Silver Dopant-Induced Effect on Structural and Optoelectronic Properties of CdSe Thin Films

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Abstract

Thin films of CdSe and silver (Ag)-doped CdSe have been prepared on glass substrates by thermal evaporation in argon gas atmosphere. X-ray diffraction pattern indicates the presence of hexagonal structure with preferred orientation along (100) plane. Elemental composition of the thin films has been analyzed using energy dispersive X-ray analysis. Scanning electron microscopy has been used to investigate the morphology of the thin films. Transmission electron microscope reveals spherical nature of nanoparticles. A decrease in the band gap due to the formation of band tails in the band gap with increase in Ag doping in CdSe lattice has been observed. Photoluminescence spectra indicate redshift in band edge emission peak with increase in Ag doping in CdSe. Electrical conductivity measurements are also studied, and two types of conduction mechanisms taking part in the transport phenomena are observed. Hall measurements indicate n-type behavior of undoped and Ag-doped CdSe thin films.

Keywords Semiconductors · Thin films · Vapor deposition · Electron microscopy · Electrical properties

1 Introduction

Semiconductor nanostructured materials (NSs) belong to an important class of functional materials with potential applications in energy storage devices [1], solar cells [2], luminescent devices [3], p–n diodes [4], electronic devices [5], photodetectors [6], light-emitting diodes [7] and other optoelectronic devices [8]. These materials feature tunable optical and electrical properties that significantly differ from the corresponding bulk materials due to the quantum confinement effect [9]. Recently, II–VI semiconductor NSs provided a promising pathway for photovoltaic devices due to direct band gap [10], spanning of band gap over a wide range from semimetallic to insulating [11], and possibility

of tailoring optical [12] and electrical properties [13] via changing the composition of alloy.

Cadmium selenide (CdSe), a well-known direct band gap semiconductor of II–VI group, has gained much attention during the last decade owing to its unique optical [14] and electrical properties [15]. Various synthesis routes including hydrothermal, electrochemical, sputtering, thermal evaporation, spray pyrolysis and electrodeposition techniques have been employed for the formation of CdSe material in different nanoforms [16]. Among these, thermal evaporation technique has extensively used due to considerably large mean free path of the vaporized atoms at low pressure, and a good-quality material is obtained with minimum unintentional impurity. This method also provides low-cost production of thin films, and films can be deposited on large area substrates. Moreover, the films produced with this method are highly adherent [17] and uniform [18]. To date, attention has been devoted to the possibility of tailoring the optical and electrical properties of CdSe NSs by addition of dopants, for further applications. The incorporation of small amount of dopants into NSs offers a new degree of freedom for controlling physical properties and acts as building blocks for functional nanodevices [19]. The approach to impurity doping has been explored in a number of recent publications reporting

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on incorporation of metals such as Mn [20], Zn [21], In [22], Sb [23], Cu [24], Mg [25], Sn [26], Pb [27] and Fe [28] into CdSe of various compositions. Doped CdSe nanobelts exhibit excellent rectification characteristic, which can give better photoresponse in optoelectronic devices [29]. Improved performance of doped CdSe photoanode in terms of photovoltaic power output can be utilized in photoelectrochemical cells [30]. Although there is significant research available on the doped CdSe NSs, very few reports are available on the silver (Ag)-doped CdSe thin films [31].

Previously, we have reported the effect of annealing and light soaking on the optical and electrical properties of Ag-doped CdSe thin films [32]. In the present work, we have successfully deposited thin films of undoped and Ag-doped CdSe at different dopant concentrations via thermal evaporation technique. The performance of optoelectronic device crucially depends on the structural, optical and electrical properties; therefore, the influence of Ag doping on the properties of CdSe thin films has been investigated systematically.

2 Experimental

2.1 Thin Film Deposition

For the preparation of thin films, the required bulk material of undoped and Ag-doped CdSe was prepared by melt quenching technique. The high purity (99.999%) constituent elements Cd, Se and Ag were weighed according to their desired atomic weight percentages and sealed in quartz ampoules, under vacuum of 2×10^{-5} mbar. The sealed ampoules were kept in the furnace, where the temperature was raised to 1100 °C at a constant heating rate of $2\text{--}3$ °C min⁻¹ and then maintained at this temperature for 24 h. The ampoules at this temperature were quenched in ice-cold water. After quenching, the material in the ampoules was crushed to obtain fine powder which acts as a source material for depositing thin films.

Thin films of undoped and Ag-doped CdSe were deposited on glass substrates using thermal evaporation technique under Argon gas atmosphere. Initially, the corning 7059 glass substrates were cleaned with soap solution and then with acetone followed by ultrasonic bath with distilled water and methanol for about an hour. Then, the substrates were washed with distilled water and dried carefully to avoid dust particles and impurities. The obtained powder was placed in the molybdenum boat positioned at the center of the vacuum chamber. The substrates were kept fixed during deposition at a distance of 10 cm directly above the boat. Before every deposition, the chamber was evacuated to a base pressure of 2×10^{-5}

mbar using rotary and diffusion pumps, and then backfilled with argon gas atmosphere at pressure of 2×10^{-1} mbar through specially designed inlet tube having a jet diameter of 0.5 mm and with growth rate of 0.5 nm s⁻¹. The jet was kept adjacent to the boat pointing toward the glass substrate, and flow of argon gas was controlled by needle valve. After passing high current, the material in the boat was turned into molten state and vapors of the material were formed. The vapors come in contact with argon gas which acts as carrier gas and transports the sublimated vapors to the substrate. The deposition conditions were kept constant for all films so that comparison of results could be made for thin films. The prepared films were kept in the deposition chamber in dark for 24 h before taking any measurements to attain thermodynamic equilibrium. The thickness of films measured by spectroscopic ellipsometry is found to be ~ 150 nm.

2.2 Details of Instrumental Analysis

Structural evolution of the prepared thin films is carried out using a Spinner 3064 XPERT-Pro X-ray diffractometer in the 2θ range from 10° to 80°. Copper target is used as an X-ray source with wavelength of 0.154056 nm. The accelerating voltage is set at 45 kV with a current of 40 mA. Transmission electron microscope (TEM) analysis is made using Hitachi H7500 electron microscope, operating at 100 kV. Thin films for TEM are deposited on carbon-coated copper grids by thermal evaporation in argon gas atmosphere. The composition of films is investigated with energy dispersive X-ray analysis (EDX) coupled with JEOL Scanning Electron Microscope (SEM) (JSM-6610 LV). The normal incidence transmission spectra of thin films are measured by UV-Vis-NIR computer-controlled spectrophotometer Perkin Elmer Lambda 750 at room temperature (300 K). Photoluminescence spectrum is recorded in visible region from a computer-controlled luminescence spectrophotometer LS-50 B with ± 1.0 nm and pulsed xenon discharge lamp as an excitation source. For electrical measurements, indium electrodes having electrode spacing 0.8 mm are deposited on thin films by thermal evaporation technique under base pressure of 2×10^{-5} mbar. Planar geometry of indium electrodes is used as it provides stable and good ohmic contacts for electrical measurements. Electrical conductivity is measured by mounting the thin films in a specially designed metallic sample holder, where a vacuum of 2×10^{-3} mbar is maintained throughout the measurements. In this sample holder, small heater is fitted with metallic base below the thin film to measure the temperature dependence of dark conductivity. A direct current voltage is applied across the thin film using Keithley Electrometer, Model 6517A, and current is noted using pico-ammeter. To check the

consistency of the results, the data experiments are repeated twice and error limits are included in the data points.

3 Results and Discussion

3.1 Phase Identification and Stoichiometry

XRD patterns of undoped and Ag-doped CdSe thin films are shown in Fig. 1. These patterns indicate that both undoped and Ag-doped CdSe thin films possess hexagonal phase having space group $P6_3mc$ and preferential orientation along (100) plane (JCPDS 8-459). After Ag doping in addition to (100) plane, additional peaks at $2\theta = 25.4^\circ$ and 41.9° , corresponding to (002) and (110) hexagonal phase of CdSe, emerge out. The broad hump in the XRD spectra is due to the amorphous nature of the glass substrate. When doping concentration increases to 5%, the crystallinity of the film decreases considerably. The decrease in crystalline character is due to the interstitial occupation of large number of dopants in the CdSe lattice that result in the increase in impurity scattering centers and prevent the growth of crystal along any preferred direction [33]. Similar behavior of decrease in crystalline character after In [34] and Zn [35] doping in CdSe has also been reported earlier. Hankare et al. [36] have also observed decrease in the crystalline behavior at high-level doped CdSe thin films.

A small shift in the diffraction angle after doping is observed, which is attributed to the replacement of smaller ionic radii of Cd atoms (0.097 nm) with larger ionic radii of Ag atoms (0.126 nm), consequently slight increase in the interplanar distance. There is a small decrease in the full width at half maxima in CdSe:Ag 1% for the (100) diffraction plane as compared to undoped CdSe, and the

corresponding crystallite size increases from 12 nm (undoped CdSe) to 20 nm (CdSe:Ag 1%). This change is ascribed to the difference in the ionic radii of Cd and Ag atoms [37].

EDX patterns of undoped and Ag-doped CdSe thin films are given in Fig. 2. The presence of emission lines of Cd, Se and Ag elements confirms the presence of Ag in CdSe. The decrease in the amount of Cd with increase in Ag doping is due to the lesser amount of Cd required for the preparation of CdSe:Ag 5% as compared to CdSe:Ag 1% bulk materials. The relative atomic weight percentages of thin films are also depicted in table given in Fig. 2(d).

3.2 Morphology Analysis

Figure 3(a–c) provides the SEM micrographs of CdSe, CdSe:Ag 1% and CdSe:Ag 5% thin films, respectively. The micrographs reveal that the substrates are covered with large number of spherical-shaped grains. It is also clear that there is homogenous distribution of grains in CdSe thin film. However, in case of Ag-doped CdSe thin film, there is an increase in inhomogeneous distribution of grains with irregularities at the grain boundaries. The agglomeration of small crystallites leads to the formation of big clusters in Ag-doped CdSe thin films. The inhomogeneous distribution of grains is also responsible for the decrease in crystallinity of CdSe:Ag 5% thin films.

TEM micrographs of CdSe, CdSe:Ag 1% and CdSe:Ag 5% are depicted in Fig. 4(a–c), respectively. It is clear from the TEM images that the thin films consist of spherical-shaped nanoparticles. The histograms given in the insets of Fig. 4(a–c) represent narrow particle size distribution of the nanoparticles with average particle size in the range of 40–45 nm, 25–30 nm and 55–60 nm for CdSe, CdSe:Ag 1% and CdSe:Ag 5% thin films, respectively. There is difference in the size values determined by XRD and TEM analysis. The difference between crystallite size and particle size is because that the grains are composed of many crystallites [38]. The crystallite size determined by XRD is the size of the coherently scattering domain coming from single crystals of parallel lattice planes, while the particle size distribution obtained from TEM analysis is the direct visualization of nanoparticles [39]. Goktas et al. have also observed the similar phenomena in Cu-doped ZnS thin films prepared by wet chemical route [40].

3.3 Optical Absorption and Luminescent Properties

The optical properties of thin films have been investigated by UV–Vis absorption and photoluminescence (PL) spectra. Figure 5(a) demonstrates that the absorption spectra of

Fig. 1 XRD patterns of undoped and Ag-doped CdSe thin films at 1% and 5% dopant concentration

Fig. 2 EDX spectra of undoped CdSe **a**, CdSe:Ag 1% **b** CdSe:Ag 5% **c** thin films and atomic fraction of thin films **d**

Fig. 3 SEM images of CdSe **a**, CdSe:Ag 1% **b** CdSe:Ag 5% **c** thin films

Fig. 4 TEM images of CdSe **a**, CdSe:Ag 1% **b** CdSe:Ag 5% **c** thin films (the insets in figures represent the histogram for particle size distribution)

Fig. 5 **a** UV-Vis spectra (the insets illustrate the Tauc plots for corresponding thin films) **b** room temperature photoluminescence spectra of undoped and Ag-doped CdSe thin films (α : absorption coefficient; h : Planck's constant; ν : frequency; λ : wavelength; λ_{ex} : excitation wavelength)

CdSe thin film are characterized by a broadband while the Ag-doped CdSe thin films consist of tail states. The formation of band tails in doped thin films is ascribed to the high density of states as the dopants induce a large number of free carrier density in the bands and a high density of ionized dopant ions [41]. The value of absorption coefficient (α) decreases after doping. Similar behavior of decrease in absorption coefficient at high-level doping is also reported by Masumdar et al. [42] in Sb-doped CdSe thin films and Bhuse [43] in Hg-doped CdSe thin films. The direct band gap value (E_g) is evaluated from the absorption coefficient using Tauc's relation by extrapolating the straight line portion of $(\alpha h\nu)^2$ versus $(h\nu)$ (energy) to zero absorption region. The value of E_g is found to decrease from 2.256 eV (CdSe) to 2.183 (CdSe:Ag 1%) and 2.170 eV (CdSe:Ag 5%) which is attributed to the development of band tails in the doped thin films. The nano-sized materials consist of inherent strain due to lattice mismatch between the substrate and film that leads to formation of some crystal defects [44]. The crystal defects produce localized states in the band structures [45]. The decrease in band gap after Ag doping can be attributed to the increase in width of localized states with the increase in amount of dopant [27]. The band gap value of CdSe bulk material 1.7 eV is smaller than the Ag-doped CdSe thin films due to quantum size effects. Another reason for the decrease in band gap is attributed to the increase in grain

size after doping. Gupta et al. [46] have observed band gap dependence on the grain size and found decrease in band gap with the increase in grain size in thin sulfide nanocrystalline thin films.

The PL study has been carried out to obtain information regarding electronic transitions associated with dopant, impurities and defect states present in the NSs. The PL spectra of prepared thin films at an excitation wavelength of 400 nm are depicted in Fig. 5(b). The PL spectra of CdSe thin film consist of two peaks centered at 531 nm (2.33 eV) and 563 nm (2.20 eV), while Ag-doped thin films consist of one sharp peak centered at 605 nm (2.05 eV) and 610 nm (2.03 eV) for CdSe:Ag 1% and CdSe:Ag 5% thin films, respectively. In general, two types of emissions are possible in semiconductor NSs, viz., excitonic and trapped luminescence. The excitonic emission is sharp and located near the absorption edge of the materials, while the trapped emission is broad and probably due to the formation of deep or shallow trap states [47]. PL spectra of undoped CdSe consist of near-band-edge emission peak at 531 nm as well as low-energy peak at 563 nm which correspond to the electron-hole recombination via trap states. The high-energy peak at 531 nm is due to the interband radiation of electron-hole recombination that emits light with energy equal to or greater than the band gap. The high-energy emission is likely associated with high-energy recombination centers associated with intrinsic

deficiencies or defect states [48]. Ziabari and Ghodsi [48] have also observed interband optical transition in undoped and Cu-doped CdS thin films prepared by sol-gel dip-coating method. PL spectra of Ag-doped CdSe thin film consist of only sharp peak that corresponds to band edge emission peak. The absence of trap-related emission in Ag-doped CdSe thin films elucidates that the defect-related levels favor the non-radiative recombination mechanisms instead of the radiative ones; therefore, only band edge recombination characterizes the PL spectrum [49]. The non-radiative transitions are mainly due to unsaturated bonds and defects, which serve as traps and prohibit radiative recombination of electrons and holes [50]. In addition, the band edge emission peak shifts toward higher wavelength from 531 (for CdSe) to 605 nm (for CdSe:Ag 1%) and 610 nm (for CdSe:Ag 5%). The redshift in the emission peak is due to the decrease in band gap of CdSe after Ag doping. Recently, Morgan and Kelley [51] have observed band edge radiative recombination of conduction band electrons and valance band holes and found weak luminescent mid-gap state with decreases in PL quantum yield with Ag doping in CdSe/CdS nanoparticles.

3.4 Electrical Response

Electrical behavior is a prominent feature that reveals reliable information about the transport phenomenon of the NSs. It is renowned that the transport phenomena in polycrystalline thin films are strongly influenced by crystallite size and highly strained grain boundaries in the NSs [52]. Temperature dependence of electrical conductivity (σ_d) for CdSe and Ag-doped CdSe thin films is presented in Fig. 6(a). The increase in σ_d with temperature indicates semiconducting behavior of the thin films. Moreover, the temperature dependence of σ_d consists of two linear regions with distinct slopes, indicating that two different

types of conduction mechanisms are taking part in the transport phenomena. The conduction in high temperature region (HTR) is associated with the transition of charge carriers in the extended states, while conduction in low temperature region (LTR) is most likely associated with the hopping of charge carriers in the localized states [53].

Grain boundaries in the thin films contain a large number of defect states within the band gap that acts as effective carrier trap states [54]. After trapping of the carriers in trap states, they become charged and create potential barriers at the grain boundaries, which modulate the conductivity of the thin films. The calculated values of σ_d for CdSe, CdSe:Ag 1% and CdSe:Ag 5% thin films at room temperature are listed in Table 1. The value of σ_d for Ag-doped CdSe thin films is found to be lesser than CdSe thin films. The Ag doping in CdSe lattice results in the increase in defect states that disturb orientation of the grains and possess discontinuities at the grain boundaries, resulting in the increase in lattice distortion. The decrease in conductivity after Ag doping may be associated with the increase in grain boundary scattering. The randomly oriented grain boundaries act as trap centers, reducing the mobility of charge carriers by trapping the carriers at trap centers and scattering the carriers at the grain boundaries [55]. The smaller sized grains lead to higher grain boundary scattering, resulting in the decrease of conductivity [56]. Therefore, the decrease in σ_d can be ascribed to the increase in grain boundary defects that will create the potential barrier which strongly affects the electrical transport behavior. It can also be concluded that low conductivity is probably due to poor crystalline quality of the Ag-doped CdSe thin films. Similar decrease in conductivity with the increase in Zn composition in $\text{Zn}_x\text{Cd}_{1-x}\text{Se}$ has also been reported by Nesheva et al. [57].

To ensure the validity of hopping conduction in the low temperature region, variation of $\ln(\sigma T^{1/2})$ versus $T^{-1/4}$ is

Fig. 6 a Temperature dependence of electrical conductivity b validity of Mott's relation

Table 1 Electrical parameters for CdSe and Ag-doped CdSe thin films

Thin film	σ_d ($\Omega^{-1} \text{ cm}^{-1}$)	Activation energy (eV)		T_0 (K)	$N(E_F)$ ($\text{eV}^{-1} \text{ cm}^{-3}$)	R (cm)	W (eV)	$\alpha'R$
		HTR	LTR					
CdSe	$(3.74 \pm 0.305) \times 10^{-7}$	1.14 ± 0.043	0.071 ± 0.005	2.53×10^8	1.57×10^{18}	1.14×10^{-6}	0.1026	14.136
CdSe:Ag 1%	$(2.24 \pm 0.303) \times 10^{-8}$	0.81 ± 0.021	0.038 ± 0.001	5.32×10^6	7.48×10^{19}	4.35×10^{-7}	0.0382	5.394
CdSe:Ag 5%	$(9.45 \pm 0.324) \times 10^{-8}$	0.61 ± 0.024	0.116 ± 0.001	2.25×10^8	1.77×10^{18}	1.11×10^{-6}	0.0986	13.764

plotted in Fig. 6(b) and found to be linear. According to Mott, linear region represents electron transport by hopping among localized states. The hopping conduction is associated with the electron jumping from occupied donor states to empty ones and characterized by Mott's relation [22]:

$$\sigma T^{1/2} = \sigma_0 \exp \left[- \left(\frac{T_0}{T} \right)^{1/4} \right], \quad (1)$$

where σ_0 is the pre-exponential factor, T is the temperature, and T_0 is related to the density of hopping states near the Fermi level $N(E_F)$ by the relation:

$$T_0 = C_0 \frac{\alpha'^3}{kN(E_F)}, \quad (2)$$

where C_0 (≈ 18) is the dimensionless constant and α' is the decay constant of the wave function of localized states near the Fermi level and is assumed to be $0.124 \text{ \AA}^{-1}$. Hopping distance (R) and hopping energy (W) are also calculated from the density of states using the following relations:

$$R = \left[\frac{9}{8\pi\alpha'kTN(E_F)} \right]^{1/4}, \quad (3)$$

$$W = \frac{3}{4\pi R^3 N(E_F)}, \quad (4)$$

where k is Boltzmann's constant.

The electron states near the Fermi level are highly localized, and conduction occurs by hopping of carriers between the occupied and empty localized states and depends on the density of states and position of Fermi level. As observed from Fig. 6(b), the linear behavior obeys Mott's relation and represents hopping of charge carriers between localized states. The value of Mott's parameters at $T = 125 \text{ K}$ has been calculated and given in Table 1.

It is well known that addition of dopant in the CdSe lattice leads to the modification of the electronic structure. The values of hopping energy (W) and hopping distance (R) for Ag-doped CdSe thin films are less than undoped CdSe. The value of $N(E_F)$ which gives density of states near the Fermi level is inversely related to the W and R as given by Eqs. (3) and (4). The value of $N(E_F)$ is found to increase after Ag

doping as given in Table 1. As there is an increase in density of states near the Fermi level, therefore the hop electrons will require less energy and less distance to hop from one state to another. According to Mott and Davis [22], the values of $\alpha'R$ and W should be greater than unity and kT ($\sim 1.08 \times 10^{-4}$ at 125 K), respectively, for hopping conduction. It is well evident from Table 1 that $\alpha'R > 1$ and $W > kT$, which agrees well with Mott's hopping condition.

Furthermore, to measure the concentration of charge carriers and type of majority carriers, Hall measurement has been performed on thin films. The negative sign of Hall voltage (V_H) has been found for both CdSe and Ag-doped CdSe thin films, which indicate n-type behavior of the thin films. The calculated values of carrier concentration (n) and mobility (μ) of thin films are given in Table 2. It is found that the value of n decreases after doping of Ag in CdSe, which is attributed to the increase in trap states and impurity scattering centers in the CdSe lattice. The smaller value of n for CdSe:Ag 1% and CdSe:Ag 5% thin films as compared to CdSe is responsible for observed decrease in conductivity of Ag-doped CdSe thin films.

The effect of Ag doping on the defect states has also been investigated by constant photocurrent method (CPM). The detailed description of this experiment is reported earlier [58]. The spectral dependence of absorption coefficient in the sub-gap region (α_{CPM}) as a function of energy of incident photons is shown in Fig. 7. The optical absorption in the sub-gap region corresponds to an exponential tail obeying the equation:

$$\alpha_{\text{CPM}} = \alpha_0 \exp (hv/E_U), \quad (5)$$

where α_0 is constant and E_U is the Urbach energy and is characteristic of the absorption in the localized tail states.

Table 2 Carrier concentration (n) and mobility (μ) of carriers for CdSe and Ag-doped CdSe thin films

Thin film	n (cm^{-3})	μ ($\text{cm}^2 \text{ V}^{-1} \text{ s}^{-1}$)
CdSe	1.20×10^{11}	21.42
CdSe:Ag 1%	1.07×10^{10}	13.12
CdSe:Ag 5%	1.07×10^{11}	5.52

Fig. 7 Sub-gap absorption spectra of undoped and Ag-doped CdSe thin films

The number density of defect states (N_d) is evaluated from Urbach energy, E_U , by using relation as follows [59]:

$$N_d = N_v \exp \{ -(E - E_v)/E_U \}, \quad (6)$$

where N_v ($\sim 10^{19} \text{ cm}^{-3}$) is the density of states at the top of the valance band (E_v), E is the energy up to which density of defect states is considerable, and $E - E_v \sim 0.2 - 0.3 \text{ eV}$ is the position of defects states for CdSe thin films [51]. The calculated value of E_U and N_d is found to increase after Ag doping as given in Table 3.

In view of our results, it has been found that Ag dopant leads to significant modification in the transport properties of CdSe thin films. The redshift in the photoluminescence spectra after Ag doping in CdSe can find applications in color tunability of the various luminescent devices. Optical band gap can be tuned by changing the Ag doping level which in present case decreases with the increase in doping. It has been seen that instead of increasing the conductivity with Ag dopant, it decreases at chosen Ag dopant levels. The ability to tune the electrical properties of CdSe by doping is crucial in exploring the potential applications in optoelectronic devices. Thus, an effort of Ag doping in CdSe is an important step toward future applications of semiconductor NSs.

Table 3 Urbach energy (E_U) and density of defect states (N_d) of CdSe and Ag-doped CdSe thin films

Thin film	E_U (meV)	N_d (cm^{-3})
CdSe	120	8.21×10^{19}
CdSe:Ag 1%	279	4.88×10^{20}
CdSe:Ag 5%	129	2.12×10^{20}

4 Conclusion

The influence of Ag doping on the structural, optical and electrical properties of CdSe thin films has been investigated. The thin films of Ag-doped CdSe at 1% and 5% doping are prepared on glass substrates by thermal evaporation technique in argon gas atmosphere. XRD analysis demonstrates hexagonal crystal structure of CdSe and Ag-doped CdSe thin films and the decrease in crystallinity at Ag 5% doping, which is attributed to the increase in discontinuities at grain boundaries. TEM micrographs reveal spherical nature of the nanoparticles having average particle size in the range of 40–45 nm, 25–30 nm and 55–60 nm for CdSe, CdSe:Ag 1% and CdSe:Ag 5% thin films, respectively. Band edge emission peak in PL spectra shifts from 531 nm (for CdSe) to 605 nm (for CdSe:Ag 1%) and 610 nm (for CdSe:Ag 5%) due to narrowing of band gap. CdSe thin films consist of trap-related emission peak which is absent in Ag-doped CdSe thin films due to non-radiative recombination of the defect levels. Electrical conductivity of Ag-doped CdSe thin films is found to be less than CdSe due to trapping charge carriers at trap centers and scattering carriers at the grain boundaries. At low temperature, conduction takes place due to hopping of charge carriers among localized states.

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