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Effects of pH on CdSe Films Fabricated by Electrodeposition

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Abstract: ***In this study, CdSe thin films fabricated by using electro deposition. Effects of pH of the final solution were investigated by this study. Structural properties were analyzed by using XRD diffractometer. When the pH is 3.5, the peak intensity is relatively high optical properties were investigated by UV-vis spectrophotometer. Optical band gap varied between 2.06 and 2.35 eV Surfaces morphologies were analyzed by using a SEM devices.***

Keywords: CdSe thin films, electrodeposition, XRD, UV, SEM

1. Introduction

II-VI thin films of compound semiconductors have studied much interest of many researchers.. II-VI compound semiconductors have the band gap between 1-3 eV in the visible region and these semiconducting materials are used worldwide in optoelectronic devices [1]. Cadmium selenide (CdSe) formed in solid hexagonal or cubic crystal structures with dark red appearance. CdSe is an n-type semiconductor material with a band gap of 1.74 eV at 300˚K. The molecular weight of CdSe is 191.37g/mol where Cd is 58.74% and Se is 41.26% [2]. The technologies such as molecular beam epitaxy, vacuum evaporation, electro deposition have been mostly used for preparation of cubic CdSe thin films [3]. In this study CdSe films obtained by electro deposition with different solution pH.

2. Experimental Procedure

In this study, chronoamperometry method of electrodepositing was employed for deposition of CdSe thin films. Before the deposition, bath container and ITO coated glass substrate were washed with soap and rinsed with deionized water. In the experiment, pH of the final solutions was adjusted to 2.51, 3,08, 3.5 and 4.1 by HCl acid. The summarized experimental procedure was given in Table 1.

Table 1: The deposition requirements of the CdSe thin films

Experiments	0,05M $CdCl_2$	0,025M $Na_2Se_2O_3$	0,1 M KCl	Cathodic Potential (V)	Deposition duration (s)	Deposition temperature (°C)	pH
S1	100mL	100 mL	100 mL	-1	3.25	50±2	2,51
S2	100 mL	100 mL	100 mL	-1	3.25	50±2	3,08
S3	100 mL	100 mL	100 mL	-1	3.25	50±2	3,50
S4	100 mL	100 mL	100 mL	-1	3.25	50±2	4,10

After the deposition, the samples were washed by using deionized water and dried in room temperature.

3. Results and Discussion

3.1 Optical studies of CdSe thin films

In Fig. 1, the transmittance plots are given. According to the plots, the transmittances were varied between 10% and 40%. The band gaps of the films were calculated by well-known Tauc Plots. And in Fig. 2, the transmittance plots are given. The band gaps of the films were varied 2.06 and 2.35. This study showed us that band gap of the CdSe films are depended on pH.

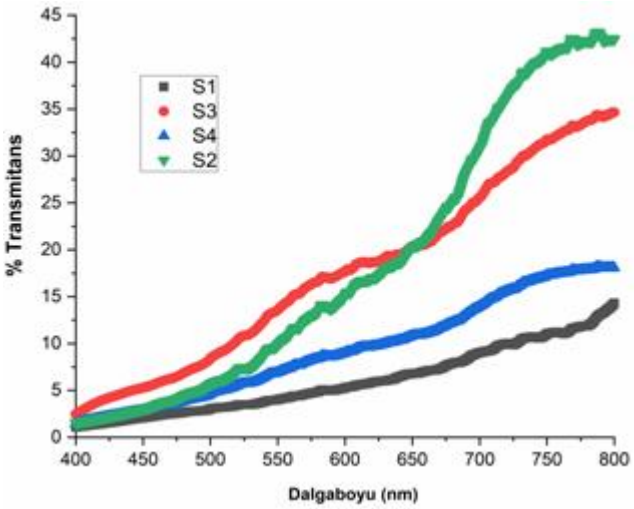

Figure 1: Transmittance spectra of CdSe thin films

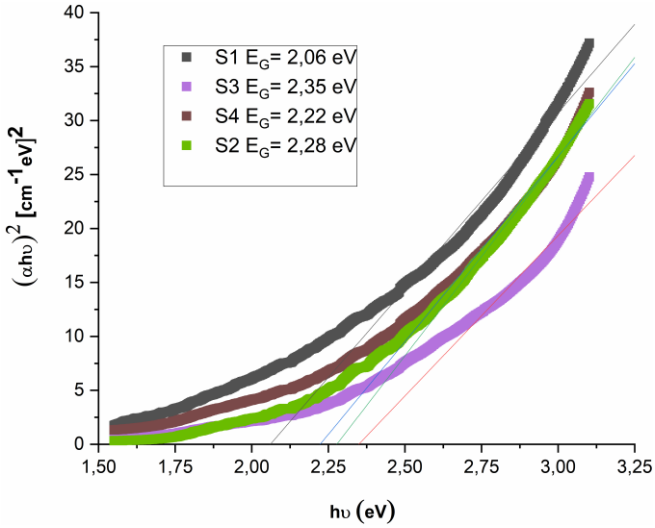

Figure 2: Tauc plots and band gaps of CdSe thin films

3.2 Surfaces of CdSe thin films

The SEM image of the film obtained at pH=2.51 was given in Fig. 4. This surface is very compact and pinhole free. This surfaces were magnified 50000 X and 90000X.

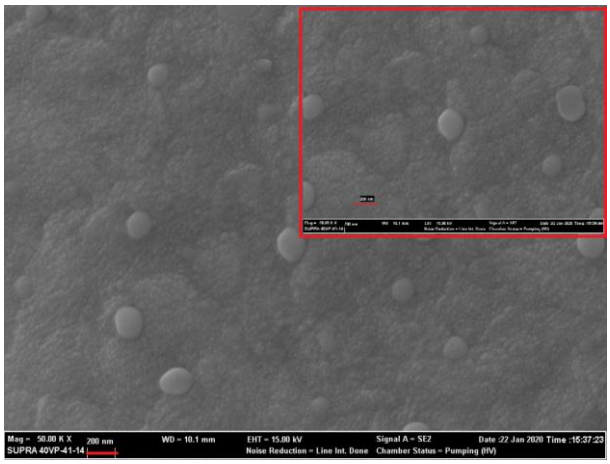

Figure 3: SEM images of the CdSe thin films SEM obtained at pH=2.51. magnified 50000 times and 90000 times.

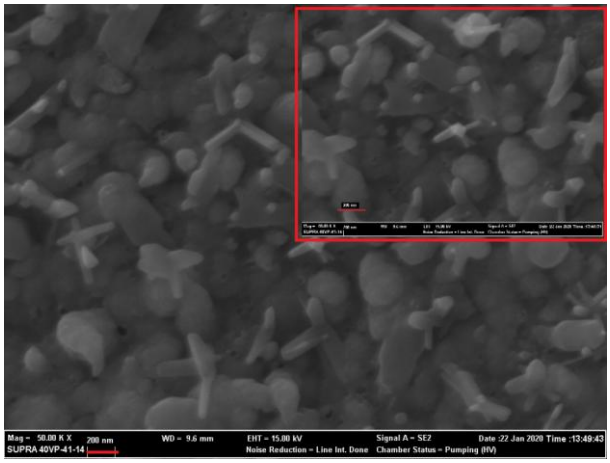

Figure 4: SEM images of the CdSe thin films SEM obtained at pH=3.08 magnified 50000 times and 90000 times.

According to the Fig.5, the surface was covered polymorphic form. There is no pinhole and cracks. Fig. 5 shows CdSe films obtained at pH= 3.50 this surface is very smooth, compact and pinhole free. The Fig. 6 shows the SEM image of the film obtained at pH=4.10. This surface is compact but on the surface there are CdSe particles.

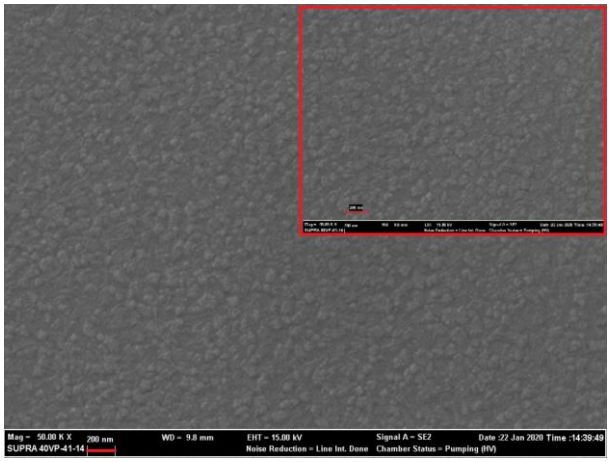

Figure 5: SEM images of the CdSe thin films SEM obtained at pH=3.50 magnified 50000 times and 90000 times

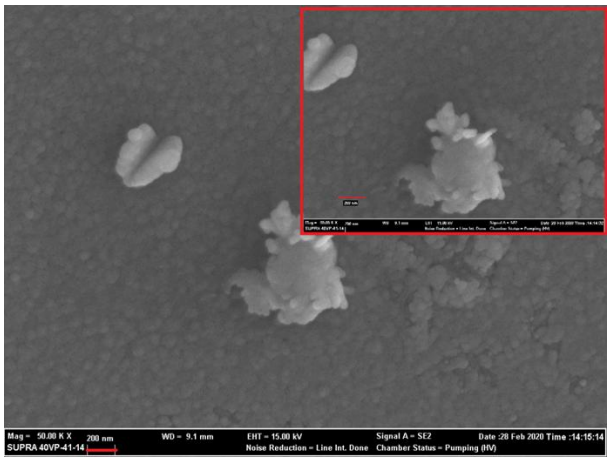

Figure 6: SEM images of the CdSe thin films SEM obtained at pH=4.10 magnified 50000 times and 90000 times

3.3 XRD of the CdSe thin films

The XRD patterns of the CdSe films were given in Figure 7. It has been determined that when the films produced at pH of 2.51, the film has 4 peaks at different angle values belonging to the cubic CdSe structure. The peaks were observed at 25.39, 30.38, 47.87, 61.15 and 62,32 angels according to (111), (111), (022), (004) and (222) plane respectively. These peaks are related to the (98-062-0421), (98-018-1027), (98-018-1026), (98-062-0421) ve (98-018-1027) ASTM card no. The texture confidents were given in Table 2. When the Table 2 was investigated, it was seen that the preferred orientation was depend on pH.

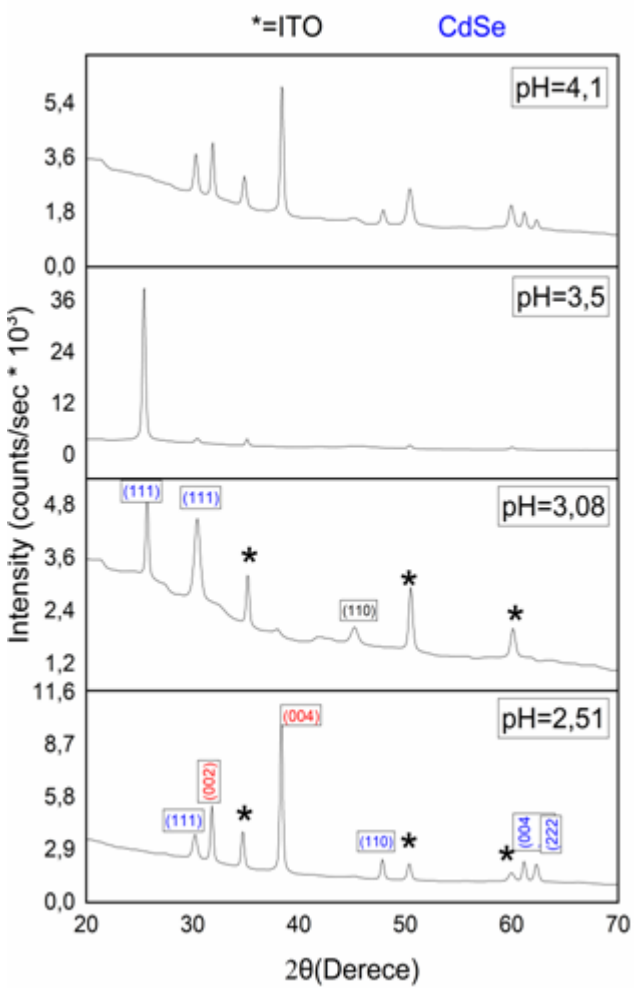

Figure 7: X-ray diffractograms of CdSe thin films acquired at different pH

Table 2: The intensity, texture coefficient and film thickness of the CdSe thin films

Experiment	2θ	Intensity (Count/ Seconds)	I / I_O	TC	(hkl)
S1	**30,1659**	**3730,491**	**15,2**	**1,068541**	**111**
	47,8299	**2381,707**	**14,45**	**1,015817**	**022**
	61,2619	**2074,221**	**15,24**	**1,071353**	**004**
	62,2739	2097,677	12,01	0,844288	222
S2	**25,7499**	**5077,893**	**100**	**1,047066**	**111**
	30,4419	4503,721	91,01	0,952934	111
S3	**25,4739**	**38992,05**	**100**	**1,946851**	**111**
	30,4419	3943,055	2,73	0,053149	111
S4	**30,2579**	**3721,599**	**28,04**	**1,880932**	**111**
	47,8299	1819,319	10,63	0,713064	110
	61,1699	1811,616	13,29	0,891498	004
	62,2739	1541,149	7,67	0,514506	222

Table 3: The crystalite size, dislocation densities, micro strain values and average stress values of the CdSe thin films

Experiment	Crystalıte Sıze (nm)	Eg (eV)	Mikro Strain	Dislocation Density (lines/m^2)*10^{15}	Average Stress (10^{10} N/m^2)
S1	17,97	2,06	0,184	3,1	153
S2	29,66	2,28	-0,0033	1,14	-2,73
S3	25,47	2,35	-0,00064	1,14	-0,531
S4	22,47	2,22	0,170	1,98	1,42

4. Conclusion

By this study, the CdSe samples were obtained by using electrodepositing. The structural properties were investigated by using a XRD device. According to the XRD patterns, CdSe films could be produced. The optical properties were analyzed by using absorbance data. It was seen that band gap was varied depending of pHs of the final solutions. The surface morphologies were investigated by using SEM images. According to the SEM images, the pinhole free and compact films could be obtained.

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Author Profile

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