	INDIAN INSTITUTE OF TECHNOLOGY BOMBAY **MATERIALS MANAGEMENT DIVISION** **Powai, Mumbai 400076**

PR. No. 1000004367 (Rfx No. 6100000067)

Technical Specifications for Design, fabrication, installation and commissioning of "Multi Chamber Hot Wire Chemical Vapor Deposition (HWCVD) Cluster Tool" for the manufacture of Heterojunction Si solar cells of size 6" by 6" (156 mm x156 mm)

General description of the system

A semi-automated multi chamber cluster tool for fabricating Silicon Heterojunction solar cells consisting of following components:

- 5 process chambers (4 HWCVD and 1 RF sputter)
- 1 Load lock
- Substrate transfer chamber
- Automatic controls for,
  - ✓ Chamber evacuation
  - ✓ Process gas flow
  - ✓ Substrate temperature
  - ✓ Chamber Pressure
  - ✓ Substrate transfer
  - ✓ Shutter motion
  - ✓ Gas manifold

The cluster tool will consist of five process chambers (of optimum dimensions considering the substrate size - to be discussed and approved by the purchaser) having the following process capabilities:

1. Process chambers

Chamber	Name of process	Films to be deposited	Side to be deposited	Comment

No				
#1	HWCVD	i-a-Si:H	Both sides	Blanket deposition
#2	HWCVD	(n-type) a-Si:H	single	With mask
#3	HWCVD	(p-type) a-Si:H	single	With Mask
#4	HWCVD	a-SiNx:H	single	Blanket deposition
#5	RF Sputtering	TCO	single	With mask
Load Lock	Substrate loading	NA	NA	NA

*TCO- transparent conducting oxide (ITO and Al:ZnO)

1.1. Each HWCVD process chamber should have :

1.1.1. Capability of handling of a silicon wafer of 6 inch x 6 inch size and thickness of about 200 microns.

1.1.2. Substrate heating arrangement to give substrate temperature up to 350° C with accuracy of ± 5 °C over the entire substrate area.

1.1.3. Each HWCVD chamber should have a hotwire module (consisting of hot wire fixture, substrate holder and gas shower) capable of giving uniform deposition over an area of 156 mm x 156 mm with a thickness variation of ±10% for 5 nm film thickness. The integrity of the filament assembly should remain unaffected over the life of the filament (the sagging of filament and similar distortions must be avoided through proper design of the filament assembly). The filament temperature range is 1400-2000°C with variation of +/- 10°C over the entire filament mesh for tantalum filament with diameter of 0.5mm, with appropriate power supply.

1.1.4. Distance between sample and the hot wire should be adjustable from 3 to10 cm.

1.1.5. The separation distance between hot wire and the gas shower to be discussed and finalized.

1.1.6. Should have a pneumatic shutter arrangement to completely avoid the residual deposition on the sample surface. Shutter closing speed should be such that the entire substrate gets covered within 50 msec.

1.1.7. The first HWCVD deposition chamber (table 1) is to be equipped with mechanism to perform depositions on both sides of the wafer while

maintaining the substrate temperature to the required value. The heating of the wafer via direct contact with the heater plate must be avoided

1.2 **RF magnetron sputtering chamber with cathode** for uniform deposition of TCO on 156 mm x156 mm substrate size(chamber 5, table 1). RF sputtering is to be done using a RF-power supply 13.6 MHz , 600 W. RF supply and impedance matching network will be provided by the user. Appropriate cooling arrangement should be provided for the cathode assembly to avoid cracking of the sputtering targets. Appropriate gas shower arrangement should be provided. The distance between the target and the substrate should be adjustable from 5 to 12 cm. The vendor should demonstrate deposition of TCO with sheet resistance 10-20 Ω/□ and transparency of > 85% for a film thickness 90 nm. The required deposition rate should be greater than 10 nm/ min.

1.3 Each chamber should have:

1.3.1 Substrate transfer slit valve (pneumatically controlled slit/gate valves)

1.3.2 Gauge head ports (2 nos. CF 35)

1.3.3 Hot wire module port (feed through)

1.3.4 Gas inlet port

1.3.5 View port (quartz) with shutter for Pyrometer focusing on the filament

1.3.6 Substrate shutter port

1.3.7 Pumping port (CF 100)

1.3.8 Spare ports as may be required for future usage (3 nos. CF 35).

1.3.9 Automatic controls for,

- Chamber evacuation,
- Process gas flow,
- Substrate temperature,
- Pressure,
- Substrate transfer
- Shutter motion,
- Gas manifold.

2. Load lock chamber:

Load lock chamber is the loading chamber connected to the main transfer chamber in case of a cluster arrangement in rotary fashion or to the nearest chamber in case of a co-linear system. The wafer will be mounted in this chamber after cleaning.

The Load Lock chamber should comprise of the following ports/flanges:

2.1 Pumping port

2.2 Gauge head ports (2 nos.)

2.3 Leak valve port with N_2 purging

2.4 View port

The automatic loading input port of the load lock chamber is the loading port. The wafer will be mounted in this chamber after cleaning. There must be appropriate access to the wafer holder at this initial stage to mount the wafer. Once the wafer is mounted on the holder, it should be immediately and automatically transferred into the load lock.

3. Substrate transfer chamber (STC):

A substrate transfer chamber should be provided with a mechanism to transfer the substrate from and to the different chambers and the load lock without breaking the vacuum. Cross contamination between the chambers must be avoided.

All chambers (including the load lock and the substrate transfer chamber) should be capable of achieving base vacuum of $< 5x10^{-7}$ Torr after evacuation with a rotary and turbo molecular pumping system. The maximum permissible leak rate will be less than $5x10^{-9}$ Torr l/s. Vacuum pumps and gauge heads will be provided by the user. The process chambers should have adequate water cooling facility to maintain the chamber wall temperature of <45°C during the deposition process. The chamber material and all ports should be made from SS-304L.

4. Substrate Holding Assembly

4.1. Substrate holder should be capable of holding sample of size of 156 mm x156 mm having thickness of 200 microns with notches for mask alignment and a window for the deposition. Maximum holding region from

all sides should not exceed 2 mm. The substrate holder should not produce mechanical stress on the wafer when heated up to 300°C.

4.2. The substrate holder should provide accurate alignment of the mask where ever needed with an accuracy of +/-50 microns.

4.3. Four number of substrate holders are needed for a simultaneous loading.

5. Process Gas Supply and Pressure Control

5.1. A gas cabinet with manifold to handle at least 5 gases (SiH_4, H_2, PH_3, B_2H_6, NH_3, Ar, O_2 and N_2) with all safety measures and gas lines to be considered in the scope of supply.

5.2. Mass flow controllers (MFCs), valves, tubing and other related hardware will be supplied by the user and the vendor will have to integrate all these components in the same cabinet.

5.3. Bypass valves are to be provided for initial evacuation of the gas lines and for maintenance purpose.

5.4. Process gas pressure in the chamber should be software controlled through appropriate throttle valve control and is part of the supply.

6. Automation and Software as per the process recipe

The total process should be automated using latest PLC software as per the recipe which includes software controls of:

6.1. Vacuum sequencing / valves open /close to reach base pressure

6.2. Substrate transfer from load lock to any of the chambers

6.3. Pressure measurements and monitoring

6.4. Evacuation to base pressure, process gas selection, pressure control and gas flow control.

6.5. Temperature set points, ramp rate, dwell time control

6.6. Actuation of pneumatic or electro/pneumatic valves

6.7. Process start, stop, emergency stop etc.

6.8. Real time animated view of the processes including substrate position, transfer status, filament on/off, gas inlet on/off, various valves status, gas

flow status, clock with buzzer for process status, chamber pressure and substrate temperature values.

7. Spare parts

7.1 A total kit of one set of gaskets used in the system should be given as standard spares along with the system.

7.2 Two substrate heater sets should be given as standard spares.

7.3 Six spare thermocouples with connectors should be provided.

8. Other important requirements

8.1 The total foot print of the system will be as small as possible considering the space required for the easy maintenance of the system.

8.2 In the chamber nos. 2, 3 and 5, the deposition is to be done using masks for which the design will be given by the purchaser and the vendor will have to manufacture the masks as per the specifications. The alignment of the mask with the sample is to be critically maintained to get a repetitive position accuracy within 50 microns.

8.3 Proof of at least one working multi chamber HWCVD system for silicon film deposition using silane gas previously fabricated and installed by the vendor for any Govt. Organization in India must be provided with technical specifications. Purchase order of such work done for Govt. organization should be attached. Physical Inspection of such a system and feedback from user will be used to take appropriate decision.

8.4. Following company details to be provided-

1) Year of establishment

2) Returns filed (for the last three years) (2015-2016, 2016-2017, 2017-2018)

3) List of Institutes where similar system has been installed

8.5. The technical specification must be uploaded along with @8.3. Without this reference the technical bid will be rejected. The technical bids would be evaluated for the following:

8.5.1. Best considerations for uniformity of film thickness as mentioned above

8.5.2. Use of standard established mechanisms of operation

8.5.3. Ease of operation and maintenance

8.5.4. Over all foot print of the system

8.5.5. Warranty and after sales service

8.6. The vendor should supply 3D design drawings/view to the user along with the technical bid.

8.7. All the above documents to be submitted in the technical bid.

8.8. The quotation should include the cost of installation, commissioning and training of potential users covering all the functions of the system.

8.9. The system should be provided with at least two years warranty on all parts supplied by the vendor. The warranty period should start from the date of installation and commissioning.

8.10. The vendor should have qualified technical service personnel for the equipment based in India.

8.11. The delivery time for the equipment should not be more than 6 months from the date of receipt of our purchase order.

8.12. The following points to be considered for returning of PBG can be given only after demonstrating the successful working of the following functions.

8.11.1. Uniformity of the deposition over 6” x 6” wafer barring the substrate holder shadow, of the a-Si:H within the +/-10% accuracy as measured by the thickness profiler in our laboratory.

8.12.2. Accuracy in the mask alignment within 50 micron tolerance for at least three separate depositions for repeatability.

8.12.3. Uniformity of sputter deposition within +/-10% over 6” x 6” wafer barring substrate holder shadow region.