LARGE AREA AMORPHOUS SILICON SOLAR MODULES MANUFACTURING LINE – SYSTEM DESIGN AND ASSEMBLY

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Abstract

A prototype production line for double junction a-Si solar modules of size 30 x 30 cm^2 has been designed and fabricated indigenously. This being scaled upto a size of 1 m^2 solar module and Hind High vacuum Company provides a turn key solution for the large area solar module.

Introduction

Amorphous silicon (a-Si) solar cell technology (single and multijunction) has reached mass production stage. Now the challenge before this technology is reduction of cost so that economically it becomes much more viable than crystalline silicon solar modules. The cost reduction may be done by upgradation of the performance of a-Si solar modules including increase in its lifetime and improvement in production technology. In this paper, the efforts to reduce the cost of a-Si solar modules by reducing the capital cost of the production equipment without compromising with its performance were discussed. The advantage of designing and fabricating production equipment in a developing country like India is that the cost is much lower than that made in a developed country. In addition if the process is also developed in India there will be further cost reduction. The operation and maintenance cost will also be lower.

Background

At the Indian Association for the Cultivation of Science (IACS), Kolkata work on the development of materials and fabrication of a-Si solar cells initiated on a small scale in 1978. Since then with intensive and continuous efforts the technology developed for single and double

junction a-Si solar modules have reached the stage of commercialization. Since a-Si solar modules are being produced on a large scale in developed countries the products from India must be competitive globally in terms of cost of production and performance. In view of the advantages mentioned above of fabricating production equipment in India, a project jointly funded by the Ministry of Nonconventional Energy Sources and Department of Science and Technology, Govt. of India has been initiated at IACS in 1999 with the following major objectives:

(a) To design and fabricate a prototype production line for double junction a-Si solar module.

(b) To transfer the process already developed at IACS to the prototype line for the fabrication of a-Si solar module.

(c) The output of the project should lead to building up of indigenous capability of setting up of large scale commercial plant for the production of double junction a-Si solar modules.

An RF PECVD system for amorphous silicon solar module fabrication has been indigenously developed and fabricated at IACS, Kolkata. Process technology has been developed by IACS under the guidance of Prof. A. K. Barua. This technology has been transferred to Hind High Vacuum Company, Bangalore in 2007. A pilot line of five chamber RFPECVD system has been installed in R&D division of Photovoltaic Division of HHV at its Bangalore campus. Presently HHV has indigenously developed ultrasonic cleaning machine, Laser Scribing System, DC magnetron System for TCO and Metal coating, PV Laminator, various quality control equipments like Sun Simulator, Light Soaking Station, and Tabbing machine. Sequence of deposition of PIN structure for 30 x 30 cm^2 solar module is shown in the figure 1. Three process chambers of similar structure have been allied each other with the slit valves and one isolation chamber and one entry exit chamber is also fixed to these process chambers using slit valves.

The basic system consists of a rectangular vacuum chamber pumped with turbo molecular pump and rotary pump to maintain a back pressure of 10^{-6} mbar. During this process this system is pumped with a rotary and roots pumps with throttling using throttle valve. The pressure of the chamber is maintained constant in the range of 1- 2 mbar while process gases are introduced into this system through the mass flow controller with required proportions. The RF electrode and heaters are fixed to the system as shown in figure 2, RF electrode is energized using an RF power supply (13.56 MHz) and uniform plasma is generated on both sides of the electrode. A thickness uniformity of ± 10 % can be achieved in this system.

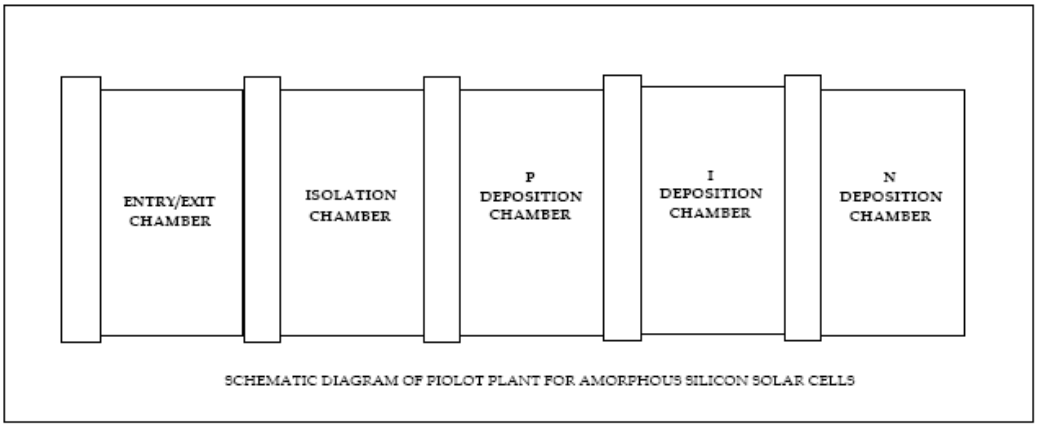


FIG 1. Schematic diagram of pilot plant for a-Si solar module.

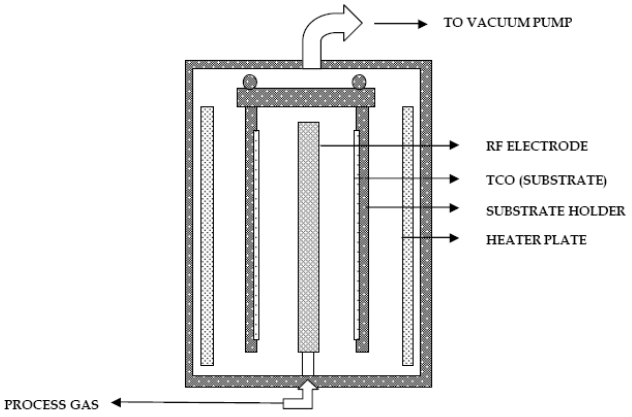
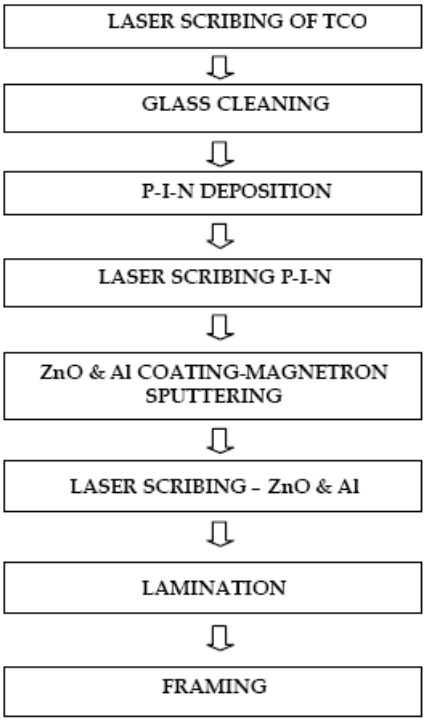


FIG 2. RF PECVD system designed for 30 x 30 cm solar modules

A chamber with similar configuration has been up scaled to deposit a-Si modules of 1 sq. meter area. Required changes have been made to make the system more user friendly.

The process sequence of solar module fabrication is given below. Hind High Vacuum Company provides a turn key solution for a-Si solar module. It consists of, glass cleaning machine, Laser Scribing machines, RFPECVD Line, Magnetron Sputtering system, PV Laminator, Sun Simulator, Tabbing Machines, Gas Distribution system and gas abatement system.



Conclusion

Indigenously developed cleaning system, laser scribing systms, PECVD system (30 x30 cm), DC Magnetron Sputtering system has been established and trilas are in progress to fine tune the the process. Efforts have been put to scale up the line to 1 sq. meter with optimum productivity and cos effective with indigenously developed peripheral supporting equipments.