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The Optical and Structural Properties of CdS Nano particles Prepared By Spray Pyrolysis Technique

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ABSTRACT
Thin films of CdS have been prepared on glass substrates by the chemical spray pyrolysis method at 250°C from solutions including different concentrations of Na_2S (0.2 g and 0.4 g). The films were examined using SEM, an X-ray spectrometer, and a UV-Visible spectrometer. The SEM images and X-ray spectrum show that the films were amorphous, and the grain size varied with Na_2S concentration. The optical properties and optical constants also varied clearly with Na_2S concentration; in addition, the energy gap changed from 2.3 eV to 2.4 eV for both films.

Keywords: CdS thin films, chemical spray pyrolysis, CdS nanoparticles.

I. INTRODUCTION

Cadmium sulfide is a solid, yellow and inorganic material, with band gap 2.42 eV [1-3] , it is a binary n-type semiconductor belonging to group II-VI of the periodic table and crystallizes with the hexagonal structure (wurtzite) and cubic structure (zinc blende) [4]. thin films of Cadmium sulfide CdS have a many application in technical fields such as photo electrochemical cells [5], Sensors [6, 7], Photocatalysis [8], Detectors [9], microwave heating [10]. Thin film of CdS can be prepared by several techniques such as electro-deposition [11], spray coating [12, 13], successive ionic layer adsorption [14], pulsed laser deposition (PLD) [15], Electron-beam evaporation [16]. In our study, thin films of CdS have been deposited on glass substrates at constant deposition temperature (250°C), Nano thin films can be deposit from different concentration[17], in our study, from mixtures include different concentration of Na_2S as in Tabel (1), the films then examined using several modern techniques such as Scanning electron microscope SEM, X-ray spectrum and UV-Visible spectrophotometer

II. EXPERIMENTAL METHOD

Cadmium sulfide thin films have been deposited on a glass substrate by chemical spray pyrolysis, the substrates were cleaned ultrasonically using methanol, acetone, and distilled water, ,then the slides were left to dry in a clean room. Sodium sulfide (Na_2S) and cadmium chloride ($CdCl_2$) were used as sources for sulfide and cadmium elements, respectively, Different

concentrations (0.2 and 0.4 g) of Na_2S were used to prepare CdS thin films (Table 1). Each compound was dissolved in 50 ml of distilled water, both mixtures were then mixed using a magnetic stirrer for 1 hour at 80°C . the later solution left for 1 minute to separate the big particles from the solution. The other parameters have been kept constant as shown in table (1).

Table 1 . deposition parameters of chemical spray pyrolysis method

Na_2S g	$CdCl_2$ g	Dep.Tem p°C	No.of sprays	Sprays rate ml/min	Pressure kg/cm²	Distance cm
0.2	0.3	250	20	5.7	7.5	25
0.4						

III.RESULTS AND DISCUSSION

Thin films of CdS were prepared on glass substrates using spray pyrolysis technique at 250°C and different concentration of Na_2S (0.2 g and 0.4 g).

Scanning electron microscope images shows that the films are completely amorphous and grain size increases with Na_2S concentration , the average grain size varied from 8.993 nm to 39.57 nm for the films prepared from a mixtures include 0.2g of Na_2S and changed from 80 nm to 300 nm for the films prepared from 0.4g of Na_2S figure (1), the increase in the grain size can be result from the grow and aggregation of the grains due to the increase in the production of CdS compound.

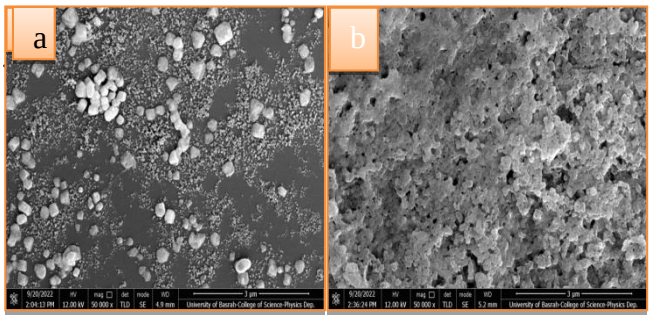

Figure (1) Scanning electron microscope images of CdS thin films (a) 0.2g of Na_2S (b) 0.4g of Na_2S

The X-ray spectrum shows that the films are completely amorphous with slight presence of crystalline phase depending on the Na_2S concentration. Scherer equation was used to calculate grain size for the films, the grain sizes were 17.97 nm and 313.41nm for the films prepared from solutions contain 0.2g and 0.4g of Na_2S respectively figure (2), and this agree with grain size in SEM images.

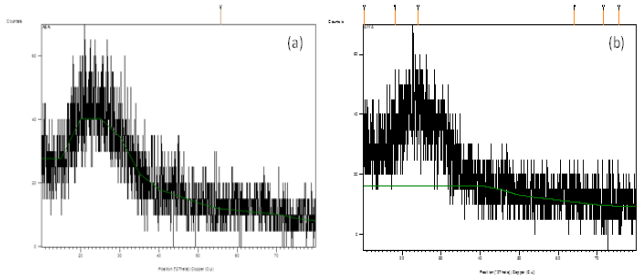

Figure (2) X-ray spectrum of CdS thin films (a) 0.2g of Na_2S (b) 0.4g of Na_2S.

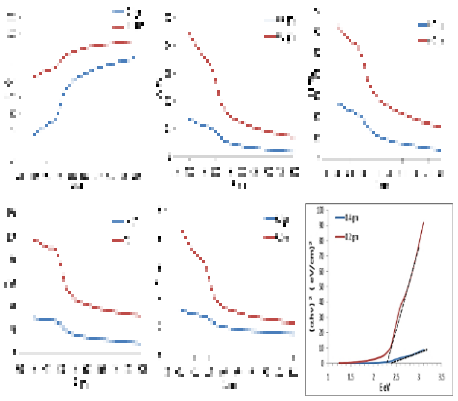

Figure (3) The optical properties and optical constants for the films prepared from solutions including 0.2g and 0.4g of Na_2S.

The optical properties and optical constants have been clearly changed for the films prepared from solutions including different concentrations of Na_2S, the transmittance, absorbance and reflectance were varied over the wavelength range (400-550 nm) then remain constant for the higher wavelengths, similarly, the optical constants (refractive index (n) and extinction constant (K)) were decreases over the same range of wavelengths (400-550 nm) figure (3). The energy gaps have been calculated for both concentrations and we found that the energy gap was 2.3eV for the films

prepared from solutions including 0.2g of Na_2S while it became 2.4eV for the films prepared from solutions including 0.4g of Na_2S. The variation in the optical properties and optical constants may be result from the variation the films structures and grain size.

IV. CONCLUSION

Scanning electron images show that the average grain size varied from 8.993 nm to 39.57 nm and from 80 nm to 300 nm for the films prepared from a solution that included 0.2 and 0.4 g of Na_2S. The SEM images and X-ray spectra show that the films are completely amorphous with a slight presence of a crystalline phase depending on the Na_2S concentration. The energy gap was 2.3 eV for the films prepared from solutions including 0.2 g of Na2S, while it became 2.4 eV for the films prepared from solutions including 0.4 g of Na_2S.

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