CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Energy is one of the most fundamental parts of our universe; it plays a vital role in the development of mankind. The conventional sources of energy are generally non-renewable sources of energy like coal, petroleum, natural gas and so on which have been used for long time. These sources of energy are being used extensively in such a way that their known reserves have been depleted to a great extent. At the same time it is becoming increasingly difficult to discover and exploit their new resources. It is envisaged that known deposits of petroleum in our country will get exhausted by the few decades and coal reserves are expected to last for another few hundred years. Another reason is that from the environmental point of view, burning of fossil fuels causes air and water contamination. More importantly, however, CO₂ from fossil fuels will almost certainly increase the average temperature on our planet.

Currently the world consumes an average of 13 terra watts (TW) of electric power; by the year 2050 this amount is likely to be 30 TW. Our Sun deposits 1, 20,000 TW of radiation on the earth. Solar power is the prime choice in developing an affordable, feasible, global power source that can substitute fossil fuels in all climate zones around the world. Solar energy can be converted into electricity or utilized directly for heating. Devices that
convert solar power directly into electricity are collectively termed as the photovoltaic devices, often abbreviated as PV, and the conversion is pollutant free.

1.2 EVOLUTION OF PHOTOVOLTAIC (PV) TECHNOLOGY

1.2.1 First Generation PV

The first generation photovoltaic, consists of a large-area, single layer p-n junction diode, which is capable of generating decent electrical energy from light sources with all possible wavelengths of solar light. These cells are typically made using silicon wafer. First generation photovoltaic cells (also known as silicon wafer based solar cells) are the products in the commercial production of solar cells, accounting for more than 86% of the solar cell market.

1.2.2 Second Generation PV

The second generation of photovoltaic materials is based on the use of thin-film deposits of direct band gap semiconductors such as CdTe, CdS, CdSe etc.. These devices were initially designed to be high efficiency, multiple junction photovoltaic cells. Later, the advantage of using a thin-film of material was noted, reducing the mass of material required for cell design. This contributed to a prediction of greatly reduced costs for thin film solar cells. However, most of the assembly costs for depositing thin film solar cells are still significantly higher than for bulk silicon technologies. Another advantage of the reduced mass is that less support is needed when placing panels on rooftops and it allows fitting panels on light materials, even textile.
1.2.3 Third Generation PV

Third generation photovoltaics are very different from the other two, broadly defined as semiconductor devices which do not rely on a traditional p-n junction to separate photogenerated charge carriers. Two fundamental mechanisms that greatly limit the performances of solar cells are: thermalization of hot carriers and transmission of sub-band gap photons. Formalization is the tendency of energetic charge carriers to lose their kinetic energy through collisions with crystalline lattices (phonon creation) as the carriers move towards the band edge. These devices have two fundamental limiting mechanisms such as transmissivity and thermalization. Transmissivity of sub-band gap photons is the inability of the semiconductor to absorb photons with wavelengths greater than the band gap. These less energetic photons pass through the material.

Thermalization is particularly degrading the open circuit voltage and transmissivity degrades the short circuit current. Structures using special band gap-engineered materials (e.g., materials with intermediate bands to absorb sub-band gap photons, materials incorporating quantum dots or quantum wells to slow down thermalization dynamics) like ZnO, TiO₂ based Dye Sensitized Solar Cells are promising topics of academic research in third generation PV.

1.2 OBJECTIVES OF THE WORK

The major objectives of the present work are to investigate the energy conversion mechanism in DSSC, understand the formation of TiO₂ thin films by fabricating a simple, efficient, and cost effective method, and
to fabricate the dye sensitized solar cells and finding the efficiency of the DSSC.

The different stages of this thesis are as follows.

a) Fabrication and Optimization of Sol gel dip-drive coating unit.

b) Preparation of TiO$_2$ thin films with the optimized system parameters and investigation of thin film parameters such as uniformity, porosity and adhesion on the substrate.

c) Identification of the structure and composition of the TiO$_2$ thin films.

d) Determination of optical band gaps of the deposited films using their transmission spectra.

e) Dye identification.

f) Investigation of the structural, optical, and electronic properties of TiO$_2$ with the ab initio studies employing the first principle within the framework of local density approximation (LDA) and generalized gradient approximations (GGA).

h) Determination of the efficiency of the fabricated DSSC.

In order to achieve the above objectives, the studies are carried out as shown in the flow chart (figure 1.1).
Figure 1.1 Thesis configuration