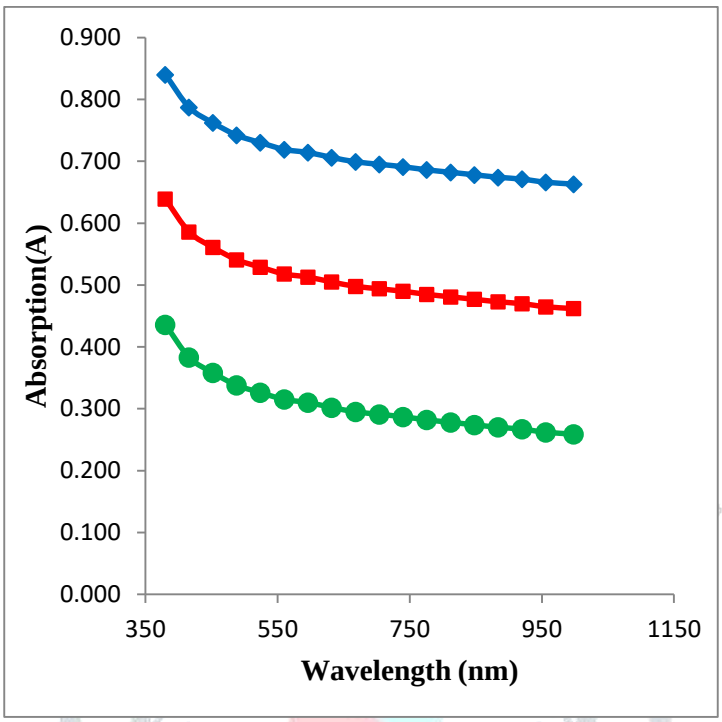

Fig.1: The absorption spectra of InS thin films as a function of wavelength

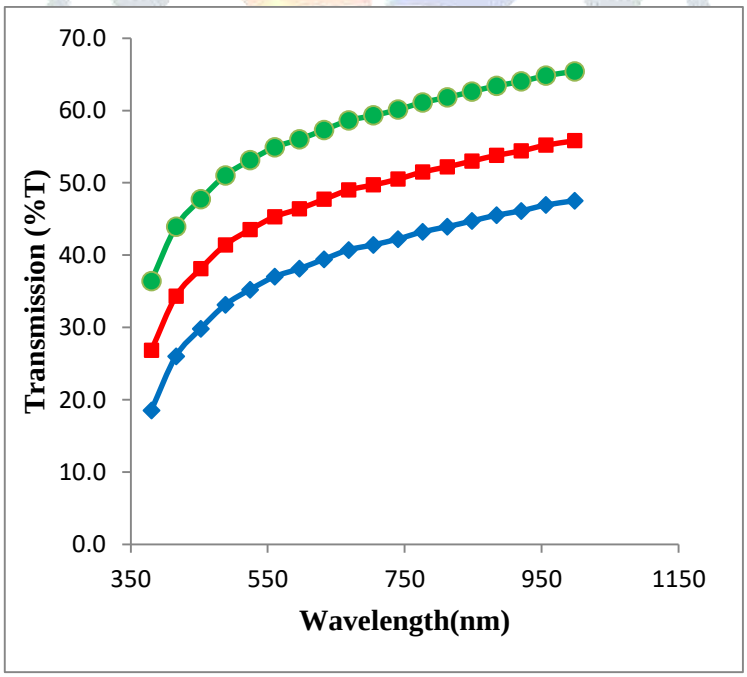

Fig 2: The transmission spectra of InS thin films as a function of wavelength

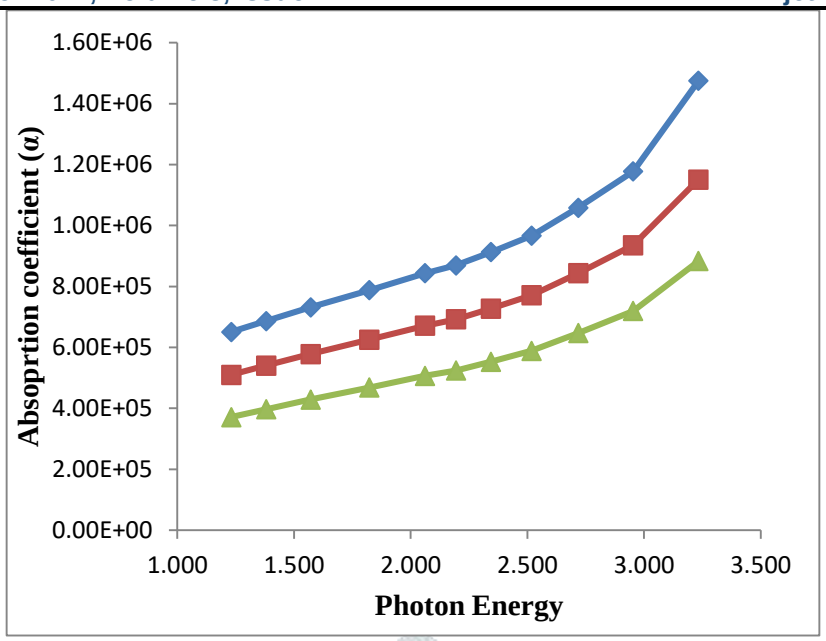

Fig 3: The absorption coefficient of InS thin films as a function of photon energy

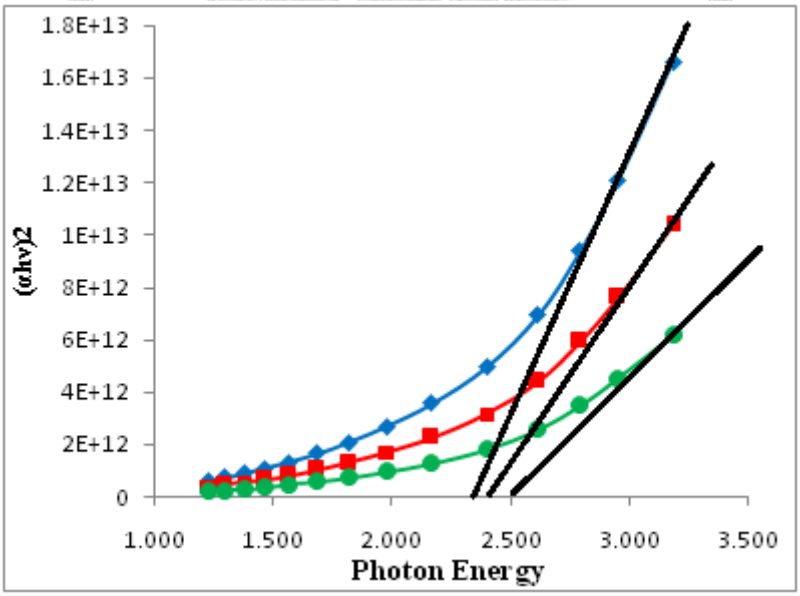

Fig 4: Optical energy band gap for the direct allowed transition of InS thin films

CONCLUSION

We have studied in this paper the optical properties of indium sulphide thin films prepared by chemical spray Pyrolysis technique at 300°C temperatures. The thicknesses of the deposited thin films were found 0.4840 µm, 0.4734µm and 0.4578µm. The UV – visible spectra showed that indium sulphide thin films have strong absorption in the ultra range .Indium sulphide thin film has high transmittance 68% which is suitable for photovoltaic application. The absorption coefficient was found in the order of 10 $^{-5}$m^{-1}. From optical studies direct band gap of indium sulphide thin films varied from 2.54 eV, 2.42 eV and 2.34 eV.

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