Novel and innovative ideas to harvest the incident solar photons with better efficiency are required to meet the faster demand of clean energy. More than 85% of the current world production of solar cells involves crystalline silicon. Nevertheless, after several years of intensive research and developmental activities, a new generation of materials is being investigated for pilot to large-scale productions. Thus, over the past decade, there are considerable efforts in advancing thin films, “second-generation” technologies that do not require the use of silicon, therefore solar cells can be manufactured at significantly reduced cost. The second-generation devices consisting of polycrystalline semiconductor thin films can bring down the price significantly, but their efficiency needs to be enhanced for making them practically viable. At lab scale, a lot of progress has been made in this regard for devices based on CdS, CdTe, Cu (In,Ga)Se₂, amorphous Si and SiGe alloys. An emerging set of photovoltaic (PV) cells rely on third-generation concepts, viz., organic- or dye-based absorbers/acceptors, organic photovoltaic cells, and a number of intermediate band devices, quantum dot solar cells, and multiple exciton devices.

Among these nanomaterials have emerged as the new building blocks to construct light energy harvesting assemblies. Efforts are being made to design organic and inorganic hybrid structures that exhibit improved efficiency toward light energy conversion. Some of these devices, which can be fabricated under open conditions are solution based processing which exhibit conversion efficiency ranging from 5 to 10%; these are attributed as low cost technology. However, intensive research is required in the interdisciplinary areas to find new materials, modules, fabrication
methods, over a large class that are low-cost and reliable with respect to their efficiency, stability and self life. It is known that the efficiency of organic photovoltaic devices is limited by the low carrier mobility of polymer donors and organic acceptors as compared to inorganic semiconductors. Inorganic nanocrystals as electron acceptors have been introduced into conjugated polymers to create hybrid bulk heterojunctions. Hybrid inorganic-organic solar cells using inorganic nanocrystals with high electron mobility can partially overcome charge-transport limitations as materials of electron affinity acceptors. Various high electron affinity inorganic semiconductors including cadmium sulphide (CdS), cadmium selenide (CdSe) nanorods and tetrapods, zinc oxide (ZnO) nanoparticles, cadmium telluride (CdTe) nanorods, and titanium oxide (TiO₂) nanoparticles have been widely investigated. CdS, an important II–VI semiconductor, is attractive for hybrid photovoltaic devices particularly due to the relatively large direct band gap (2.42 eV) that absorbs light in the visible wavelength range and also acts as window material for solar cells.

The present work concentrates on growing high quality CdS thin films by chemical bath deposition to develop a low cost hybrid photovoltaic device using Copper (II) phthalocyanine- tetrasulfonic acid tetrasodium salt (CuPcTc) as a dye and study their electric charge transport mechanism. The entire thesis is divided into seven chapters,

Chapter One: This chapter begins with brief introduction on energy importance and energy crisis of modern world. A possible solution to this is the efficient utilization of solar energy. In the beginning, a general classification of photovoltaic cells such as first, second and third generation will be discussed.
Among these, thin films and nanomaterials that are grown and processed by simple solution techniques will be discussed.

Transparent electrodes, which provide electrical contact to the active layer and allow light to pass through are ubiquitously used in displays and solar cells with increasingly large industry demands [6]. These are also an equally important class of material for the development of thin film low cost solar cell. A broad survey on such material will be presented.

The growth of certain photovoltaic active semiconductors by chemical bath will be discussed in detail. At the end the motivation of the present work is discussed.

Chapter Two: This chapter devoted to experimental techniques to deposit antimony doped tin oxide and cadmium sulphide thin films by simple wet chemical routes. A concise discussion is presented on various techniques such as X-ray diffraction, thickness measurement, scanning electron microscopy, optical absorption spectroscopy, and electrical conductivity measurements. Since these are important tools for the characterization of modern materials.

Chapter Three: This chapter has been focused on the importance of transparent conducting oxide, which provides electrical contacts to active layer and allows light to pass in many electronic devices including solar cells, these are also equally important class of materials in the development of low cost thin film solar cell. A broad survey is presented on tin oxide (SnO₂) as transparent conducting oxide. A simple spray pyrolysis set up is developed to prepare highly conducting tin oxide thin films with various amounts of (antimony) Sb doping. In the process of achieving this goal, it is observed that with increase in Sb content for doping these materials exhibit longitudinal surface plasmons which are sharp and
shifted well in a visible region of spectrum. Such plasmonic features are never reported earlier, it is believed that these features, ease of synthesis, low cost and chemical stability make the present SnO$_2$: Sb as potential candidate for plasmonic applications in various fields.

**Chapter Four:** This chapter is devoted to describe the chemical bath deposition of CdS thin films of present work. These films are grown under different bath conditions by changing complexing agents and sources of cadmium ions. The structure, optoelectronic and surface morphology of films grown under different conditions are characterized by X-ray diffraction, optical absorption and scanning electron microscopy respectively. Based on these informations, optimum conditions for deposition are established to grow smooth, adherent and uniform films which can be implemented for large number of device applications.

The solution based ion exchange is an interesting and a simple method to control the electrically conductivity of chemically bath deposited CdS films. Doping (interstitial substitution) and phase conversion of intrinsic CdS in solution based cation-exchange process will be discussed in detail. Thiols are known to interact readily with metal nanoparticles and are expected to coordinate with the Cd atoms on the surface of CdS nanoparticles. The impact of thiol treatment on conductivity will also be discussed.

**Chapter Five:** Open air thermal oxidation of copper will be discussed to obtain photovoltaic active cupric oxide semiconductor CuO. The surface passivation of starting material by the different amines and effects of amines will be discussed in detail.
**Chapter Six:** This chapter discusses the photo electrochemical properties of CdS based films. Various structures of ITO- CdS- redox couple-ITO, ITO- CdS-CuO-redox couple-ITO & ITO-CdS-CuTcPc-redox couple-ITO will be discussed for charge transport measurements under the dark and light conditions to establish the suitability of these structures for photoelectrochemical applications.

**Chapter Seven:** This chapter describes the summary of entire work carried out in the present thesis. Some of the important results obtained on various aspects of SnO$_2$:Sb thin films, CdS thin films and various devices will be discussed. Finally, a future scope on the present work is presented.