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Band gap of Cadmium Sulfide thin films as a function of thickness by spray pyrolysis method

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Abstract: CdS thin films are prepared on glass substrate using aqueous solutions of cadmium chloride and thiourea in double distilled water by using spray pyrolysis deposition method at 350^0C temperature. The prepared CdS thin films of varying thickness are characterized by optical and micro structural using UV-VIS spectrophotometer and X ray difractometer. Optical absorption measurements in the visible region (380-1000 nm) were carried out. The strong absorption edge of the absorption spectrum shift towards longer wavelength as function of thickness of the CdS film. Strong absorption edge is used to calculate the optical energy band gap. The calculated values of energy band gap of CdS films are in close agreement with literature values.

Key Words:- **CdS thin films, XRD, optical energy band gap, CdS semiconductor**

1. Introduction

Study of thin films of metal and non metal compounds is a old and important field of research [1]. The measurement of electronic applied for solid powder semiconductor materials. But in this note we demonstrates how the band gap of thin films determined from its UV absorption spectrum is a simple and no thickness of the film is required. The present determinations explore semiconducting behavior of thin films of II-VI group elements [3].

Energy band gap of nano material is important in the semiconductor and solar industries [2]. In the present work, a simple method to determine energy band gap [1] is utilized which is in fact

2. Experimental

Biological glass plates which are used for disposition are content of impurity. So before deposition the glass substrate was cleaned several times in conc. Nitrate acid, alcohol and distilled water to remove the impurities on the surface of substrate. The glass substrate is weigh on electron unipan microbalance of accuracy 10-4 gm. Aqueous solutions of Cadmium chloride (MW 201.32gm/cc) (0.01N) and thiouria (M 76.12gm/cc) (0.01N) were mixed together at room temperature to form a stock solution. Different volumes of stokes solution (5ml to 20ml) were sprayed on pre cleaned glass slides at 350^0 C to form CdS thin films on glass substrate [4-7].

XRD of these films were obtained on X-Ray difractometer. Nature of the deposited thin films were checked from the XRD pattern and it is found that the deposited thin films are crystalline in nature and of nanometer size.[9] (Fig-1)

3. Result and discussion:

Optical absorption of the deposited CdS films (A1-A8) were measured in the visible region (380-1000nm) on ELCO-SL-159 Spectrometer.The resulting absorption spectrum of all the spraypyrolytically prepared CdS thin films shown in fig (2). The absorption spectrum recorded showed the strong cutoff where the absorbance value is minimum. The cutoff value is utilized to calculate electronic energy band gap by the following equation [2,3,9]

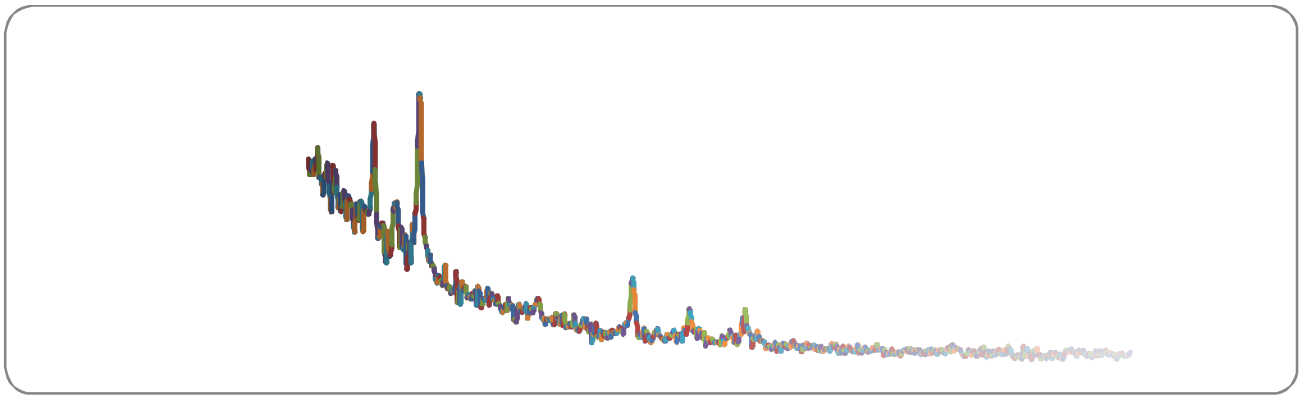
$E = hC/\lambda_c$ ----------(1)

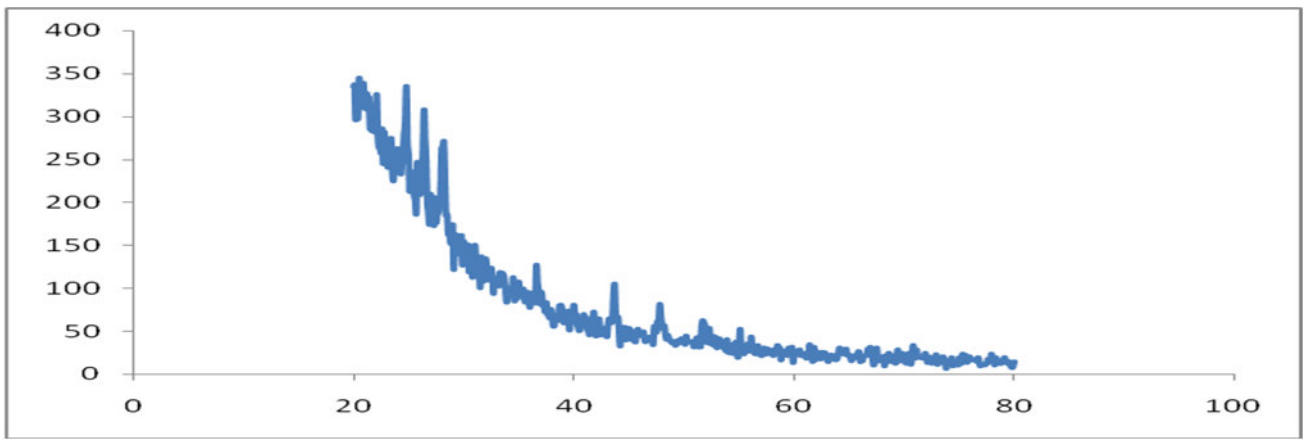
Where h= Plancks constant=$6.626 * 10^{-34}$ Joules.sec

C= velocity of light = $3*10^{-8}$ m/s

λ_c = Cutoff wavelength at strong absorption

1 eV = $1.6*10^{-19}$ Joules (conversion factor)





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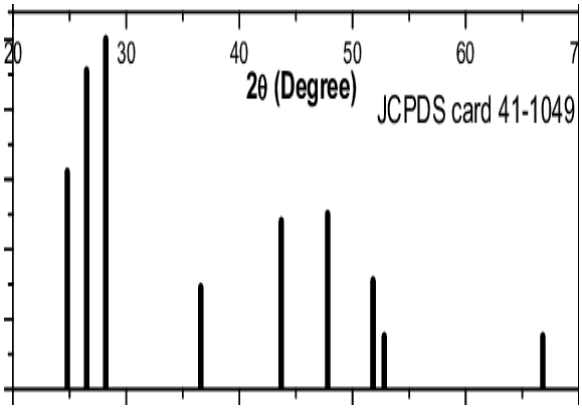

Fig (1) XRD of CdS film no A1 and no. A8 with JCPDS Card no.41-1049

Structural characterization: - XRD pattern of CdS thin film deposited by spray Pyrolysis method (fig. 1). The film was characterized by using X-ray diffractometer. The XRD pattern is mixed phases of Cubic and hexagonal symmetry [4].The peak observe at 2θ = 24.8°, 26.2°, 28.2°,34.6^{O} 43.5^{O} and 52.8° (JCPDS card no. 41-1049). A sharp peak located at the angle 24.8° is assigned as the (111) plane of the cubic phase [14]. The other orientation are observed at (200), (211),(222) The nature of deposited CdS thin film is polycrystalline.

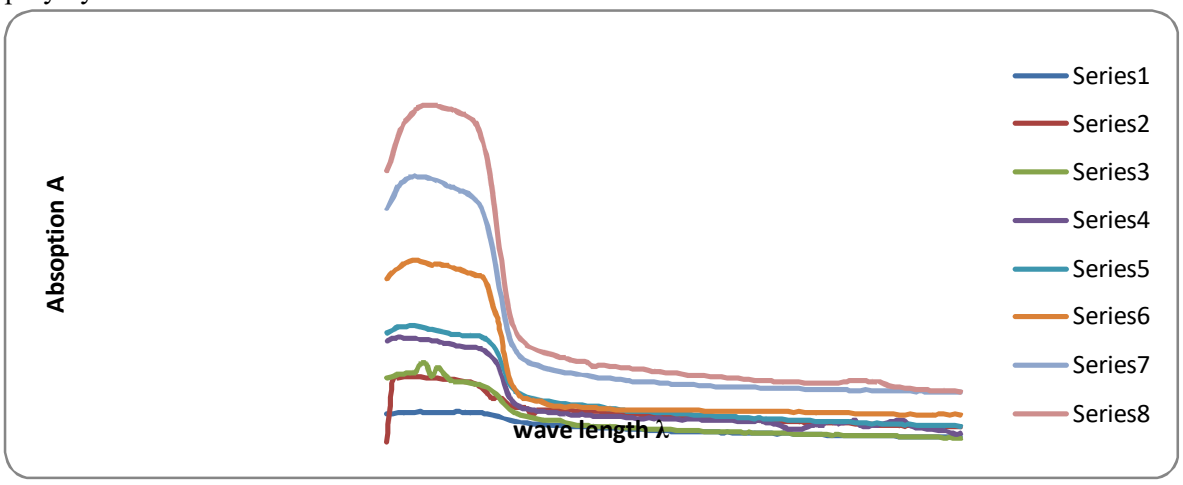

Fig2. Absorption spectra Vs excitation wavelength λ nm of CdS thin films.
series1-(film-1 0.120 µm), series2-(film-1 0.133 µm), series3-(film-3 0.138 µm), series4-(film-4 0.145 µm), series5-(film-5 0.156 µm), series6-(film-6 0.160 µm), series7-(film-7 0.167 µm), series8-(film-8 0.190 µm)

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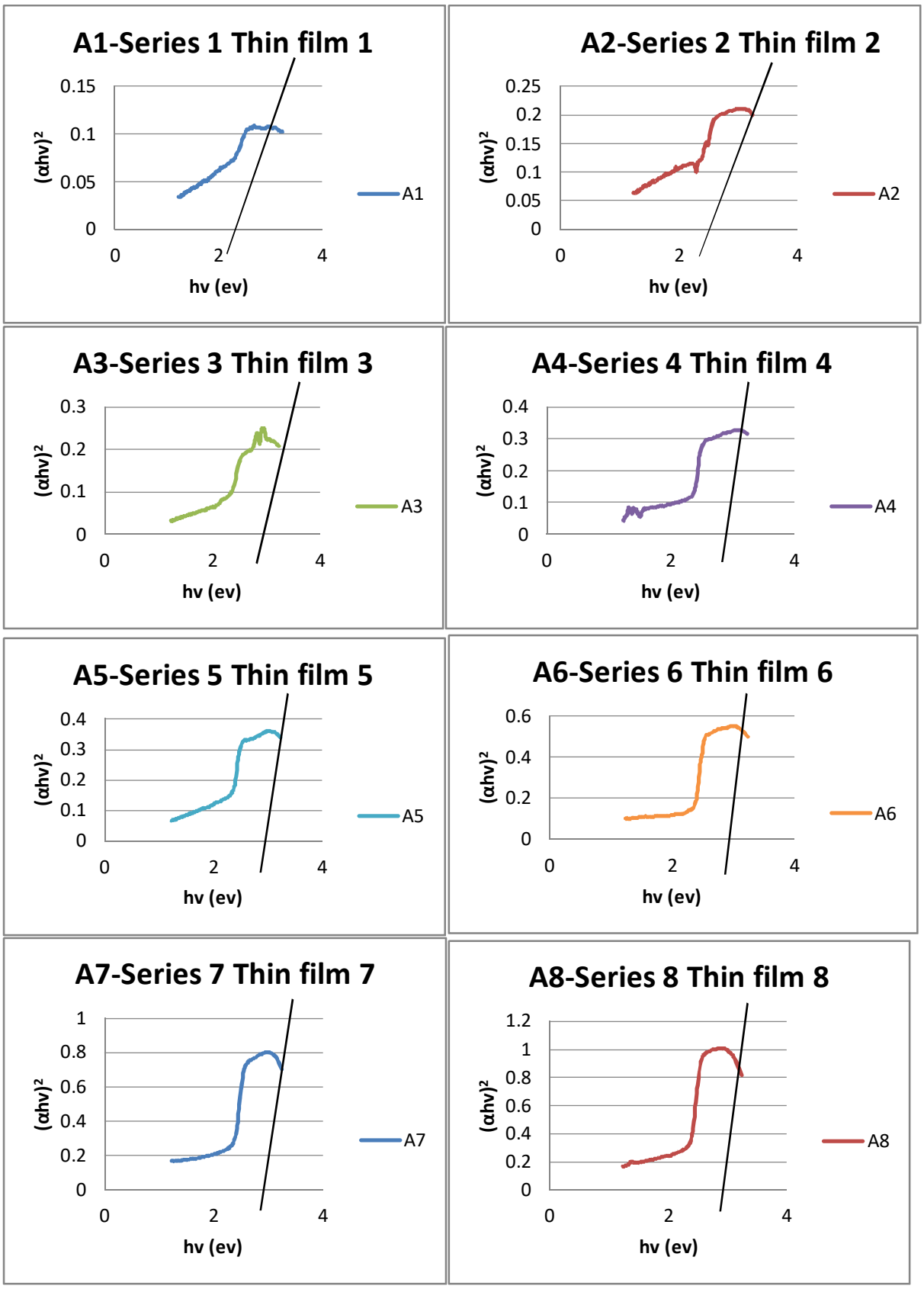

Fig3. **$(\alpha hv)^2$** Vs **hv (ev) i.e. Optical energy band gap** of Different CdS thin films From thin film 1to 8.

4. Conclusion

Absorption vs wavelength plots of CdS films shows strong absorption edge shifting as function of thickness of the film. From strong absorption edge, an optical energy ban gap was determined. In the absorption spectra, the strong absorption edge shift towards longer wavelength side [10-12].

In this present note, optical energy band gap of CdS thin films lies in the range of semiconductor material band gap (E_g = 1.8 to 2.4 eV) and it decreases as function of thickness of the thin film. This shows that CdS thin film behaves as semiconducting behavior, may be because of the material size which is of the order of nanometer size.[10-13] The XRD pattern of CdS thin films matches with JCPDS card and literature and from that we can say that CdS thin films of polycrystalline structure is form. The thickness of the thin film and XRD of the thin films show crystalline nature and of nanometer size [14].

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