bath and kept undisturbed for 48 hrs to get deposited. After the prescribed time, the deposited substrate is washed with de- ionized water to remove the granules and is allowed to get dried in a dessicator. The experimental setup is as shown in Figure 1. The experimental procedure is repeated for different reaction bath BI, BII and BIII with molarities of $CaSO_4$ as 0.5M, 1.0M… and of EDTA with 1.0M, 0.10M and of Sodium thiosulphate with 1.0M .The deposition time is also varied and different CaS films are prepared for deposition hours of 48 hrs, 17hrs and 18 hrs as shown in Table 1.

Table 1: Chemical Bath Conditions

Reaction Bath	Deposition Time (hours)	Temperature (°C)	$CaSO_4$		EDTA		$Na_2S_2O_3.5H_2O$		H_2O Vol (ml)
			Mol (M)	Vol (ml)	Mol (M)	Vol (ml)	Mol (M)	Vol (ml)	
B I	48	Room	0.5	3.5	0.10	3.5	1.0	7.0	34
B II	17	Room	1.0	3.0	1.0	3.0	1.0	3.0	34
B III	18	Room	0.5	3.0	0.10	3.0	1.0	3.0	28

Figure 1: Chemical Bath Setup of a Cas thin film

2.3 Mechanism of the Reaction

The reaction that occurs due to $CaSO_4$, $Na_2S_2O_3.5H_2O$ and water are as follows:

When $CaSO_4$ and EDTA are added up, the Sulphate ions get separated and it occurs as:

$CaSO_4$ + EDTA $\Leftrightarrow$ [Ca (EDTA) $^{2+}$] + SO_4^{2-}

There occurs a reversible reaction and hence [Ca (EDTA) $^{2+}$] becomes,

[Ca (EDTA) $^{2+}$] $\Leftrightarrow$ Ca^{2+} + EDTA

Thus, EDTA get separated giving Ca^{2+} ion.

The next reaction goes on with sodium thiosulphate and it produces a sulphide ion

$Na_2S_2O_3.5H_2O$ $\Leftrightarrow$ Na_2O_3+$5H_2O$+S^{2-}

From this two process Ca^{2+} and S^{2-} combine to from the precipitate of CaS.

$$Ca^{2+} + S^{2-} \Leftrightarrow CaS \downarrow$$

2.4 Measurement of thickness of the thin film

After the deposited film has been dried, the film is etched with Hcl on one side. Now, the dried deposited substrate is weighed using Mass Balance and the weight of the film after deposition is noted.

Weight of the thin film on the Glass substrate (W) = Weight after deposition - Weight before deposition

Now, the thickness of the thin film is determined from the mass difference before and after deposition.

$$t = \frac{W}{\rho A}$$

Where, ρ is density of the material chosen for deposition (2600Kg/m^3) and A is area of deposition.

The thickness of the three samples is found to be in micrometer range (0.96154µm, 0.58719µm and 0.89969µm) as shown in Table 2.

Table 2: Thickness of the film samples

Samples	Weight Before Deposition (gm)	Weight After Deposition (gm)	Thickness (µm)	Area m^2
Sample	4.389	4.391	0.96154	0.0800

3. Result and Discussion

3.1. Optical characterization for the thin film

The optical Characterization was carried out using ***Jasco V-570 spectrophotometer*** and the investigation includes absorbance, transmittance, extinction coefficient, band gap energy etc. The optical properties of the thin films were studied in the UV – VIS – NIR region using bare glass slide as reference.

3.1.1 Transmittance T (%)

The ratio of flux transmitted by a medium to the incident flux.The transmittance percentage of the thin film is measured using the above spectrophotometer and they are obtained as, T = I/ I_0 where I – transmitted flux and Io – incident flux is shown in figure 2.

3.1.2 Absorbance (A)

$$\text{Absorbance} = \log \frac{1}{\text{Transmittance}}$$

The absorbance value of the film in the IR region is the logarithmic reciprocal of the transmittance and the curve is obtained by taking the absorbance value along Y –axis and λ along X axis is shown in figure.3.

3.1.3 Extinction Coefficient (K_f)

The extinction coefficient is calculated as follows:

$$K_f = \frac{2.303 \ x \ \log \left(\frac{1}{T}\right) x \ \lambda}{4\Pi t}$$

Where T is the Transmittance (%), λ is the Wavelength (m) and t is the Thickness (µm).

3.1.4 Absorption coefficient (α)

With the help of extinction coefficient (K_f) and wavelength (λ), α is calculated as $\alpha = \frac{4\Pi Kf}{\lambda}$ m^{-1}

From α , Eg is determined.

3.1.5 Energy Band Gap (Eg)

The photon energy is

$$h\nu = \frac{hc}{\lambda} = \frac{6.626x10^{-34} x 3 x10^{8}}{\lambda} \ \text{eV}$$

Where h – Planck's constant, ν – Frequency and c – Velocity of light . From the value of α and hν , $(\alpha h\nu)^2$ is calculated.Taking hν along X-axis and $(\alpha h\nu)^2$ along Y – axis, graph is plotted and the intercept on X axis gives the value of Eg and it is given by the relation . Eg = hν - α With the value of Eg and thickness, a graph is plotted for all the samples as shown in figure 4.

3.1.6. Reflectance (R)

The percentage of light reflected back from a surface, the difference having been absorbed or transmitted from a surface. Reflectance is given by, R= 1- A- T , where A is the absorbance , T is the transmittance. Reflectance graph are shown in figure 5. The spectral absorbance of the CaS thin films are displayed and the absorbance value are found to be low in the range of 0-0.17% with varying bath conditions. The film exhibits high transmittance, ranges from 70-85% in the UV-VIS region and the band gap was found to be in the range of 3.9eV, The plot against photon energy and extinction coefficient for the Sample is shown in figure 6 and maximum extinction coefficient value ranges from 0.12-0.2 in the UV region.

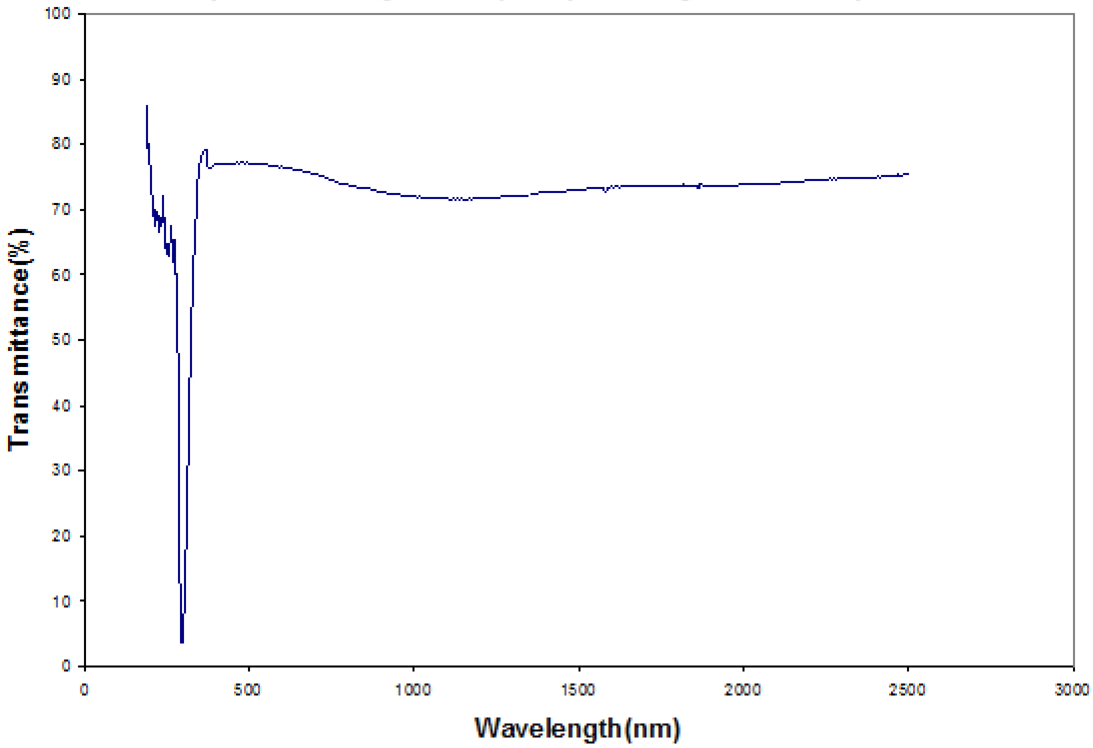

Figure 2: Transmittance Spectrum for the Sample

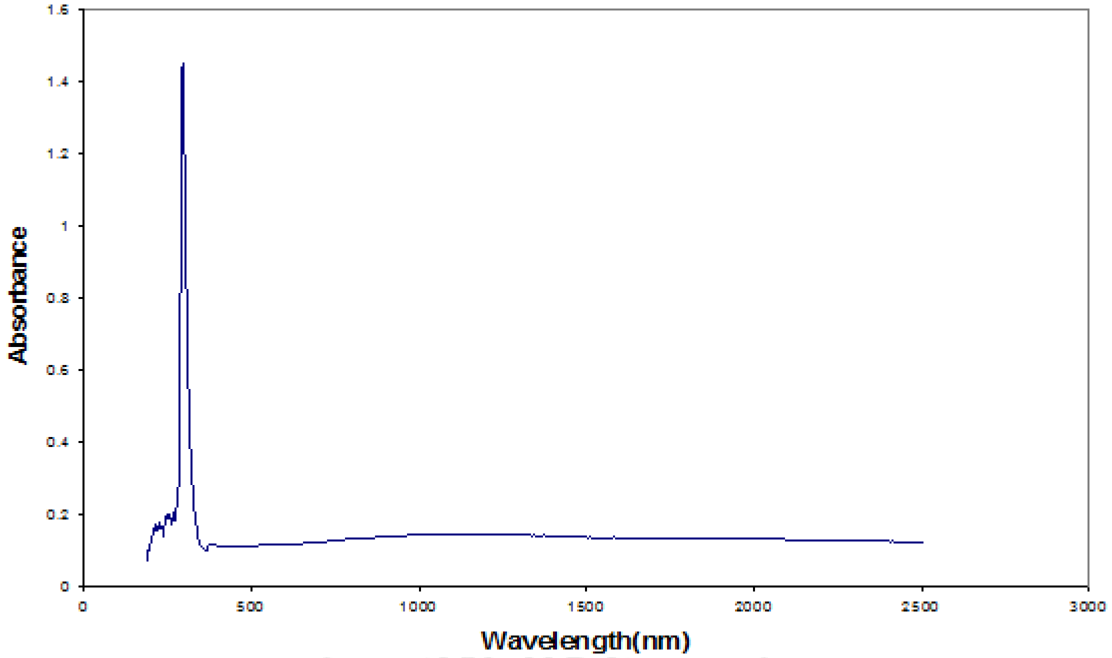

Figure 3: Absorbance Spectrum for the Sample

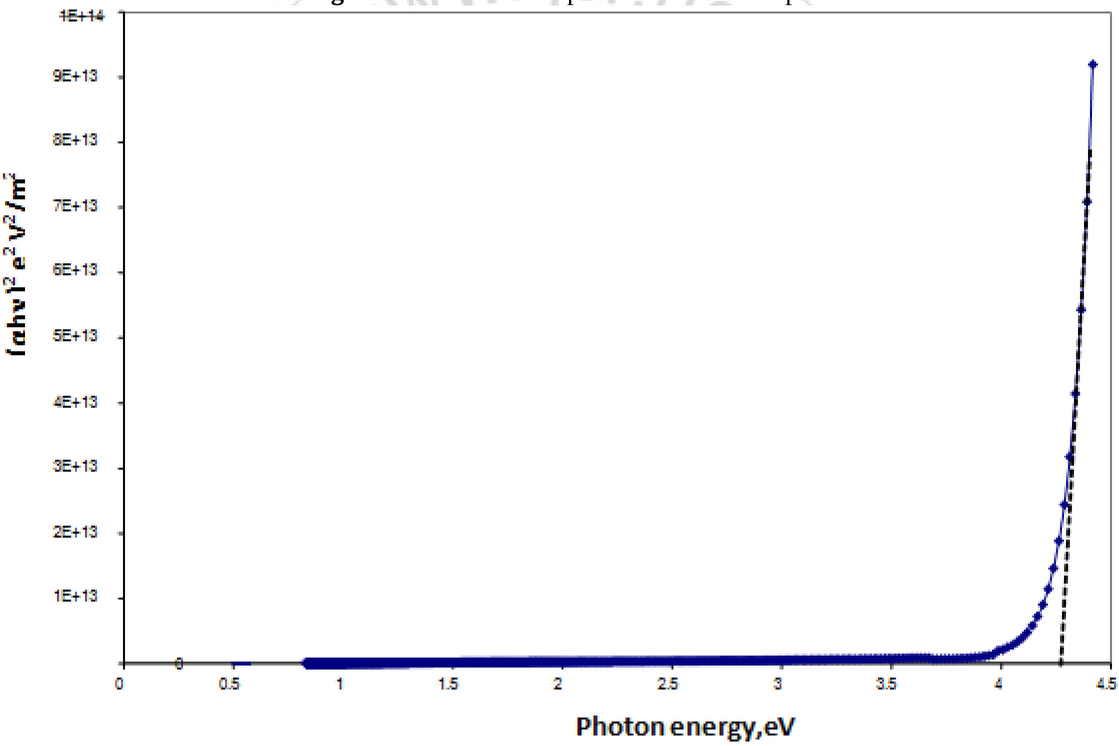

Figure 4: Band gap Energy for the Sample

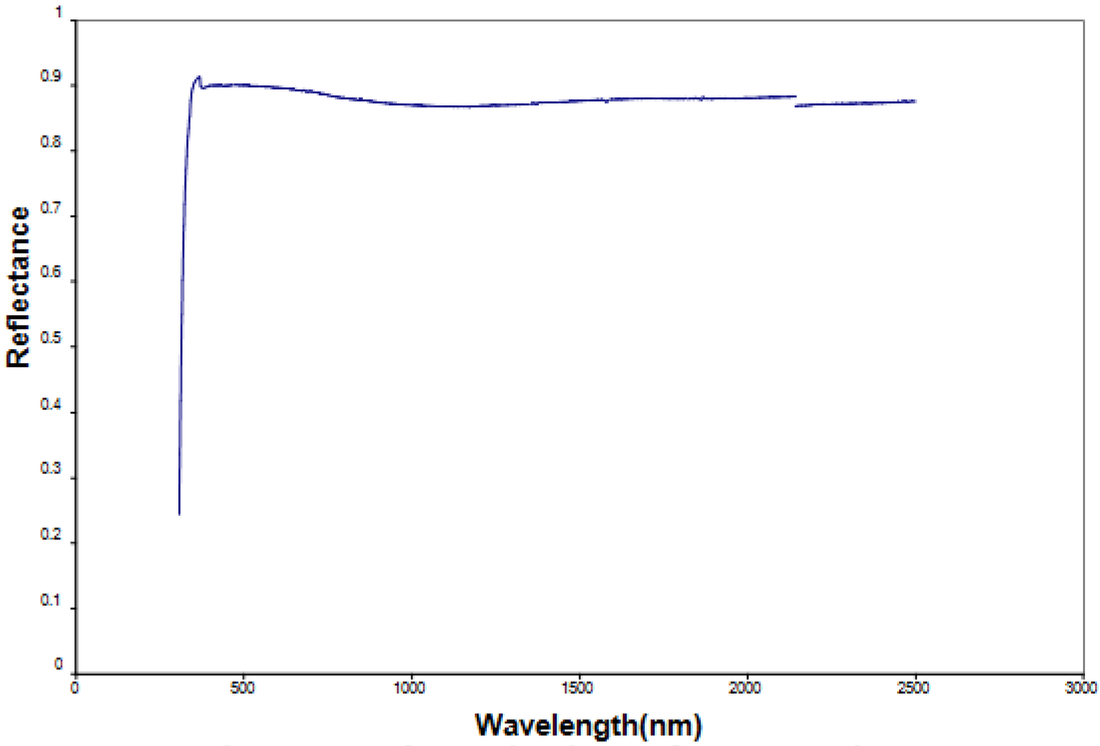

Figure 5: Reflectance for the Sample

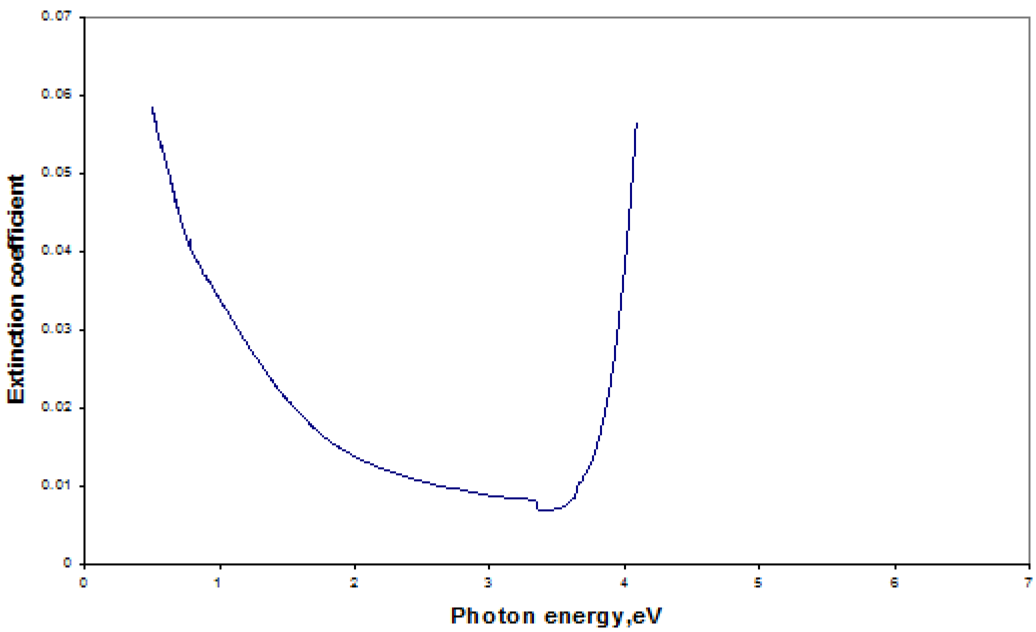

Figure 6: Photon Energy Vs Extinction Coefficient for the Sample

4. Conclusion

In the present work, Calcium Sulphide is chosen as the depositing material since it involves wide range of applications in the field of semiconductor devices and optical coatings.It is suitable for use as a photosynthetic and window coating material. Of all the deposition technique CBD is the least cost by technique. Chemical Bath Deposition technique is chosen to deposit thin films of CaS on glass substrate at varying bath parameters as the technique involves the precipitation from solution of a compound on suitable substrate. Thin films with less than one micron in thickness can be conductive or dielectric and are used to make solar panels and solar roof shingles. The optical Characterization was carried out and the samples exhibit a low absorbance of 0-0.17% and high transmittance which ranges from 70-85% in the UV-Visible region. The range of extinction coefficient is 0.12 – 0.2 for photon energy of 4.2eV. The band gap determined from $(\alpha h\nu)^2$ Vs hν graph is found to be ~ 3.9eV. Since the material exhibits high transmittance in the UV-Visible region it is suitable for window coating. The deposited film is also used in solar energy collector and anti reflection coatings

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