

Investigation of Physical Properties in II-VI Ternary Semiconductors of Sulphides, Selenides And Tellurides

¹Alla Srivani , ²Prof Vedam Rama Murthy , ³G Veera raghavaiah

Assistant professor in Vasireddy Venkatadri Institute Of Technology (VVIT) Engineering College, Andhra Pradesh

Professor & Head Of The Department, T.J.P.S College, Guntur, Andhra Pradesh, Head Of The Department, PAS College, Pedanandipadu

Abstract: This work explains recent advances in II–VI Ternary Semiconductor Alloys. Current work has significant potential for low-cost, scalable solar cells. The close interplay among the properties of the materials and their utility in solar cells is also briefly discussed. Almost group II–VI materials are direct band gap semiconductors with high optical absorption and emission coefficients. Group II–VI materials are good candidates for use in solar cells. The Electrical and Optical Properties of II-VI Ternary Semiconductor Alloys from Binary Semiconductor Alloys are derived using Additivity rule with Quadratic expressions. The Electrical and Optical Properties studied in this group are confined to Refractive index, Optical Polarizability, Absorption coefficient and Energy gap. A comparison of these data is made with reported data available. The relative merit of Present method based on refractive indices without recourse to the experimental methods is stressed. Merits of study of this group alloys is also outlined.

Keywords: Semiconductors, II-VI Group, Sulphides, Selenides and Telluride Semiconductor alloys

I. INTRODUCTION

Compound semiconductors formed from II–VI or III–V elements are key materials in plans to harvest energy directly from sunlight in photovoltaic devices. In the search for low-cost alternatives to crystalline silicon, thin film compound semiconductor materials are commonly used, it offer advantages over silicon. It is more efficient to create an electric field at an interface among two different Semiconductor materials, known as a heterojunction. A typical polycrystalline thin film has a thin layer on top known as a “window” material if lets almost of the light through the interface to the absorbing layer. The absorbing layer has to have a high absorption to be weak in the generation of current and a suitable band gap to provide good voltage. This work shall focus on II–VI and III–VI materials, and emphasize their potential in solar cells and highlight challenges still to be met. [1]

7.1) CdS_xSe_{1-x}

The ternary compound CdS_xSe_{1-x} is a highly photosensitive material, and finds many practical applications such as in discrete and multielement photo resistors, in optical filters, signal memory devices, laser screens, LSI circuits, Infrared imaging devices, Optoelectronic switches, linear image sensor for digital facsimile page scanners, Electro photography, Image intensifiers and exposure meters. CdS_xSe_{1-x} films were deposited by thermal vacuum evaporation using the powders of CdS and CdSe synthesized in laboratory. The films were characterized by x-ray diffraction, optical studies, photo conductivity studies and photo electrochemical studies. By using the appropriate amount of pure selenium powder, sodium sulphide and triply distilled water, sodium seleno sulphate is obtained after heating at 95^0 C for nearly 20 hours.

Before the preparation of the CdS_xSe_{1-x} thin films, CdS_xSe_{1-x} powder was prepared by sintering the appropriate ratio of CdS and CdSe powders in argon atmosphere at 550^0 C for 20 min. The substrates used were glass and titanium, the substrate temperature was varied in the range of 300 to 473 K. The thickness of the films were found to be 2.5 m from weighing method. X-ray diffractograms of the CdSe, CdS and CdS_xSe_{1-x} films deposited at different substrate temperatures in the range 30 -200°C.indicated reflections corresponding to single phase hexagonal structure. As the substrate temperature is increased, the intensity of the peaks is found to increase. Films prepared at a substrate temperature of 200°C indicated maximum intensity with better crystalline nature [2].

7.2) $Zn_{1-x}Hg_xTe$

The Electro deposition and characterization of $Zn_{1-x}Hg_xTe$ (ZMT) thin films are reported. Many efforts have been focused on hetero structures based on popularly known ternary solid solution $Zn_{1-x}Hg_xTe$ ($0 < x < 1$) thin films as well as bulk materials. CdTe, HgCdTe and other compounds of II-VI group are sparingly promising materials for use in optoelectronic and high-temperature electronic devices. Ternary alloys of II-VI compounds are potential candidates for the detection of electromagnetic radiation. Zinc mercury telluride, a solid solution has a wide range of band gap tunable among 0 eV and 2.25 eV. $Zn_{1-x}Hg_xTe$ thin films Electro deposition offers a low cost, scalable technique for the fabrication of thin films [3].

7.3 $CdSe_{1-x}Te_x$

The alloys of $CdSe_{1-x}Te_x$ compound have been prepared from their elements successfully with high purity and stoichiometry ratio ($x=0.0, 0.25, 0.5, 0.75$ and 1.0) of Cadmium, Selenium and Telluride elements. Films of $CdSe_{1-x}Te_x$ alloys for different values of composition have been prepared by thermal evaporation method at cleaned glass substrates heated at 473K under sparingly low pressure of 4×10^{-5} mbar at rate of deposition ($3 \text{ \AA} / \text{s}$), after that thin films have been heat treated under low pressure of 10-2mbar at 523K for two hours [4].

7.4 $Zn_{1-x}Hg_xTe$

$Zn_{1-x}Hg_xTe$ films were deposited on to SnO₂ coated glass substrates from an aqueous solution bath of ZnSO₄, HgCl₂ and TeO₂ at bath temperatures among 30°C and 80°C. Well adherent $Zn_{1-x}Hg_xTe$ thin films with compositions various among $x = 0$ to $x = 0.4$ were obtained. The concern of growth parameters such as Deposition potential, concentration of electrolyte bath, pH and temperature on the properties of the film was studied. X-ray diffraction technique was used to determine composition, crystalline structure and grain size of the films. The films exhibited zinc blend structure with predominant (111) orientation. Optical and electrical studies were also reported and the results are discussed [5].

7.5 $Zn_xCd_{1-x}S$

The electronic and optical properties of $Zn_xCd_{1-x}S$ thin films are fabricated using chemical spray method. $Zn_xCd_{1-x}S$ thin films are deposited on glass substrates at 420°C substrate temperature. Optical data are recorded in the wavelength range 200-700nm. In addition, the absorption coefficient is determined and correlated with the photon energy to estimate the direct transition energy band gap. The crystalline size and degree of preferential orientation were found to decrease with the increase of Zn Concentration x . $Zn_xCd_{1-x}S$ thin films have been prepared by a variety of techniques, including spray pyrolysis, ion beam deposition, molecular beam epitaxial growth and screen printing method [6].

7.6 $Pb_{1-x}Sn_xTe$

The optical properties of single-crystal $Pb_{1-x}Sn_xTe$ thin films in the fundamental absorption edge region were investigated in compositions of $0 < x < 0.24$, where x is the mole fraction of SnTe. Two thin film samples with $x = 0.70$ and $x = 0.85$ were also studied in an try to confirm the inversion of the conduction and valence bands that had been previously predicted for this narrow-gap semiconductor. The index of refraction n and the absorption coefficient a were determined from transmission and reflection measurements made on films 0.8 to 5.0 microns thick, that were deposited on cleaved (100) faces of KCL rock salt substrates. The optical energy gap was determined from the position of the absorption edge in the absorption spectrum. The index of refraction was obtained using the interference fringe method. The absorption coefficient was calculated from an analysis of the theoretical reflectance R and transmittance T for a thin film on substrate [7].

7.3 Method of study

The refractive index, Optical polarizability, Absorption coefficient and Energy gap of II-VI Semiconductor alloys are evaluated by using Principle of additivity and quadratic expressions. The principle of additivity is used to study Physical properties even at very small compositions.

The calculated Properties of refractive index, Optical polarizability, Absorption coefficient and Energy gap versus concentrations was fitted by equations

Method 1

$$A_{12} = A_1 * x + A_2 * (1-x) + 1/1000 * \text{SQRT} (A_1 * A_2) * x * (1-x) \quad (7.1)$$

Method 2

$$A_{12} = A_1 * x + A_2 * (1-x) + 1/1000 * \text{SQRT} (A_1 * A_2 * x * (1-x)) \quad (7.2)$$

Method 3

$$A_{12} = A_1 * x + A_2 * (1-x) - 1/1000 * \text{SQRT} (A_1 * A_2 * x * (1-x)) \quad (7.3)$$

Method 4

$$A_{12} = A_1 * x + A_2 * (1-x) - 1/1000 * \text{SQRT} (A_1 * A_2 * x * (1-x)) \quad (7.4)$$

Additivity

$$A_{12} = A_1 * x + A_2 * (1-x) \quad (7.5)$$

Where A_{12} denotes Refractive index (n_{12}), Optical Polarizability (α_{m12}), Absorption coefficient (α_{12}) and Energy gap (E_{g12}). A_1 and A_2 denotes Refractive index (n), Optical Polarizability (α_m), Absorption coefficient (α), Energy gap (E_g) of two binary compounds forming ternary compound. The relations for Optical Polarizability, Absorption coefficient and Energy gap from Wave length and Refractive index values are given in previous III-Nitride Materials

II. RESULTS

The refractive index values of Ternary semiconductor alloys are calculated by using different expressions of 7.1 to 7.5 for whole composition range ($0 < x < 1$) and are presented in tables from 7.1 to 7.8. These values are compared with literature reported data [11, 12]. It is found that calculated values are in good agreement with reported values. Graphs are drawn for all these alloys by taking their composition values on x axis and Refractive index values on y axis. These graphs are given from fig 7.1 to 7.2.

The refractive indices at various wavelengths for the binary semiconductors are taken from hand book of Optical constants of solids [14] are presented in table 7.1 to 7.8 along with $\frac{1}{n-1}$ and $\frac{1}{\lambda^2}$ values. The graphs drawn between $\frac{1}{n-1}$ and $\frac{1}{\lambda^2}$ for these Semiconductors are shown in figures. From these graphs intercept α values and the slope β of the straight line are determined and γ values are calculated. All these values are given from the table 7.1. The evaluated Optical Polarizabilities of Binary Semiconductors by using equation 7.8 are also given from the table 7.6. The computed Optical polarizabilities by new dispersion relations are compared with reported values.

The values of Molecular weight (M), density (ρ) and refractive index (n) of the semiconductors which are required for evaluation of α_m are taken from CRC Hand book [15].

Table 7.1: Optical polarizability, Absorption coefficient and Energy Gap of $Cd_xHg_{1-x}Te$

X=0.00

Wave length λ (μm)	$\frac{1}{\lambda^2}$ $\ln(10)^8$ (cm^{-2})	R.I value n	$\frac{1}{n-1}$	Optical polarizability α_m $([10]^{-25} (cm)^3)$	Absorption coefficient (α) $([10]^{-1} cm^{-1})$	Energy Gap e.v
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4133	5.854	2.664	0.601	<u>Calculated</u>	<u>Reported</u>	2.44	<u>Calculated</u>	<u>Reported</u>
4158	5.784	2.678	0.596	107.7	82.03 [12]	2.4	1.50	
4235	5.576	2.727	0.579	108		2.3		1.42[8]
4315	5.371	2.790	0.559	110		2.21		
4370	5.236	2.844	0.542	111		2.14		
4426	5.105	2.908	0.524	113		2.1		
4543	4.845	3.056	0.486	115		2.01		
4699	4.529	3.175	0.459	118		1.83		
4900	4.165	3.239	0.447	121		1.59		
5120	3.815	3.279	0.439	122		1.35		
5277	3.591	3.313	0.432	123		1.21		
5488	3.320	3.382	0.419	124		1.05		
5765	3.009	3.586	0.387	128		1.01		

Table 7.2- Optical polarizability, Absorption coefficient and Energy Gap of Cd_xHg_{1-x}Te**X=0.20**

Wave length λ	$\frac{1}{\lambda^2}$ $\ln(10)^8$ (cms) ²	R.I Value n	$\frac{1}{n-1}$	Optical polarizability α_m ([10]) ⁻²⁵ (cms) ³		Absorption coefficient (α) ([10]) ⁻¹ cm	Energy Gap e.v	
				<u>Calculated</u>	<u>Reported</u>		<u>Calculated</u>	<u>Reported</u>
4133	5.854	4.943	0.254	<u>Calculated</u>	<u>Reported</u>	2.657	<u>Calculated</u>	<u>Reported</u>
4275	5.472	4.757	0.266	80.0	81.17	1.943	1.35	1.75[8]
4428	5.100	4.547	0.282		[12]	1.645		
4592	4.742	4.375	0.296			1.389		
4769	4.397	4.235	0.309			1.170		
4959	4.066	4.118	0.321			0.984		
5166	3.747	4.022	0.331			0.822		
5391	3.441	3.940	0.340			0.684		
5636	3.148	3.871	0.348			0.566		
5904	2.869	3.815	0.355			0.465		
7293	1.880	3.635	0.379			0.591		
8266	1.463	3.457	0.407			0.220		
						0.193		
						0.112		

Table7.3: Optical polarizability, Absorption coefficient and Energy Gap of Cd_xHg_{1-x}Te**X=0.29**

Wave length λ [(A)]	$\frac{1}{\lambda^2}$ $\ln(10)^8$ (cms) ²	R.I Value n	$\frac{1}{n-1}$	Optical polarizability α_m ([10]) ⁻²⁵ (cms) ³		Absorption coefficient (α) ([10]) ⁻¹ cm	Energy Gap e.v	
				<u>Calculated</u>	<u>Reported</u>		<u>calculated</u>	<u>Reported</u>
4133	5.854	4.781	0.264	<u>Calculated</u>	<u>Reported</u>	2.604	<u>calculated</u>	<u>Reported</u>
4275	5.472	4.582	0.279	78.2	80.23	2.539	1.42	1.85[8]
4428	5.100	4.404	0.294		[12]	2.478		
4592	4.742	4.258	0.307			2.424		
4769	4.397	4.135	0.319			2.378		
4959	4.066	4.032	0.330			2.336		
5166	3.747	3.945	0.339			2.300		
5391	3.441	3.872	0.348			2.269		
5636	3.148	3.815	0.355			2.244		
5904	2.869	3.758	0.362			2.218		
7293	1.880	3.509	0.398			2.159		
8266	1.463	3.404	0.416			2.334		

Table7.4: Optical polarizability, Absorption coefficient and Energy Gap of Cd_xHg_{1-x}Te

X=0.43

Wave length λ [(A)]	$\frac{1}{\lambda^2}$ In (10) ⁸ (cms) ²	R.I Value n	$\frac{1}{n-1}$	Optical polarizability α_m [(10)] ⁻²⁵ (cms) ³		Absorption coefficient (α) [(10)] ⁻¹ cm	Energy Gap e.v	
				Calculated	Reported		Calculated	Reported
4133	5.854	4.605	0.277	79.44	79.40	2.239	1.30	1.05[8]
4275	5.472	4.430	0.291		[12]	1.911		
4428	5.100	4.280	0.305			1.626		
4592	4.742	4.159	0.317			1.379		
4769	4.397	4.047	0.328			1.666		
4959	4.066	4.957	0.338			0.982		
5166	3.747	3.881	0.347			0.823		
5391	3.441	3.820	0.355			0.687		
5636	3.148	3.747	0.364			0.670		
5904	2.869	3.686	0.372			0.654		
7293	1.880	3.422	0.413			0.099		
8266	1.463	3.341	0.427			0.090		

Table7.5: Optical polarizability, Absorption coefficient and Energy Gap of Cd_xHg_{1-x}Te

X=0.76

Wave length λ [(A)]	$\frac{1}{\lambda^2}$ In (10) ⁸ (cms) ²	R.I Value n	$\frac{1}{n-1}$	Optical polarizability α_m [(10)] ⁻²⁵ (cms) ³		Absorption coefficient (α) [(10)] ⁻¹ cm	Energy Gap e.v	
				Calculated	Reported		Calculated	Reported
4133	5.854	4.483	0.287	81.49	78.83 [12]	2.032	1.25	1.65[8]
4275	5.472	4.328	0.300			1.738		
4428	5.100	4.195	0.313			1.481		
4592	4.742	4.081	0.324			1.258		
4769	4.397	3.985	0.335			1.064		
4959	4.066	3.903	0.344			0.898		
5166	3.747	3.838	0.352			0.753		
5391	3.441	3.761	0.362			0.626		
5636	3.148	3.696	0.371			0.178		
5904	2.869	3.665	0.375			0.274		
7293	1.880	3.368	0.422			0.172		
8266	1.463	3.283	0.438			0.102		

Table7.06: Optical polarizability, Absorption coefficient and Energy Gap of Cd_xHg_{1-x}Te

X=0.86

Wave length λ [(A)]	$\frac{1}{\lambda^2}$ In (10) ⁸ (cms) ²	R.I Value n	$\frac{1}{n-1}$	Optical polarizability α_m [(10)] ⁻²⁵ (cms) ³		Absorption coefficient (α) [(10)] ⁻¹ cm	Energy Gap e.v	
				Calculated	Reported		Calculated	Reported
4133	5.854	4.343	0.299	79.20	78.04	1.801	2.30	2.05[8]
4275	5.472	4.208	0.312		[12]	1.543		
4428	5.100	4.092	0.323			1.317		
4592	4.742	3.992	0.334			1.120		
4769	4.397	3.909	0.344			0.949		
4959	4.066	3.837	0.352			0.801		
5166	3.747	3.758	0.362			0.671		
5391	3.441	3.690	0.372			0.582		
5636	3.148	3.658	0.376			0.464		
5904	2.869	3.546	0.393			0.377		
7293	1.880	3.313	0.432			0.153		
8266	1.463	3.287	0.447			0.091		

Table7.07: Optical polarizability, Absorption coefficient and Energy Gap of Cd_xHg_{1-x}Te

X=0.99

Wave length h λ (Å)	$\frac{1}{\lambda^2}$ In (10) (cms) ²	R.I Value n	$\frac{1}{n-1}$	Optical polarizability α_m ((10)) ⁻²⁵ (cms) ³		Absorption coefficient (α) ((10)) ⁻¹ cm	Energy Gap e.v	
4133	5.854	4.196	0.313	Calculated	Reported	5.873	Calculated	Reported
4275	5.472	4.084	0.324	77.96	77.16	5.042	d	2.36[8]
4428	5.100	3.987	0.338		[12]	4.290	2.50	
4592	4.742	3.906	0.344			3.677		
4769	4.397	3.823	0.354			3.114		
4959	4.066	3.746	0.364			2.625		
5166	3.747	3.696	0.371			2.208		
5391	3.441	3.595	0.388			1.817		
5636	3.148	3.500	0.400			1.497		
5904	2.869	3.425	0.412			1.222		
7293	1.880	3.225	0.449			0.500		
8266	1.463	3.153	0.464			0.297		

Table 7.08: Optical polarizability, Absorption coefficient and Energy Gap of Cd_xHg_{1-x}Te

X=1.00

Wave length h λ (Å)	$\frac{1}{\lambda^2}$ In (10) (cms) ²	R.I Value n	$\frac{1}{n-1}$	Optical polarizability α_m ((10)) ⁻²⁵ (cms) ³		Absorption coefficient (α) ((10)) ⁻¹ cm	Energy Gap e.v	
4133	5.854	4.050	0.328	Calculated	Reported	5.678	Calculated	Reported
4275	5.472	3.961	0.338	75.66	76.33	4.889	d	2.67[8]
4428	5.100	3.872	0.348		[12]	4.181	2.45	
4592	4.742	3.787	0.359			3.559		
4769	4.397	3.783	0.365			3.032		
4959	4.066	3.635	0.379			2.541		
5166	3.747	3.519	0.397			2.106		
5391	3.441	3.440	0.410			1.745		
5636	3.148	3.378	0.420			1.440		
5904	2.869	3.322	0.431			0.180		

Table 7.09 CdS_xSe_{1-x}

Composition x	1-x	R.I Method1	R.I Method2	R.I Method 3	R.I Method4	R.I Reported[9]
0.00	1.00	2.457	2.457	2.457	2.457	2.457
0.36	0.64	2.408	2.408	2.407	2.406	2.400
0.58	0.42	2.377	2.378	2.376	2.376	2.368
0.79	0.21	2.348	2.348	2.347	2.347	2.342
1.00	0.00	2.319	2.319	2.319	2.319	2.319

Table 7.10 Zn_{1-x}Cd_xTe

Composition X	1-x	R.I Method1	R.I Method2	R.I Method 3	R.I Method4	R.I Reported[9]
0.00	1.00	3.56	3.56	3.56	3.56	3.56
0.20	0.80	3.348	3.349	3.347	3.347	3.348
0.40	0.60	3.137	3.137	3.135	3.134	3.136
0.50	0.50	3.031	3.031	3.029	3.028	3.030
0.60	0.40	2.925	2.925	2.923	2.922	2.924
0.80	0.20	2.712	2.713	2.711	2.711	2.712
1.00	0.00	2.50	2.50	2.50	2.50	2.50

Table 7.11 CdSe_{1-x}Te_x

Composition X	1-x	R.I Method1	R.I Method2	R.I Method 3	R.I Method4	R.I Reported [9]
0.00	1.00	2.46	2.46	2.46	2.46	2.46
0.20	0.80	2.468	2.469	2.468	2.467	2.467
0.40	0.60	2.476	2.477	2.475	2.475	2.475
0.60	0.40	2.484	2.485	2.483	2.483	2.483
0.80	0.20	2.492	2.493	2.492	2.491	2.491
1.00	0.00	2.50	2.50	2.50	2.50	2.50

Table 7.12 CdS_xSe_{1-x}

Composition X	1-x	α -Pol Method1	α -Pol Method2	α -Pol Method3	α -Pol Method4	α -pol Reported [9]
0.00	1.00	83.855	83.855	83.855	83.855	83.855
0.36	0.64	79.043	79.062	79.007	78.988	79.035
0.58	0.42	76.092	76.111	76.055	76.036	76.078
0.79	0.21	73.269	73.288	73.244	73.255	73.256
1.00	0.00	70.439	70.439	70.439	70.439	70.439

Table 7.13 Zn_{1-x}Cd_xTe

Composition X	1-x	α -Pol Method1	α -Pol Method2	α -Pol Method3	α -Pol Method4	α -pol Reported [9]
0.00	1.00	95.971	95.971	95.971	95.971	95.971
0.20	0.80	97.449	97.474	97.418	97.394	97.434
0.40	0.60	98.921	98.946	98.873	98.848	98.897
0.50	0.50	99.653	99.678	99.604	99.579	99.628
0.60	0.40	100.384	100.409	100.336	100.311	100.36
0.80	0.20	101.839	101.863	101.807	101.783	101.823
1.00	0.00	103.286	103.286	103.286	103.286	103.286

Research on Physical properties of II-VI Ternary Semiconductor alloys is due to operating characteristics of Semiconductor devices depending critically on the physical properties of the constituent materials. The theoretical study has been made on II-VI Ternary Semiconductor alloys as a function of composition x .

The various applications of II-VI Semiconductor Alloys of $\text{CdS}_x\text{Se}_{1-x}$, $\text{CdSe}_{1-x}\text{Te}_x$, $\text{Zn}_{1-x}\text{Hg}_x\text{Te}$, $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$ as Electronic, Optical and Optoelectronic devices are determined by elementary material properties of Refractive index, Optical Polarizability, Absorption coefficient, Energy gap and Mobility. Photonic crystals, wave guides and solar cells require knowledge of refractive index and Energy gap of all above Arsenide Group alloys. The Energy gap of Semiconductor alloys determines Threshold for absorption of photons in semiconductors. Refractive index is measure of transparency of Semiconductor alloys to incident radiation. Refractive index and Energy gap of Ternary Semiconductor alloys has significant impact on Band structure. High absorption coefficient Semiconductor alloys can be used for fabricating in thin film hetero junction photovoltaic (PV) devices.

Applications on these Ternary Semiconductor Alloy span from communications to biomedical engineering. Narrow band gap semiconductor alloys allow Hetero junction Bipolar Transistors to present terahertz (THz) operation capability. Sensors of this type exploit the unique piezoelectric, polarization characteristics, as well as the high temperature stability of wide-band gap semiconductors in order to allow stable operation with high sensitivity. Using this material system one can also explore the possibility of developing fundamental sources operating in the Terahertz regime and employing Micro-Electro Mechanical Systems (MEMS) approaches.

Recent progress and new concepts using narrow and wide-band gap Ternary semiconductor alloys of $\text{CdS}_x\text{Se}_{1-x}$, $\text{CdSe}_{1-x}\text{Te}_x$, $\text{Zn}_{1-x}\text{Hg}_x\text{Te}$, $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$ and device concepts such quantum wells with very high mobility and plasma waves will lead in Terahertz detectors and emitters. Semiconductors of this type may also be used for other novel applications such as spintronics and field emission. Terahertz signal sources based on super lattices have explored applications cover a wide range of devices, circuits and components for communications, sensors and biomedical engineering.

Research on Physical properties of II-VI Ternary Semiconductor alloys is due to operating characteristics of Semiconductor devices depend critically on the physical properties of the constituent materials. The Refractive index of Group II-VI Arsenide Semiconductor alloys of $\text{CdS}_x\text{Se}_{1-x}$ reduces significantly from 2.457 to 2.319 by adding a small amount of Sulphur to CdSe and also in $\text{Zn}_{1-x}\text{Cd}_x\text{Te}$ Refractive index decreases from 3.56 to 2.50 by adding small amount of Cadmium to ZnTe. But Refractive index of $\text{CdSe}_{1-x}\text{Te}_x$ increases from 2.46 to 2.50 by adding small amount of Tellurium to CdSe. This occurs due to the large disparity in the electro negativity and the atomic size

The binding which was totally covalent for the elemental Semiconductors, has an ionic component in II-VI Arsenide Ternary semiconductor alloys. The percentage of the ionic binding energy varies for various Semiconductor alloys. The percentage of ionic binding energy is closely related to electro negativity of the elements and varies for various compounds. The electro negativity describes affinity of electrons of the element. In a binding situation the more electro negative atoms will be more strongly bind the electrons than its partner and therefore carry net negative charge. The difference in electro negativity of the atoms in a compound semiconductor gives first measure for Energy gap. A more electro negative element replacing a certain lattice atom will attract the electrons from the partner more strongly, become more negatively charged and thus increase the ionic part of the binding. This has nothing to do with its ability to donate electrons to conduction band or accept electrons from the valence band. Mobility at high doping concentration is always decreased by scattering at the ionized dopants. Band gap increases with Electro negativity difference between the elements. Bond strength decreases with decrease of orbital overlapping. Electrons are more stabilized by more electro negativity atom.

Semiconductor Materials with higher absorption coefficients more readily absorb photons, which excite electrons into the conduction band. Knowing absorption coefficients of various II-VI Ternary Semiconductor alloys of $\text{CdS}_x\text{Se}_{1-x}$, $\text{CdSe}_{1-x}\text{Te}_x$, $\text{Zn}_{1-x}\text{Cd}_x\text{Te}$, $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$, $\text{Zn}_x\text{Cd}_{1-x}\text{S}$ aids engineers in determining which material to use in their solar cell designs. The absorption coefficient determines how far into a material light of a particular wavelength can penetrate before it is absorbed. In a material with a low absorption coefficient, light is only poorly absorbed, and if the material is thin enough, it will appear transparent to that wavelength. The absorption coefficient depends on the material and also on the wavelength of light which is

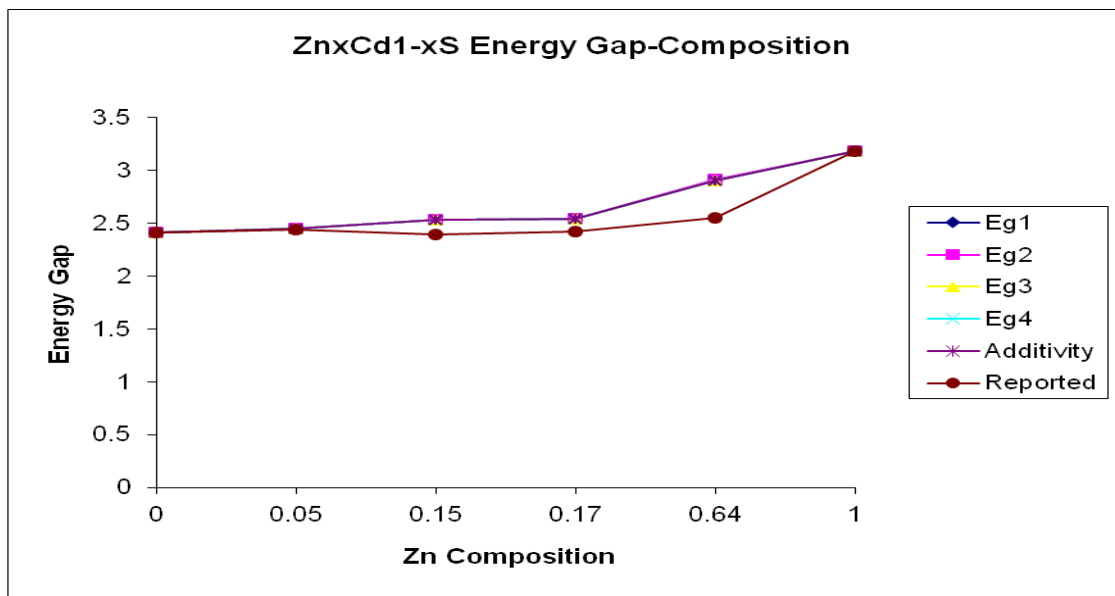
being absorbed. II-VI Ternary Semiconductor Alloys have a sharp edge in their absorption coefficient, since light which has energy below the band gap does not have sufficient energy to excite an electron into the conduction band from the valence band. Consequently this light is not absorbed.

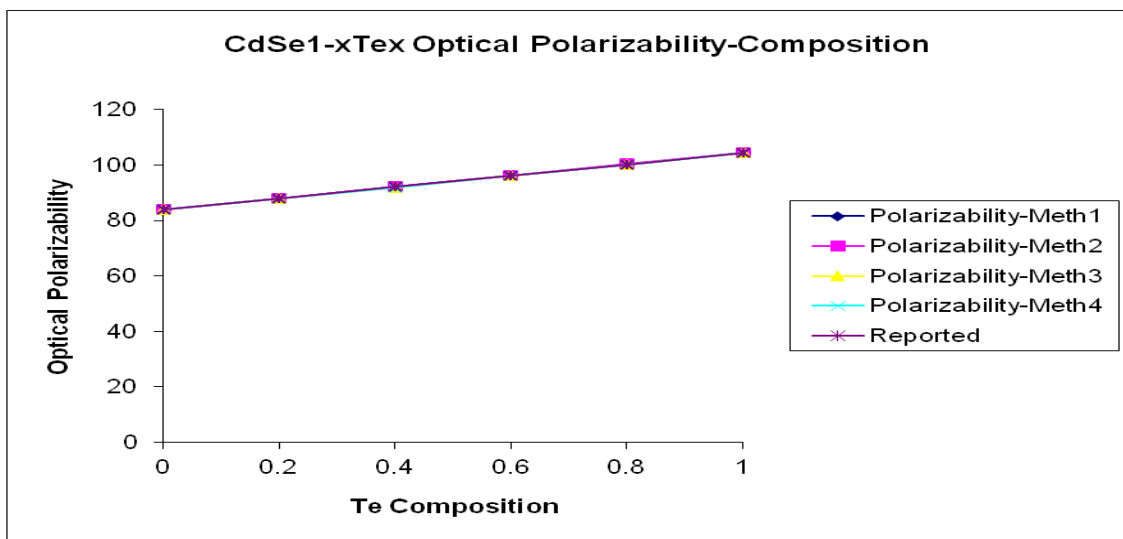
The plot of $h\nu$ versus $(\alpha h\nu)^2$ of III-Arsenide Ternary Semiconductor alloys of $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$ at various concentrations of Cd forms a straight line, it can normally be inferred that there is a direct band gap, measurable by extrapolating the straight line to the $\alpha=0$ axis. On the other hand, if a plot of $h\nu$ versus $\alpha h\nu^{1/2}$ forms a straight line, it can normally be inferred that there is an indirect band gap, measurable by extrapolating the straight line to $\alpha=0$ axis. Measuring the absorption coefficient for Ternary Semiconductor Alloys gives information about the band gaps of the material. Knowledge of these band gaps is extremely important for understanding the electrical properties of a semiconductor. Measuring low values of Absorption coefficient (α) with high accuracy is photo thermal deflection spectroscopy which measures the heating of the environment which occurs when a Semiconductor sample absorbs light.

The energy levels adjust with alloy concentration, resulting in varying amount of absorption at different wavelengths in II-VI Ternary Semiconductor alloys of $\text{CdS}_x\text{Se}_{1-x}$, $\text{CdSe}_{1-x}\text{Te}_x$, $\text{Zn}_{1-x}\text{Hg}_x\text{Te}$, and $\text{Cd}_x\text{Hg}_{1-x}\text{Te}$. This variation in optical properties is described by the material optical constants, commonly known as Refractive index (n). The optical constants shape corresponds to the material's electronic transitions. Thus, the optical constants become a "fingerprint" for the semiconductor alloys.

The Optical Polarizability of II-VI Ternary Semiconductor alloys $\text{CdS}_x\text{Se}_{1-x}$ reduces significantly from 83.855 to 70.439 by adding a small amount of Sulphur to CdSe, and in $\text{Zn}_{1-x}\text{Cd}_x\text{Te}$ Optical Polarizability increases from 95.971 to 103.286 by adding small amount of Cadmium to ZnTe. This occurs due to the large disparity in the electro negativity

In II-VI Ternary Semiconductor alloys replacing existing atom with high Atomic number results in Decreasing of Energy gap due to increase of charge carriers with increase of mobility and by replacing existing atoms of low atomic number result in Increase of Energy gap due to decrease of charge carriers transmitting from valence band to conduction band with decrease of mobility.





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