Solar energy is a clean, abundant, renewable energy resource that can benefit us by diversifying the energy supply. Solar energy holds tremendous long term potential to reduce our dependence on fuels, improve the quality of the air we breathe, and stimulate the economy by creating jobs in manufacture and installation of solar systems. Solar energy is the most plentiful and widely available form of renewable energy throughout the world. Solar energy is the origin for all fossil fuels, and we never need to worry about solar energy being depleted, as the sun continues to shine.

One important way to convert solar radiation into electricity occurs by the photovoltaic effect, which was first observed by Becquerel. It is generally defined as the emergence of an electric voltage between two electrodes attached to a solid or liquid system upon shining light onto this system. Practically all photovoltaic devices incorporate a p-n junction in a semiconductor across which the photovoltage is developed. These devices are also known as solar cells. The semiconductor material should be able to absorb a large part of the solar spectrum. Depending on the absorption properties of the material the light is absorbed in a region more or less close to the surface.

Heterojunction solar cells with narrow bandgap window have been studied to develop efficient, stable, and low cost solar cells. CdS/CdTe
heterojunction is an important candidate for photovoltaic conversion of solar energy. Cadmium sulphide (CdS) is found to be suitable as a window layer material for thin film solar cells. It has a wide optical bandgap of 2.42 eV with suitable physical parameters. Zinc sulphide (ZnS) is also widely used photovoltaic material for window layer application in solar cells. ZnS is an n-type semiconductor with a wide direct band gap of 3.6 eV at room temperature. It is suitable for window layer in heterojunction photovoltaic solar cells, because the wide band gap will decrease the window absorption loss and improve the short circuit current of the solar cell.

\[ \text{Cd}_{1-x}\text{Zn}_x\text{S} \] (cadmium zinc sulphide) thin films have found an extensive application in the optoelectronic devices, such as photodetector and light emitting devices. This is because \( \text{Cd}_{1-x}\text{Zn}_x\text{S} \) is a direct band gap semiconductor whose band energy can be controlled in the range of binary band gaps by changing the \( x \) value in the alloy. \( \text{Cd}_{1-x}\text{Zn}_x\text{S} \) films are also the subject of considerable interest due to the possibility of using these alloys as window layer materials in heterojunction solar cells.

Tin sulphide (SnS) is a p-type IV-VI compound semiconducting material, belongs to the group of orthorhombic crystal structure with a distorted rock salt structure. SnS has attracted considerable attention in recent years due to the possibility of its application in photovoltaic devices. Its direct and indirect bandgap energies were reported to be 1.2 to 1.5 and 1.0 to 1.2 eV, respectively. These properties make it suitable as an ‘absorber’ layer in the fabrication of thin film heterojunction solar cells. In addition, it has added
advantage of its constituent elements being abundant in nature and not posing any health and environmental hazards.

The deposition of ZnS and CdS thin films was carried out by photochemical deposition technique. The optimized condition for the deposition is found by varying the deposition parameters like pH, chemical composition, deposition time etc. A well ultrasonically cleaned indium tin oxide (ITO) coated glass substrate is immersed into an aqueous solution containing sodium thiosulfate and metal ions. An ultra high pressure mercury lamp having 500 W power has been used for the present deposition. The light was focused by using simple converging lens and is focused on the substrate for about 1cm diameter. Under UV irradiation the metal ions were reduced and the sulfide semiconductors were deposited on the surface of the substrate. Initially for getting the deposition higher ion concentration was used in the deposition bath. The prepared solution was dropped on the surface of the ITO substrate and was irradiated for 2 to 3 seconds. Hence the solution is very small, the photochemical reaction takes place very quickly and the materials nucleate on the surface of the substrate very fast. Then the deposition is carried out for 30 minute by dipping the substrate in the deposition bath. The initial dropping helps for the favourable deposition. CdSO₄ and Na₂S₂O₃ have been used for the deposition of CdS thin films, and ZnSO₄ and Na₂S₂O₃ have been used for the deposition of ZnS thin films. The films were characterized by using Raman spectroscopy, scanning electron microscopy, X-ray diffraction and current voltage measurements.
The Cd$_{1-x}$Zn$_x$S ($0 \leq x \leq 1$) alloys were deposited from the aqueous bath with Cd$^{2+}$, Zn$^{2+}$ and S$_2$O$_3^{2-}$ ions. The alloy composition was varied by varying the chemical composition of CdSO$_4$, ZnSO$_4$ and Na$_2$S$_2$O$_3$ in the deposition bath. The composition of the alloy was varied by changing the ZnSO$_4$ concentration and keeping the concentration of CdSO$_4$ and Na$_2$S$_2$O$_3$ as fixed. By increasing the concentration of ZnSO$_4$ it is possible to obtain 25% zinc in the alloy. By changing the CdSO$_4$ concentration and keeping concentration of the other two as fixed the remaining alloy composition was obtained. The deposited films were characterized by X-ray diffraction analysis, Raman spectroscopy and auger electron spectroscopy. The alloy composition was estimated using the lattice constant calculated from the results of XRD analysis. Using longitudinal optical (LO) phonon frequency observed from the Raman spectrum, the alloy composition was calculated and the composition was also calculated from the AES measurement. Using these three techniques the calculated compositions were cross checked and found to be consistent. The surface morphology of films was analyzed from the SEM analysis.

The SnS thin films were deposited using electrochemical deposition technique. In the present study the pulsed electrochemical deposition technique was used rather than the conventional normal DC applied voltage. Mainly three step pulsed electrochemical deposition was used in which the reduction, diffusion and oxidation potentials were adopted. The deposited films were characterized for their surface morphology, which is the most essential information for fabricating the solar cell structure. The films were
also subjected for photoelectrochemical (PEC) measurement to obtain the conductivity type of the deposited SnS films. The structural aspects and resistivity of the films were analysed by X-ray diffraction and I-V measurement, respectively.

The solar cells were fabricated using photochemical deposition and electrochemical deposition methods. CdS and CdZnS films deposited from photochemical deposition were used as n-type window layers and SnS films deposited using pulsed electrochemical deposition were used as absorbing layer. The fabricated solar cell structures are Glass/ITO/CdS/SnS/In and Glass/ITO/Cd\textsubscript{1-x}Zn\textsubscript{x}S/SnS/ITO. The absorbing layer was deposited with different applied potential \( V_1 = -1.0 \), \( V_2 = -0.6 \) and \( V_3 = 0.0 \) V vs. SCE. The surface morphology and the structural details were studied by using SEM and XRD. The fabricated solar cell was characterized under 100 mW/cm\textsuperscript{2} (AM 1.5) using xenon lamp as a light source. The fabricated solar cell structure is Glass/ITO/Cd\textsubscript{0.87}Zn\textsubscript{0.13}S/SnS/In, where SnS was deposited by the three step pulsed electrochemical deposition. The applied potential is from positive to negative and the photovoltaic parameters observed are \( V_{oc} = 288 \) mV, \( I_{sc} = 9.1 \) mA/cm\textsuperscript{2}, FF= 0.27 and \( \eta = 0.71\% \).

The findings of this thesis work have been published in six international journals and presented in seven international/national conferences.