

## GENERAL INTRODUCTION

Recently, there has been great awareness about using solar energy for (i) large scale electrical power generation, (ii) rural electrification, (iii) industrial and space applications. Different thrust areas for solar energy application have been recognised and efforts have been put forth all over the world, and as a result of which many integrated energy systems have been developed. As human society stands on the threshold of the twenty-first century it is confronted with the problem of finding a cheap and adequate source of power for meeting its exponentially increasing energy demands. At the same time it faces the need for adequate control of the pollution caused by industrial production of energy. The answers to both the above mentioned problems appear to lie in harnessing the solar energy. The development and exploitation of non-conventional sources of energy ( including solar energy ) have, therefore, certainly become an important techno-economic proposition. At present, the generating costs of solar power using bulk solar devices ( from crystalline and polycrystalline material ) are much higher than for conventional power. The cost of bulk devices is limited by the cost of the wafer itself and thus lowering of cost below the price of wafers is not possible. Hence, thin

film technology needs to be developed to meet the cost goals. Thin film devices require much less material compared to bulk device and it can be deposited over large area which prevents complicated interconnections for the fabrication of large-area devices. Also large variety of deposition techniques are available in thin film technology. In recent years, hydrogenated amorphous silicon (a-Si:H) thin films have been receiving lot of attention as a low cost material for solar cells and other applications [ 1-25 ] . Although amorphous silicon films exhibit certain properties similar to its crystalline bulk and polycrystalline thin film counterparts but it has some excellent characteristics like very high photoconductivity and optical absorption coefficient for visible light, due to this reason, material required for a-Si:H solar cells is about 1000 times less compared to monocrystalline Si solar cells [ 12 ]. Recently, remarkable progress has been seen in both physics and technologies of a-Si:H thin films and as a result of which more than 11-13 percent conversion efficiency [ 26-40 ] has been attained in a small area ( 6 x 6 - 10 x 10 mm<sup>2</sup> ) laboratory phase cells, and for the large area cells of 10 x 10 cm<sup>2</sup> module, more than 7 - 9 percent efficiency [ 31,41,42 ] are presently quite common in the industrial production. These technological achievements have been extended to other new device developments, such as, photo-sensors, imaging devices, photo-receptors, thin film transistors etc.

If amorphous Si solar cells are to be mass-produced,

its fabrication cost must be reduced to that extent, so that they can compete with commercially produced electricity. Conventionally, amorphous Si solar cells are produced by the glow discharge method using silane (  $\text{SiH}_4$  ) and disilane (  $\text{Si}_2\text{H}_6$  ) [ 43-54 ]. However, this method for producing a-Si:H films is characterized by, slow growth rates typically of the order of few angstroms per second [ 55 ], and the use of expensive vacuum and electrical equipment. Also the radiation damages to the films caused by the high energy particles generated in the silane plasma deteriorates the quality of the films. Neither of these conditions is acceptable for the large scale solar cell production. Thus a method which is feasible, economically competitive, having large deposition rate and easily scalable to very large throughputs is necessary. In-situ deposition of a-Si:H films by thermal chemical vapour deposition (CVD) of silane at atmospheric pressure which was developed by Gordon et al. could potentially satisfy these requirements [ 56 ]. In this process silane gas mixture ( monosilane and higher silanes ) are generated by the acid hydrolysis of magnesium silicide (  $\text{Mg}_2\text{Si}$  ) and immediately used for the deposition of a-Si:H. The advantages of thermal CVD technique over the conventional glow discharge technique are summarised as follows :

(i) The growth rates of the good quality thermal CVD films are much higher (  $50 - 100\text{\AA}/\text{sec.}$  ) than those by typical glow discharge method [ 57 ].

(ii) The CVD technique for the deposition of a-Si:H films does not need sophisticated vacuum systems and electrical equipment compared to those in glow discharge technique.

(iii) Also in this in-situ CVD process for the deposition of a-Si:H films, the highly flammable silane and polysilanes need not be distilled, stored or transported. Thus it reduces the cost of production of the material and may make it suitable for large scale solar cell applications.

(iv) Inexpensive and abundant starting materials are used.

(v) No radiation damage in the CVD materials due to high energy particles [ 58 ] which is often present in the glow discharge materials.

(vi) Fewer process parameters are present for optimization of the quality of the CVD a-Si:H films in comparison to glow discharge a-Si:H films and there is relative ease of scaling-up [ 59 ] .

The above mentioned process has some disadvantages which easily can be overcome. The main disadvantages of CVD process may be enumerated as follows :

(a) The higher deposition temperature required for the thermal CVD may limit the selection of substrate materials.