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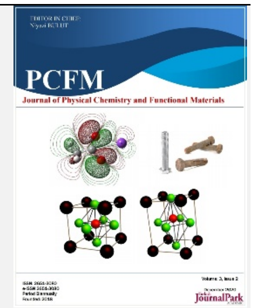

A review on Physical Properties of CdS Thin Film

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ABSTRACT

CdS Cadmium Sulfide is the important semiconductor materials. Semiconductors are solids with conductivities ranged from 104 to 10-10 (Ohm cm)-l. The properties of CdS are structural, Electrical and Optical. We examine a number of papers published between 1983 and 2015 that created CdS thin films in a variety of ways, including chemical bath deposition, spray pyrolysis, thermal evaporation, close spaced sublimation, and pulsed laser ablation. They found band gap energy in (eV), Refractive index (n) and Extension coefficient (k). X-ray diffraction, the researchers employed energy dispersive X-ray spectroscopy with scanning electron microscopy in this study. The crystallinity the quality of the movie improves after annealing, as a result, optical transmittance is reduced. The structure is hexagonal in general. All of the films are ideal as efficient for solar cell applications, there are a number of different window layers that may be used. Due to their high transmittance and low resistance values. These findings suggest that CBD films with a broad Low resistivity, high mobility, and a high carrier concentration are all characteristics of the band gap. Produced at pH 11 are ideal contenders for use in various optoelectronic devices.

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1. Introduction

Today material science has a major role to development of modern technology [1] specially the smart materials [2-9]. Semiconductors are one type of smart materials that have conductivity between conductors and insulators (nonconductor) Semiconductors are conductivity-rich solids ranged from 10^4 to 10^{-10} (Ohm cm)$^{-1}$. The transition from semiconductors to insulators is significantly slower, and it is determined by the energy gap to temperature ratio. According to the statement the existence of an energy gap in semiconductors whereas Metals and semimetals do not. Semiconductors that are extremely pure can become insulator [10]. Cds Cadmium Sulfide is the important semiconductor materials [11, 12]. As indicated in the periodic table, the group of (II-VI) [13].

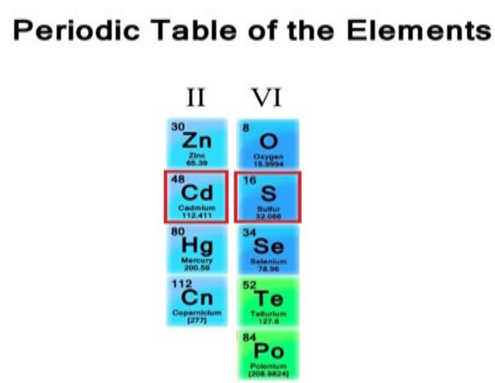

Figure 1. Sample of periodic table

According to the classification of band gap energy one can be identified the narrow band gap in the Semiconductor family having narrow fundamental bands that are banned. Materials having a restricted bandwidth E.g of less than 0.5

eV are generally prohibited [14].and wide band gap is exhibit unique electronic and optical properties and intermediate ban gap [15]. Is the band gap the n-type direct is (2.42 ev) [16-18]. (300K) at room temperature [12]. Binding energy of exciton 28 Mev [12].And has used as a window material together with CdTe,Cu_2S,$CuInSe_2$,Cu(In,Ga)Se_2, Cu_2ZnSnS_4, InP The device's efficiency and performance are determined by the electrical and optical characteristics of thin films is about 14 to16%[16, 19, 20] .The infrared reflectance is high, while the visual transmittance is high [20]. To prevent Cds thin films, electrical short-circuit effects with high transitivity and low resistivity must have an appropriate conductivity (> 10^{16} carriers/cm^3) and thickness to enable for good homogeneity and high transmission. Being a semiconductor with direct transmission [17]. CdS thin films have a very high resistance. in general, which can be decreased through making use of multiple dopants [21].

Researchers are interested in CdS thin semiconductor films when they are used in photo detectors, Light emitting diodes, optical coatings, and optoelectronic devices [16, 21].Many photovoltaic solar cell modules use it as a window layer material because of its electrical and optical properties [21]. Solid-state solar cells, optical coatings, optoelectronic devices, and light emitting diodes were among the items on the list are all examples of uses. [13]. RF sputtering, thermal evaporation, and hydrothermal approach, metalorganic chemical vapor deposition, sol-gel approach, chemical bath deposition, spray pyrolysis, chemical bath deposition, and chemical bath deposition are some of the techniques used (CBD)[13]. close space sublimation , laser ablation ,`electro deposition[22]. Semiconductors can be used in a variety technology of Solar cells, photo transistors, transparent electrodes, and solid-state gas sensors are some of the technologies used in solid-state gas sensors. are examples of optoelectronic devices [17].

2. Physical Properties of CdS Thin Film

Cds Cadmium Sulfide is the important semiconductor materials [11, 12].In the group of (II-VI) the physical properties are:

- Electrical [12, 17, 23, 24]
- Optical [12, 16, 21, 23-25]
- Structural [26, 27]
- Thermal coating [28, 29]

One of the most promising thin-film solar cell materials is heterojunction CdS thin films. CdS thin films play a significant role in a variety of scientific fields., technology, in the realm of optoelectronic devices, as well as industrial applications, including solar cells, because their optical properties are important [16]. Because of its electrical and optical properties, it is an excellent many photovoltaic solar cell modules use this material as a window layer. CdS has also been a topic of interest in the material science community due to its huge band gap, conversion efficiency, high absorption coefficient, stability, and, last but not least, it's comparatively cheaper cost [21].
One of the most promising thin-film solar cell materials with heterojunction CdS thin films. However, because to the high price of such a material, research into polycrystalline compound semiconductors, namely thin polycrystalline films, has been conducted [23]. Cds is poly crystalline thin film [25]. Hexagonal and cubic phases are two types of hexagonal and cubic phases [21]. Because of its wide band gap, it has a lot of potential. 2.45 eV, thin films of cadmium sulfide (CdS) have been studied extensively as an optical window layer for thin film solar cells. N-type semiconductor CdS thin films material characterized by a high electrical resistance when deposited. Both hexagonal and cubic phases of CdS exist the evolution of these structures is influenced by a number of factors, including the deposition process [24].

3. CdS Thin Film Deposition Methods:

- Evaporation[16]
- Sputtering [13, 16]
- Chemical bath deposition [13, 16, 21, 23, 24]
- Spray pyrolysis [13, 16, 21, 23, 24]
- Vapor deposition of metals and organic chemicals (MOCVD)[13, 16]
- The technique of molecular beam epitaxy (MBE) [16]
- Electrodeposition [16, 21, 24]
- Photochemical deposition[16, 21]
- Thermal evaporation [13, 21, 23, 24]
- Close space sublimation[21, 24]
- Laser ablation [21, 24]
- Vacuum evaporation[21, 28]
- Chemical vapor deposition [21, 28]
- Molecular beam epitaxy (MBE)[23]
- Hydrothermal method [13]

4. Literature

In 1983 Baranski, Bennett, and Fawcett. Studied the structural and CdS thin film electrical characteristics prepared by aqueous diethylene glycol solutions electrodeposited, as well as their physical properties. Samples grew in chloride-containing solutions and those grown in perchlorate-containing solutions showed significant variations. X-ray diffraction experiments revealed significant variations the difference in the crystal structures of the two types of films. Type II films have a strong orientation. Whereas Type I films lack columnar structure and are poorly crystallographic ally oriented. The electron density and mobility are the most important electronic properties. Hall measurements were used to determine the former, and a combination of Hall and resistivity measurements were used to determine the latter [30].

In 1998 Palafox, et al. studied the physical CdS thin film characteristics as well as CdS:

In Chemically sprayed thin films on a variety of substrates was used to prepare the films. Chemical spraying was used to deposit cadmium sulfide thin films that were both its indium-doped and pure. Chemical spray was used to make pure cadmium sulfide (CdS) and iridium-doped thin films (CdS: In). The lowest value of resistivity obtained in thin films was about (3×10^{-2} Ω.cm). The temperature of the substrate increases. Rises and the concentration of impurities in the solution [In]/ [Cd] is less than 0.1atomic percent, the absorption edge remains nearly constant. The band gap energy appears to decrease with substrate temperature for solutions with larger atomic ratios, such as 8%. X-ray diffraction was used random polycrystals are deposited at low temperatures, and strongly textured films are deposited at intermediate temperatures. The structure undergoes from cubic to hexagonal, there is a transition. 'The' optical band difference was between 2.5 and 2.9 eV [31].

In 2000 Mahmoud, Ibrahim and Riad, studied Physical characteristics of thin CdS films made by using a thermal evaporation method, using a modified source of evaporation. To find the X-ray diffraction was used to investigate the structure of produced films in glass substrate, the Structural of the films was found for different thicknesses and at room temperature. They calculated optical parameters. For a prepared sample, the wavelength dependency of the refractive index, n, and extinction coefficient, k. In the end, is at temperature 373 there are a total of K distinct thicknesses to choose from about [140 - 300] nm, the intensity with increasing film thickness, the peak width rose while the peak width decreased. The Electrical properties showed at low voltages, the conductivity is Ohmic, while at higher voltages, it is SCL based on current density-voltage measurements. For any of the devices, reversing the polarity also have no effect on the magnitude of the current, with increasing film thickness, the thermally produced concentration of electrons, n, as discovered to be decreasing. Moreover, the refractive index, n, rose as the crystallite size rose [28].

In 2002 Acevedo, et al., studied a contrasting of the physical characteristics of thin films of CdS that have been produced, using various method. The characteristics thin film of CdS formed via Laser Ablation (LA), Close Space Vapor Transport (CSVT), Sputtering (Sp), and Chemical Bath Deposition (CBD) are compared, considering that the physical characteristics of CdS thin films are influenced by the rate of growth approach, as well as growth optimization technique for each technique's description, growth conditions are the best structural properties were found in LA-CIS thin films. When the films were grown on SnO2I glass instead of pure glass, improvements in morphological properties were observed in all cases. It's worth noting that in this situation, the lower crystallization efficiency, the higher the samples' relative photoconductivity. Because of their high photoconductivity (relative) and morphological features (roughness and pinhole density) superior to films made using conventional methods, CBD films can provide for photovoltaic applications, the results are outstanding., despite their poor crystalline quality. This fact has typically been overlooked when attempting to justify why the finest CdTdCdS solar cells have been made using CBD-CdS thin films, as well as other potential At the CdSICdTe contact, strange things happen. The resistivity of a series of films generated by various processes utilizing x-ray diffraction was discovered to be thickness dependent; the structure is hexagonal [32].

In 2003 Atay, et al. Studied CdS's physical characteristics films with the effect of doping, used spray pyrolysis technique. The technique of X-ray diffraction was used to the electrical, structural, morphological, and elemental characteristics of the The technique of -ray diffraction was used to the technique of -ray diffraction was used to the The technique of -ray diffraction was used to the deposited films CdS and CdS are two different types of cadmium sulfate (C At a temperature of, were deposited on glass substrates in percentages of 25, 35, and 45. 300±5°C. CdS films have electrical, structural, morphological, and elemental characteristics. Significantly changed as a result of these investigations. For use in photovoltaic solar cells as a window layer, in doping CdS: In films are preferable to CdS.

CdS and CdS: In have different electrical properties. Doping drastically lowered this high-resistivity value. Thin-film photovoltaic solar cells, this is a very desirable property. The All films were found to have the same XRD patterns have a polycrystalline structure; as a result of this doping, CdS films have strong crystallinity. CdS films have a large optical band gap also investigated It was done with the use of optical absorbance data discovered that while CdS films' band gap remained unchanged. Significantly with the indium all films need focus. Relatively high levels of transmittance. This is for thin-film photovoltaic solar cells, window materials such as efficiency thin-film solar cells made of p-CdTe/n-CdS [33].

In 2003 Oliva, et al. examined the characteristics of polycrystalline cds produced on glass substrates by close-spaced sublimation (CSS) and chemical bath deposition (CBD) Cds thin films are studied. The temperature differences between the two techniques are important. Used a maximum temperature of >300°C Morphology, optical propagation, the terms crystallinity and band gap energy are used interchangeably used interchangeably the properties of CdS in both techniques. The energy of the band gap in the wrath of [2.42-45].

In 2004, Ashour, for five years, researchers investigated the physical characteristics of CdS thin films different substrate temperature prepared by spray pyrolysed technique. The substrate temperature was varied in the range (200–400°C), he showed that the substrate temperature during the phase and preferred orientation of the films have been altered by the deposition. The crystallization quality of the films made at the lowest temperature was found to be the poorest, and as the temperature climbed, the crystallization quality improved, and the XRD patterns revealed the presence of single phase hexagonal CdS. It was also discovered that when the substrate temperature rose, the film thickness dropped. The resistivity of the as-deposited films varied depending on the substrate temperature. [10^3 – 10^5] cm. The resistivity of films generated at higher temperatures was found to be lower than those created at lower temperatures, and the resistivity of films generated at higher temperatures was found to be lower than that of films created at lower temperatures. In the range of the films, there was a clear change (2.39 – 2.42 eV) [23].

In 2004 Quiebras, et al, studied Physical characteristics of deposited CdS thin films at different thicknesses by chemical bath deposited (CBD), from x-ray diffraction they show that the structure is hexagonal .They also studied the electrical behavior in the dark and in the light The band gap is 2.47 eV, and the material has acceptable properties for usage as a window layer in solar applications [11].

In 2005 Raji, Sanjeeviraja, and Ramachandran. Using spray pyrolysed to prepare and they study the thermal thin films of CdS, as well as their structural characteristics, the thermal CdS thin film characteristics developed by spray pyrolysis are calculated using a photo acoustic technique. In these films, Thermal diffusivity and conductivity decline by two or more orders when in contrast to bulk. The present investigates the relationship between thermal diffusivity and the thickness of the coating or the particle size distribution on the glass substrate. The film is polycrystalline according to X-ray diffraction at 400°C. Photoacoustic measurements of thermal diffusivity and thermal conductivity on thin films are more exact than any other method now available procedure since none of the participants touch the sample. Probes during measurement. This is consistent with previous measurements on a variety of other films, and it is generally accepted characteristics of thermal transport are significant thin films have a density that is a fraction of the cost of bulk materials. (Lee and Cahill 1997) [27].

In 2006 Galán, et al., studied the Physical properties of CdS thin films grown on conducting substrates by pulsed laser ablation: the effect of heat treatment was also conducted, use the pulsed laser ablation technique to prepared of Cds thin films, optical, Structural and morphological, SnO2 conducting glass substrates was also studied. The grain size of the samples decreases after heat treatment, and the grain size also decreases as the film thickness is reduced. At room temperature, the exciton band has a BGE of 2.40 eV and a perfect crystal structure [34].

In 2007 Sahay, Nath and Tewari, studied the optical properties for different film thicknesses used thermally evaporated technique for CdS thin films with the help of the optical transmittance ranged between [300 – 1100] nm, UV-VIS region, used for studied the absorbance and reflectance. The films high transmittance's about [~ 60 - 93 %], low reflectance and low absorbance near infrared the region about [~ 500 nm – 1100] nm. Optical band gap energy in the range [2.28 – 2.53] eV. , then in the longer wavelength absorptions shifted towards and decrease in the optical transmittance the result is decreased of the optical band gap [16].

In 2007 Lee structural and optical properties were investigated characteristics of chemically produced Films made of CdS as a function of substrate. The substrates (we employed the same materials) impact the structural phase of CBD CdS thin films). Different substrates yielded hexagonal or cubic phases, although hexagonal was obtained on a glass substrate is consistent with the help of findings. According to certain studies, Low ammonia concentration in solution, since Cd (OH) 2 is clearly visible suspension leads to the manufacture in the wurtzite process of CdS.

The edge of optical transmission was smoother the films were annealed at 200°C and 300°C, respectively. Suggesting the temperature at which the annealing takes place promote crystalline nature. We additionally observed that each and every film had good visible transmission of light, implying that CdS thin films produced under comparable circumstances by CBD might be employed The energy band gap in solar cells as a window material is 2.42 eV [35].

In 2008 Tepantlán, Gonzalezand and Arreola. Studied the CdS thin film characteristics Structural, optical, and electrical considerations obtained used Spray pyrolysis is a method of pyrolysis. X-ray diffraction was utilized at temperatures between [200 and 400] C. Single-phase hexagonal CdS was suggested by the patterns. The refractive index is dependent on the substrate temperature, and values of 2.37-2.41 eV were obtained. The films' resistivity was based on the substrate temperature and ranged from 10^3 to 10^5.cm. The film thickness decreases as the temperature increased [36].

In 2009 Mahdi, et al. studied CdS thin films properties, Structural and optical of chemical deposition. The glass substrates at the temperature are Cadmium acetate was employed as a source of Cd^{+2} and thiourea was employed as a source of S^{-2} at 80 degrees Celsius. CdS thin films is obtained Deposition of a 100 nm layer after three repetitions of sequencing. Used X-Ray diffraction to investigate the structure of, polycrystalline hexagonal phase CdS may be found in three crystal structures in films made using various preparation methods: hexagonal, cubic, and both tetrahedral coordinated and cubic. In the wavelength range of 500-900 nm, the films show a high optical transmittance T [50-100] percent and a low reflectance. In the spectrum area, they also determined the optical constants (n, k). This deposited optical energy gap is in the [2.35-2.43] eV region. The films' crystalline structure was studied. enhanced by vacuum annealing at [200,300] °C [25].

In 2009 Moualkia, Hariech and Aida, Chemical bath deposition was used to prepare and the study of the structural and optical properties of CdS thin films. NH4OH, CdSO4, and CS (NH2)2 are used in a reaction. The films' properties were researched in relation to bath temperature and deposition time. Transmittance is fine at various bath a temperature range of 55°C to 65°C. As the temperature of the solution rises, the size of crystallites in CdS thin films decreases. The structural investigation was carried out using X-ray diffraction analysis properties of the obtained films. Crystallite size and other structural parameters have been assessed. The transmission spectra the films acquired have been reported in the UV visible range, indicating that they have a relatively high transmission coefficient (70%). The deposition circumstances have a strong influence on the optical band gap according to the transmittance data analysis, with a gap in the straight band varying Deduced from 2.0 eV to 2.34 eV. The dark conductivities the deposition rate of CdS films can be controlled by either the deposition rate or the deposition rate of CdS films time or the bath temperature, according to the electrical characterization. Deposition when the temperature is low (50°C) and for a long time times have high optoelectronic capabilities, meaning that these circumstances are excellent for manufacturing CdS thin films for optoelectronic CIS solar cells, for example, have a buffer layer [26].

In 2011 Kim, Lee, and Sohn, studied Chemical bath deposition using a directly submerged CdS thin film ultra-sonication a component yielded the following physical properties. The technique of ultrasonically colloid chemistry deposition (UCCD) has been developed. Commonly UCCD (ultrasonically colloid chemistry deposition) is a technique for depositing colloid chemistry using ultrasound. Particle source located outside the reaction bath. Homogenous laying down, excellent mixing, and improvement the ion-by-ion reaction is a type of reaction where one ion reacts with another ion. Are all advantages of the ultrasonic homogenizer. We examined the physical characteristics of CdS thin films were created with and without the use of ultrasound. XRD, SEM, AFM, and a 3D surface analyzer, as well as UV–Vis–NIR studies. Structures that are hexagonal, cubic, or a mixture of the two, depending on the conditions of preparation. The optical property ensures high transmittance, especially in the low-wavelength field, where the optical band-gap, Eg, is 2.45 and 2.32 eV [37].

In 2012 Shah, et al the research Physical properties of CdS thin films by doped Ag used thermal evaporation technique. Used X-ray diffraction,

He showed that the structure is polycrystalline and average grain size is increased [195.7- 409.5] nm and also increase the thickness of film [248 – 860] nm, respectively the films were able to dwell in a low-concentration silver nitrate solution for longer periods of time without being affected. Silver diffused across the films after annealing He also demonstrated that when the silver mass percent increased, optical transmission dropped, indicating that silver is an excellent reflector. When silver is doped, transmission drops by roughly [80 percent - 30 percent]. There was a modest change in the optical band gap. The refractive indices are in the range [2.02 – 3.14], and the thickness is between [248 – 860] nm. Band chasm (2.42 eV) [21].

In 2012 Kariper, et al., studied the Effect of PH on CdS Thin Film Physical Properties chemical bath deposition technique CBD. Used different pH values changing about [9 – 12] and deposited on the glass substrates exhibited cubic structure, used X-ray diffraction in order to find the cubic phase develops with a predilection for orientation in the (1 1 1) direction, according to the structure of the produced films and data from X-ray diffraction. The 1LO and 2LO phonons of CdS were ascribed to all samples have Raman peaks at 296 cm^{-1} and 593 cm^{-1}. and they moved to the blue region when pH values rose. With rising pH values, the band gap energy of the thin films rose [2.29 - 2.40] eV. Hall Effect measurements were used to estimate the films' resistivity, carrier density, and mobility. These findings suggest that CBD-produced films at pH 11 are suitable for use in a variety of optoelectronic devices. When the pH increased the chemical bath, the diffraction peak intensity decreased this is indicating to decreased crystallinity. The CdS thin films' resistivity reduced by a certain amount. [$4.72x10^5$- $4.80x10^4$] Ω·cm raising the pH value the band gap grew from 2.29 to 2.40 eV, while the pH of the chemical bath rose from 9 to 12 eV. Because of their low resistivity, high mobility, and high carrier concentration, films produced at pH 11 with a broad band gap are attractive candidates for application in different optoelectronic devices. The efficiency of thin-film solar cells made of p-CdTe and n-CdS on the other hand, can be very high. Increased by increasing the pH of the chemical bath to 11[13].

In 2012 Elmas, et al., studied the properties of electrical and optical for CdS thin films with the influence of annealing temperature, using spray pyrolysis technique. At the substrate temperature of 573 ± 5 K Electrical resistivity tests and a UV/VIS spectrophotometer were used to describe the films', electrical and optical properties before and after thermal annealing. CdS films were thermally annealed in an air environment at temperatures ranging from 473 to 673 K. Electrical conductivity and optical properties as a function of thermal annealing temperature including transmittance, absorbance, and energy band gap was studied. All of the films have high electrical resistivity's, and the thermal annealing temperature has no effect moment the CdS sheets are formed, on their electrical characteristics The optical absorbance and transmittance spectra for CdS films as-deposited and annealed at various temperatures in the 350–900 nm range are wavelength dependent [38].

In 2013 Gilic, et al. They investigated the optical AFM and thermal evaporation techniques were used to investigate the characteristics of CdS thin films at a base pressure of 2×10^{-5} torr.They also used Raman scattering and far-infrared spectroscopy to At 297 cm^{-1}, a Surface Optical Phonon (SOP) mode is discovered. The effective permittivity of the mixture was modeled using the Maxwell–Garnet approximation. A computer model for calculating the reflectivity coefficient of a device with coatings and substrate. was used to analyze the far-infrared reflection spectra [19].

N0	Country	Material method	Energy gap (E.g) ev	Refractive index (n)	Extension coefficient (k)	Reference

In 2014 Butt, et al. closely spaced sublimation was used to study polycrystalline CdS thin films. Samples, were prepared with the different range of thickness [250 t- 940] nm. They studied of Pure CdS thin films' optical and electrical characteristics are proportional to their thickness. The temperature is increasing then resistivity decreasing lowered to a factor of 10^{-2} –10^{1} cm the structural, optical, and electrical characteristics of in-doped CdS films were discovered to be temperature dependent when annealed at [350 and 400]0C. Cubic structure is a preferred development place. Two smaller diffraction lines indexed in the hexagonal structure were used to confirm it. Because the UV area has a greater amount of energy than the optical band gap of 2.44 eV, the transmittance is insignificant [24].

In 2014 Sivaraman, Nagarethinam and Balu, the influence of substrate temperature on the physical characteristics of CdS thin films was investigated. The films were studied by Energy dispersive X-ray analysis, X-ray diffraction, scanning electron microscopy, UV-Vis-NIR spectroscopy, and UV-Vis-NIR spectroscopy after being made using the Spray process. At various substrate temperatures, the films were produced on glass substrates utilizing cadmium chloride precursor as a Cd source and thiourea as S source. The hexagonal polycrystal line existence of the deposited films with increasing substrate temperatur e, electrical resistivity decreases, the film coated at 0.1057 x 101 ohm-m has electrical minimum resistance of 0.1057 x 101 ohm-m. 425 °C. All of the films have high transmittance and low resistivity, making them better appropriate for solar cell applications as a window layer. (Eg = 2.42 – 2.45 eV) [17].

In 2015 Marquez, et al. Thermal and chemical treatments to enhance the physical characteristics of CdS were used to increase CdS/CdTe thin film solar cells' performance. CdS polycrystalline thin films have been employed in the form of a window layer CdTe, Cu (In, Ga)Se2, and Cu2ZnSnS4 solar cells because their fundamental optical and electrical qualities are crucial in photovoltaic systems [39].

Discussion

CdS thin films prepared [30] using vaporous deposition technique in 1983. It was showed that the Changing of the electro deposition bath, temperature, and/or current density may result in enhanced electrical properties.

Table 1. Summarized result of literature.

1	Mexico	Chemical bath deposition&spray pyrolysed	2.5-2.9			[31]
2	Egypt	Thermal evaporation		2.24-2.12 (λ= 520 to 700nm)		[28]
3	Mexico+Cuba	L.A&CSVT&SP &CBD	2.37&2,41&2.46&2.48			[32]
4	Trkey	spray pyrolysed	2.44-2.45			[33]
5	Mexico	Chemical bath deposition&Close spaced sublimation	2.42-2.45			[20]
6	Egypt	spray pyrolysed	2.39-2.42			[23]
7	Mexico+Cuba	Chemical bath deposition	2.47			[11]
10	India	Thermal evaporation	2.28-2.53			[16]
11	Korea	Chemical bath deposition	2.42			[35]
12	Mexico	spray pyrolysed	2.37-2.41	Direct gap=1, indirect=4		[36]
13	Iraq	Chemical bath deposition	2.35-2.43	0.5 (λ=300)		[25]
15	Korea	Chemical bath deposition	2.45-2.32			21
16	Pakistan	Thermal evaporation	2.42	2.02-3.14 (λ= 1081.43 - 1065.57)		[21]
17	Turkey	Chemical bath deposition	2.29-2.4	1.46-2.98 (λ= 400-700)	0.021-0.099	[13]
18	Trkey	spray pyrolysed	2.42			[38]
19	Serbia+Egypt	Thermal evaporation	2.42			[19]
20	Pakistan+Italy	Close spaced sublimation	2.44	2.27-2.31 (λ=1585.94 - 1256.90)		[24]
21	India	spray pyrolysed	2.42-2.45			[17]

Chemical spray method was used to make CdS thin films [31] in 1998. The structure undergoes a from cubic to hexagonal, there is a transition. All of the crystals have the same crystalline structure. films are almost same at high deposition temperatures, and the as the substrate temperature rises, the absorption edge stays nearly constant, and the impurity concentration is less than 0.1 percent atomic in the solution [In]/[Cd]. The band gap tends to decrease with substrate temperature at increasing atomic ratios in the solution 8%.

Thermal evaporation technology was used to make CdS thin films [28]in 2000. With increasing film thickness, the thermally trapped factor, u, as well as the trapping factor, u, produced n stands for electron concentration. Observed to lessen on. In addition, when it is crystallite size grew larger, the refractive index, n, increased. Extension coefficient with rising K, the rate of reduction is quick. Wave length between 400 and 600 nanometers.

Thin CdS films prepared ablation with a laser (LA), technique [32] in 2002.It was observed that the lower the crystalline quality higher it is samples' Photoconductivity is measured in terms of its relative value. The higher the samples' respective photoconductivity, the lower the crystalline efficiency.

Spray pyrolysis was employed in order to make CdS thin films [33]in 2003. CdS has a somewhat high resistivity, and when doped, it becomes much more so. Reduced this resistance significantly. Thin-film photovoltaic solar cells, this is a much-desired characteristic. Patterns created by XRD revealed this all of Polycrystalline films are used. CdS thin films prepared chemical bath deposition and close-spaced sublimation (CSS) (CBD) technique [19] in 2003. It was showed that the temperature employed during film deposition or annealing has a big influence on the crystalline structure. The use of a high temperature (>300°C) deposition method promotes the creation of hexagonal phase of life, whereas the use of a low temperature deposition chemical bath deposition approach generated cubic phase crystallinity in the films. CdS thin films were made using spray pyrolysis [23] in 2003. It was found that the substrate temperature during the deposition was an influence on the time period and crystalline structure the films, that is films Low-temperature preparation yields low scores. Crystalline structure compares to ones that are prepared at high temperature also the film thickness was discovered to be decreases as it is substrate temperature increase. The temperature of the substrate's impact also reflected in it is increase in the conductivity of the films.

Chemical bath deposition method was used to make CdS thin films [11]in 2004. The deposition time and bath concentration were used to adjust the thickness of the films. Offer suitable properties for usage as Photovoltaic applications need a window layer. The hexagonal phase of the films is seen in the XRD patterns. CdS thin films were made using the chemical bath deposition technique [27] in 2005. The heat transport capabilities of bulk CdS are minimal, according to the current data. The current measurement examines the effect of on the glass substrate, thermal diffusivity is dependent on the layer thickness or particle size. Pulsed laser ablation was used to create CdS thin films [34]in 2006. The structural, optical, and morphological features of plants are shown as a function of growth factors. After heat treatment, the grain size of the samples reduces, and the grain size likewise lowers when the film thickness is lowered. Thin films of CdS were made by thermally evaporated method [16] in 2007. From 500 nm to 1100 nm in the visible and near-infrared wavelengths range, all of the films are transparent and have a high transmittance (60-93 percent), poor absorption and poor adsorption reflection, making them appropriate for optoelectronic devices.

Thin films of CdS were made by chemically deposited by method [35] in 2007. The hexagonal on glass, the structure of CdS films was observed, in addition the edge of optical transmission was smoother at 200°C and 300°C when the films were annealed, implying the temperature at which the annealing takes place increase crystalline nature. We noticed that's it of the films had a very high level of visible transmission of light. Spray pyrolysis was used to make CdS thin films [36] in 2008. As seen in XRD patterns, the films made have the least at the lowest temperature. Crystalline high-quality it is thickest. Depending on the substrate temperature, the refractive index and energy are provided. As the temperature rises, the layer thickness falls. CdS thin films were made using the chemical bath deposition technique [25]in 2009. CdS it was found that the structure of films is cubic or a mixture of cubes and hexagons phases; the hexagonal structure, on the other hand, is more stable in solar cells and other optoelectronic devices. It is cubic structure. The wavelength ranges from 500 to 900 nm, and the films show a T [50-100] percent optical transmittance, reduced reflectance.

CdS thin films were made using the chemical bath deposition technique [26] in 2009. Films developed at temperatures 55°C - 65°C have excellent transmittance. It is size of crystallites in CdS thin films shrinks as the solution temperature rises. The transmission spectra measured visible in the UV region demonstrate the fact that produced There have been films that have a transmission coefficient (70%). CdS thin films were created using the chemical bath deposition approach. by [37] in 2011. The XRD data reveal that we were able to create a stable hexagonal-phase the optical characteristic, notably in the low-wavelength band, also ensures high transmittance.

Thermal evaporation technology was used to make CdS thin films [21] 2012. It had been observed it is average size of the grain grew as the film thickness grew, according to structural examinations. Because silver is an excellent reflector, optical transmission reduced as the silver mass percent increased. CdS thin films were made using the chemical bath deposition technique [13] in 2012. XRD analysis validated the crystalline growth of cubic CdS films. As pH rose, the film grain size and resistivity of CdS thin films reduced, whereas the band gap rose.

Spray pyrolysis technology was used to make CdS thin films [38] in 2012. Thermal annealing and its effects temperature pertaining to electric conductivity as well as optical characteristics for example, transmittance, absorbance, as well as the film's energy band was examined. The electrical resistivity of all of the films is high, and the thermal annealing temperature has no effect on their electrical characteristics. Thermal evaporation technology was used to make CdS thin films [19] in 2013. The surfaces of all of the samples are quite smooth consistent, with nanosomic granules that are well-defined and low abrasion scores. A mathematical model for determining the coefficient of reflection for a complex the system, which consists of films and a substrate, was developed used to analyze far-infrared spectra. CdS thin films prepared by close spaced sublimation technique [24]in 2014. Cubic and hexagonal structures were discovered in the deposited films. As the film thickness increases, the resistivity of pure CdS film decreases. Spray pyrolysis technology was used to make CdS thin films. [17] in 2014. As the temperature of the substrate rises, the film thickness falls. At high temperatures, all of the films were discovered to be hexagonal. The excellent transmittance and low resistance. CdS thin films were made using the chemical bath deposition technique. [39] in 2015. It was observed that Resistance levels in the series and shunt drop and increase, respectively.

Conclusion

They found band gap energy in (ev), Extension coefficient (n) and Refractive index (n). They determined the Refractive index in the visible wave length in relation to [400-700] nm by increasing wave length decreasing (n). They also discovered that as temperature rises, the band gap energy decreases.

We also discovered that as the substrate temperature increased, the thickness of the film was lowered. The resistivity of the films as they were deposited ranged between [10^3 – 10^5] Cm depending on the temperature of the substrate The resistance of films generated at higher temperatures was found to be lower than those created at lower temperatures, and the resistivity of films generated at higher temperatures was found to be lower than that of films created at lower temperatures. It was observed that the preparation technique of thin film material has direct effects on the physics properties. These findings suggest that CBD films with a broad at pH 11, materials with a wide band gap, low resistivity, high mobility, and high carrier concentration are suitable candidates for use in a variety of optoelectronic devices.

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