

# Deposition and testing of the amorphous silicon thin layers for optimization for HIT solar cells

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**Abstract-** The plant is an R&D facility having features adaptable for diverse research and development activities in the area of crystalline and thin film silicon PV technologies. The plant, equipped with a number of safety features, has a view of the Process Area at ASSCP complete fabrication facility for large area (upto 1' x 3') a-Si thin film PV modules as well as mono and multi crystalline silicon solar cells and modules. Some of the key process and test capabilities that are housed in a 1500 sq. m of Class 1,00,000 clean room area are:

- High-throughput TCO deposition furnace
- RF PECVD system for a-Si & related thin films
- Laser scribe (both IR and green)
- 3-stack diffusion furnace for c-Si & mc-Si wafers
- Precision screen printers and curing furnaces
- Spectral response measurement set-up

## I. INTRODUCTION

BHEL is an integrated power plant equipment manufacturer and one of the largest engineering and manufacturing companies in India in terms of turnover. It was established in 1964, ushering in the indigenous Heavy Electrical Equipment industry in India - a dream that has been more than realized with a well-recognized track record of performance. The company has been earning profits continuously since 1971-72 and paying dividends since 1976-77

It is engaged in the design, engineering, manufacture, construction, testing, commissioning and servicing of a wide range of products and services for the core sectors of the economy, viz. Power, Transmission, Industry, Transportation, Renewable Energy, Oil & Gas and Defence. They have 15 manufacturing divisions, two repair units, four regional offices, eight service centers, eight overseas offices and 15 regional centers and currently operate at more than 150 project sites across India and abroad. They place strong emphasis on innovation and creative development of new technologies. Our research and

development (R&D) efforts are aimed not only at improving the performance and efficiency of our existing products, but also at using state-of-the-art technologies and processes to develop new products. This enables us to have a strong customer orientation, to be sensitive to their needs and respond quickly to the changes in the market.

The high level of quality & reliability of our products is due to adherence to international standards by acquiring and adapting some of the best technologies from leading companies in the world including General Electric Company, Alstom SA, Siemens AG and Mitsubishi Heavy Industries Ltd., together with technologies developed in our own R&D centers. Most of our manufacturing units and other entities have been accredited to Quality Management Systems (ISO 9001:2008), Environmental Management Systems (ISO 14001:2004) and Occupational Health & Safety Management Systems (OHSAS 18001:2007).

They have a share of around 59% in India's total installed generating capacity contributing 69% (approx.) to the total power generated from utility sets (excluding non-conventional capacity) as of March 31, 2012. They have been exporting our power and industry segment products and services for approximately 40 years. They have exported our products and services to more than 70 countries. They had cumulatively installed capacity of over 8,500 MW outside of India in 21 countries, including Malaysia, Iraq, the UAE, Egypt and New Zealand. Their physical exports range from turnkey projects to after sales services.

They work with a vision of becoming a world-class engineering enterprise, committed to enhancing stakeholder value.

Their greatest strength is our highly skilled and committed workforce of over 49,000 employees. Every employee is given an equal opportunity to

develop himself and grow in his career. Continuous training and retraining, career planning, a positive work culture and participative style of management - all these have engendered development of a committed and motivated workforce setting new benchmarks in terms of productivity, quality and responsiveness.

## II. AMORPHOUS SILICON SOLAR CELL PLANT

### BACKGROUND

The Amorphous Silicon Solar Cell Plant (ASSCP) at Village GwalPahari, Gurgaon is an R&D facility for the development of crystalline and thin film photovoltaic (PV) technologies. Bharat Heavy Electricals Limited (BHEL) set up the plant as an S&T project on behalf of MNES in 1988-89 on a turnkey basis.



A view of the Administrative Block

### OBJECTIVE

The initial objective of developing single junction amorphous silicon (a-Si) PV technology was modified in 2000 to include development of improved double junction a-Si PV technology. The objective was further expanded in 2004 to include PV technologies based on mono (c-Si) and multi crystalline silicon (mc-Si) and also development of PV based products.

### EXPERTISE AVAIBLE AT ASSCP

Over the years, the skilled and highly motivated technical manpower at ASSCP has acquired considerable expertise in the area of a-Si thin film as well as crystalline silicon PV technologies. It can boast of being the only group in the country having wide experience at industrial scale in thin film technologies such as APCVD, PECVD and laser scribing as well as in the conventional technologies

such as diffusion, AR coating and screen-printing, This allows this group to draw benefits from both the technologies and initiate projects in the area of high efficiency silicon solar cells. Adequate importance is also attached to characterization of thin films and silicon devices, the very basis of high efficiency concepts in solar cells.

## III. ACHIEVEMENTS IN TECHNOLOGY

Some of the technological achievements in the recent past have been

- Development of square foot size single junction a-Si modules and pilot production in a continuous moving mode process
- Development of double junction a-Si modules in batch process that is typified by:
  - Single chamber based simple process for large area (1' x 3') modules.
  - Highest module power of 19.7 W (as produced) corresponding to an h of 7%.
  - Average module power in batch production of 18.4 W
  - Stable wattage of 14.5 to 15 W after 18-20 months of field exposure.
  - Deployment of modules in the field in the form of street lights / blinkers.



- Development of Transparent Conductive Oxide (TCO) coated glass for PV and non-PV applications. TCO properties are:
  - Throughput of 1 sq. ft./min
  - Haze between 0 and 18 %
  - Sheet resistance between 5 and 15 Ohm per square /Transmission in excess of 78%.



TCO coated glass substrate for defence application

- Development of plasma deposited silicon nitride Anti-reflection coating for c-Si and mc-Si substrates. The principal features are:
  - Throughput of 1 wafer / min
  - AR Coating of complete solar cells with special masking
  - Improvement in cell efficiency by 1 to 1.5 % absolute Mono and multi crystalline silicon wafers with SiNAR coating.

#### IV. MAJOR ON-GOING / PLANNED RESEARCH PROJECTS AT ASSCP

- Technology development of High efficiency Hetero junction (HIT) solar cells
- Development of high efficiency selective emitter solar cells

#### REFERENCES

- **BHEL Plant, Faridabad.**