

Fig.2 Plots of $(\alpha hv)^2$ vs. $h\nu$ of the $(Cd_xZn_{1-x})S:CdCl_2$ Thin Film.

The calculated values of refractive index n and extinction coefficient k were plotted as a function of wavelength, as shown in the fig. 3. We also calculated the real and imaginary part of the dielectric constant as it is directly related to the density of states within the energy gap of the films.

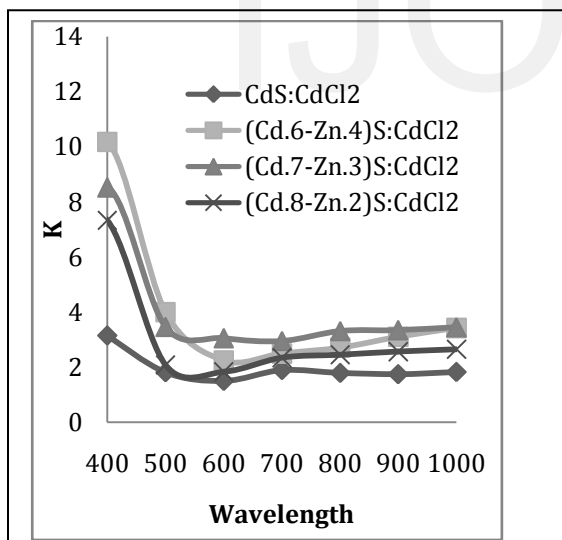


Fig.3(a) Variation of Extinction Coefficient k with wavelength

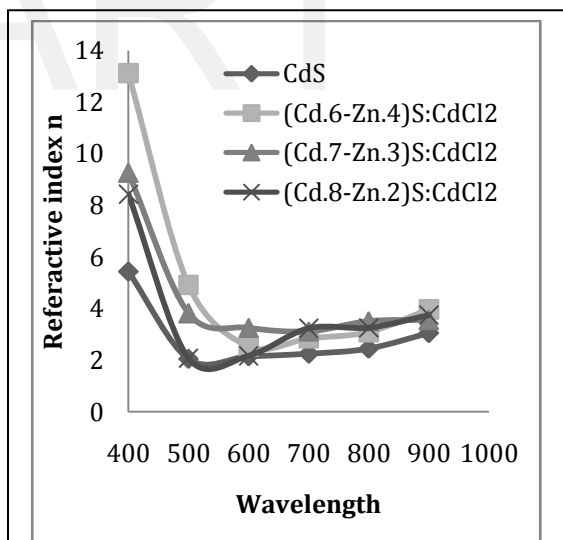


Fig.3(b) Variation of Refractive Index n with wavelength

The real (ϵ_1) and imaginary (ϵ_2) parts of the dielectric constant of the films are shown in figs. 4a and 4b respectively. It is seen that both, real and imaginary parts of dielectric constant decreases with increasing wavelength. It is seen that the values of real part is higher than that of the imaginary part. Increasing Zn content causes important changes in these optical constants.

T A B L E: Direct energy band gaps and the optical constants for the $(\text{Cd}_x\text{Zn}_{1-x})\text{S}:\text{CdCl}_2$ thin films

Material	E_g	E_o	E_d	M_1	M_3
$\text{CdS}:\text{CdCl}_2$	2.8	3.99	11.93	2.989	0.1878
$(\text{Cd}_{.6}\text{-Zn}_{.4})\text{S}:\text{CdCl}_2$	2.92	4.4	12.59	2.861	0.1478
$(\text{Cd}_{.7}\text{-Zn}_{.3})\text{S}:\text{CdCl}_2$	3.0	3.5	15.89	4.539	0.3706
$(\text{Cd}_{.8}\text{-Zn}_{.2})\text{S}:\text{CdCl}_2$	3.09	4.4	12.59	2.861	0.1478

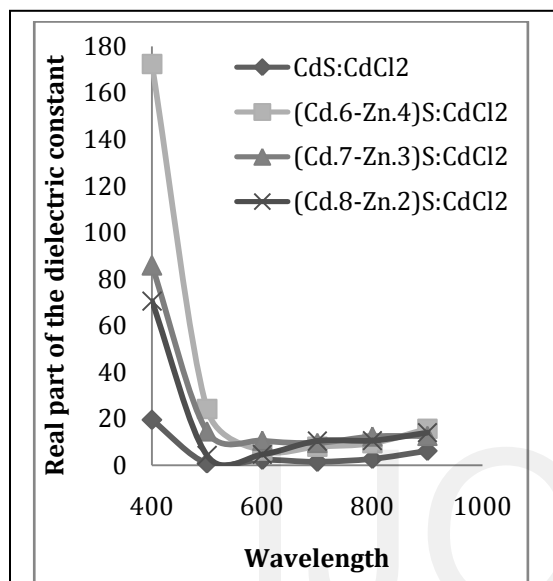


Fig.(4a) Real part ϵ_1 of the dielectric constant

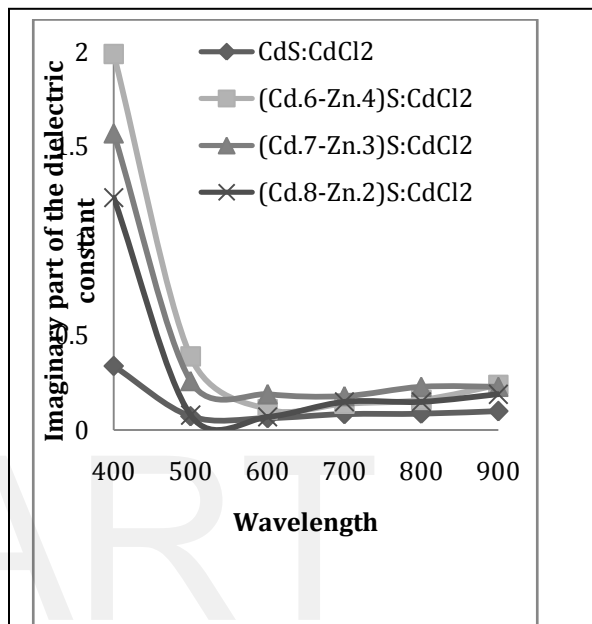


Fig.(4b) Imaginary part ϵ_2 of the dielectric constant

The single-oscillator parameter were calculated and discussed in terms of the Wemple-Di-Domenico model. The dispersion parameters of various materials were investigated by using the model, as reported in [14, 17]. This model describes the dielectric response for transitions below the optical gap. This plays an important role in determining the behavior of the refractive index. The dispersion data of the refractive index can be described by a single-oscillator model [18].

$$n^2 - 1 = \frac{E_d E_o}{E_o^2 - (h\nu)^2}$$

Where E_o and E_d are single oscillator constants (E_o is the single-oscillator energy and E_d is the dispersion energy which is a measure of the strength of interband optical transitions). By plotting $(n^2 - 1)^{-1}$ versus $(h\nu)^2$ and fitting a straight line shown in fig. 5,

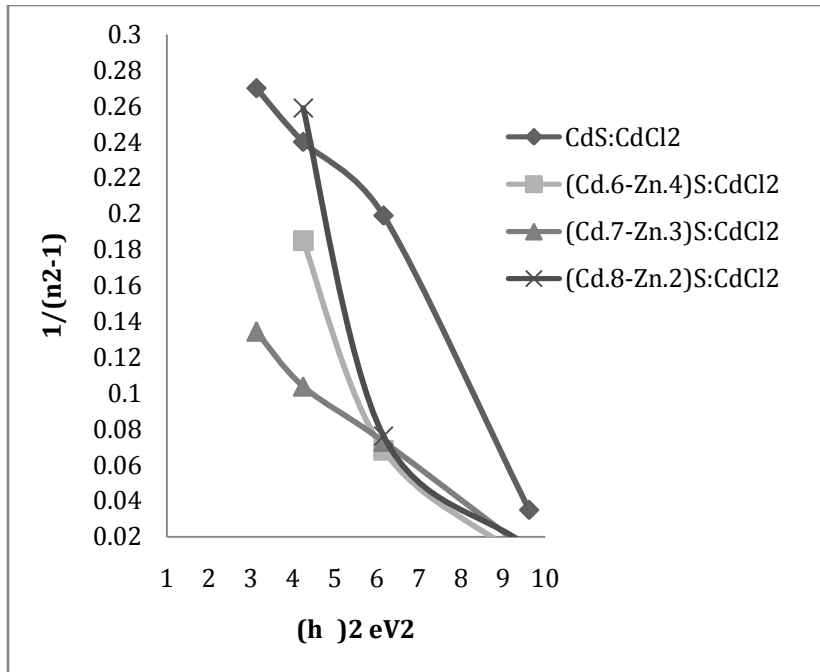


Fig.5 Plots of $1/(n^2 - 1)$ vs. $(hv)^2$ for the $(\text{Cd-Zn})\text{S}:\text{CdCl}_2$ thin films.

E_0 and E_d are determined directly from the gradient, $(E_0 E_d)^{-1}$ and the intercept (E_0/E_d) , on the vertical axis. The values of E_0 increases with increasing Zn content. The E_0 and E_d values for the $((\text{Cd}_x\text{Zn}_{1-x})\text{S}:\text{CdCl}_2)$ thin films are given in the table. The oscillator energy E_0 is an average energy gap as pointed out in many references [19-22]. We found that E_0 value of the films is related empirically to the lowest direct band gap by $E_0 \approx 1.36 E_g$. This relation is in agreement with the relation $(E_0 \approx 1.4 E_g)$ obtained with the use of single oscillator model [19].

The M_{-1} and M_{-3} moments of the optical spectra can be derived from the following relation:

$$E_0^2 = \frac{M_{-1}}{M_{-3}}$$

$$E_d^2 = \frac{M_{-1}^3}{M_{-3}}$$

The values obtained are given in the table. It is seen that M_{-1} and M_{-3} moments have a tendency to increase with an increase in Zn content.

4. Conclusion

$(\text{Cd}_x\text{Zn}_{1-x})\text{S}:\text{CdCl}_2$ ($x=0, x=.2, x=.3, x=.4$) thin films have been deposited by CBD method on glass substrate at 60°C . Based on the optical investigation of the films, the following results were obtained. The maximum transmission value is obtained for $(\text{Cd}_{.7}\text{Zn}_{.3})\text{S}:\text{CdCl}_2$ film. The optical constants such as refractive index (n), extinction constant (k), real part of dielectric constant (ϵ_1) and imaginary part of the dielectric constant (ϵ_2) of the films, were calculated for the films. All of these constants decreases with wavelength. The optical absorption spectra of the films under study shows that the absorption spectra mechanism is due to direct transition. The optical dispersion (E_0 and E_d) using Wemple-Di-Domenico model were also analyzed. In conclusion we can state that the influence of Zn content on the optical properties of CdS thin films is noticeable.

References:

- [1] L. Zhou, Y. Xue, J. Li, Journal of Environmental Sciences **21**(1), S76 (2009).
- [2] J. Cheng, D. Fan, H. Wang, B. Liu, Y. C. Zhang, H. Yan, Semicond. Sci. Technol. **1h8**, 676 (2003).
- [3] A. E. Raevskaya, A. L. Stroyuk, S. Y. Kuchmiy, V. M Dzhagan, M. Y. Valakh, D. R. T. Zahn, J. Phys.: Condens. Matter **19**, 386237 (2007).
- [4] A. Banerjee, P. Nath, V. D. Vankar, K. L. Chopra, Physica Status Solidi **46**(2), 723 (2006).
- [5] R. Xie, U. Kolb, J. Li, T. Basché, A. Mews, J. Am. Chem. Soc. **127**(20), 7480 (2005).
- [6] S. Bhushan, S. Pillai, Radiation Effects and Defects in Solids **163**(3), 241 (2008).
- [7] M. Gunasekaran, P. Ramaswamy, M. Ichimura, J. Electrochem. Soc. **153**(7), G 664 (2006).
- [8] I. O. Oladeji, L. Chow, Thin Solid Films **474**, 77 (2005).
- [9] S. Fujji, N. Tasaki, N. Shinomura, S. Kurai, Y. Yamada and T. Taguchi; J. Light, Vis. Env. **31**(2), 61(2007).
- [10] H. K. Min, L. Sung-Nam, P. Nae-Man, P. Seong-Ju, Jpn. J. Appl. Phys. **39**, 6170 (2000).
- [11] S. Maraki, H. Nakanishi, M. Sugiyama, S. Chichibu, Physica Status Solidi (c) **5** (9), 3135 (2008).
- [12] O. Akinwummi, M. A. Elereja, J. O. Olowalafe, G. A. Adgboyega, E. O. B. Ajayi, Optical Materials **13** (2), 255 (1999).
- [13] O. S. Kumar, E. Watana, R. Nakai, N. Nishimoto, Y. Fujita, Journal of Crystal Growth **298**, 491 (2007).
- [14] A.H. Ammer, *Studies on Some Structural and Optical Properties of Zn_xCd_{1-x}Te thin films*, Applied Surface Science **201**(1-4), 2002, pp. 9-19.
- [15] F. Yakuphanoglu, M.Sekerci, *Optical Characterization of an Amorphous Organic Thin Film*, Optica Applicata **35**(2), 2005. Pp. 209-14.
- [16] F. Yakuphanoglu, M.Sekerci, *Determination of the Optical Constants of Co(II) Complex of Schiff base obtained from 1,8- diaminonaphthalene thin film by infrared spectra*, Journal of molecular Structure, **751**(1-3), 2005, pp. 200-3.
- [17] M. Caglar, M. Zor, S. Ilcan, Y. Caglar, *Effect of Indium Incorporation on the optical properties of Spray Pyrolyzed Cd₂₂Zn₇₈S thin films*, Czechoslovak Journal of Physics, **56**(3), 2006, pp. 277-87.
- [18] M. Didomenico, S. H. Wemple, *Oxygen-Octahedra Ferroelectrics I, Theory of Electro-Optical and Nonlinear Optical Effects*, Journal of Applied Physics **40**(2), 1969, pp. 720-34.
- [19] S. H. Wemple, M. Didomenico, *Behavior of the Electronic Dielectric Constant in Covalent and Ionic Materials*, Physical Review B: Condensed Matter **3**(4), 1971, pp. 1338-51.
- [20] K. Tanaka, *Optical Properties and Photoinduced Changes in Amorphous As-S films*, Thin Solid Films **66**(3), 1980, pp. 271-9.
- [21] E. Marquez, J.B. Ramirez-Malo, P. Villares, Jimenez-Garay R., Swanepoel R., *Optical Characterization of Wedge-Shaped Thin Films of Amorphous Arsenic Trisulphide based only on their Shrunken Transmission Spectra*, Thin Solid Films, **254**(1-2), 1995, pp. 83-91.
- [22] J.M. Gonzalez-Leal, E. Marquez, A.M. Bernal-Oliva, J.J. Ruiz-Perez, R. Jimenez-Garay, *Derivation of the Optical Constants of Thermally-Evaporated Uniform Films of Binary Chalcogenide Glasses using only their Reflection Spectra*. Thin Solid Films **317**(1-2), 1998, pp. 223-7.