

Detailed specifications of Diffused Reflectance Measurement Set-up (DRMS)

A new design has been conceived to measure the diffused reflected light from the surface of the silicon wafers for optimising a few processes for solar cells application. This design consists of a metallic housing to house a light source, collimator and some electronic controls for automation. The specifications have been divided into two sections, namely:

Section i: Hardware components

Section ii: Automation

Section i: Hardware components

Detailed specifications of Hardware (HW) required for Diffused Reflectance Setup

The HW consists of a metallic housing which accommodates light source, a collimator and an arrangement to place the Si wafer precisely at a specified location. The details are given below:

1. The sketch of the enclosure is shown in Fig 1.
2. The enclosure should be made of MS sheet of thickness 1.5 mm with powder coating of grey shades from outside and dark black mat finish from inside.
3. A drawer has to be provided at the bottom of the enclosure to move the wafer table in and out with a facility to place the wafer on a flat jig to position the Si wafers exactly in the centre of the enclosure when the drawer is closed. The design of the jig will be such that the Si wafer remains at least 25 cm above the bottom of the drawer.
4. The drawer has to move on very high quality telescopic rails to enable almost 100 % movement of the drawer when pulled out. A limit switch has to be integrated to confirm electronically that the drawer is closed or open.
5. The edges of the drawer have to be very precisely designed not to allow any leakage of ambient light into the enclosure.
6. The Si wafer placed on the bottom jig will be illuminated with a strong collimated beam of light and in order to avoid any dispersion of reflected light, a truncated pyramidal box needs to be inserted as shown in the sketch (Fig 2).
7. For efficient collection of diffused reflected light from the Si wafer, the truncated pyramidal (TP) reflector box, will have with mirrors pasted on inside walls. This TP reflector will have smaller opening exactly equal to the size of Si wafer and the bigger opening will accommodate all the detectors. The number of detectors may vary from four to eight depending on the accuracy requirement.

8. The enclosure should have levelling screws so that it can be placed on a table and levelled. A spirit level may be integrated in the enclosure for levelling purpose.
9. The enclosure will have strong (50 W or 100 W) halogen light source with a collimator and a barrel to ensure that the collimated light beam falls at right angle on the Si wafer.
10. The vendor has to prepare a detailed engineering drawing of the set-up and finalise after due consultation with the engineer in-charge of BHEL.

List of items in the scope of supply of the vendor (for two sets)		
S. No.	Item	Quantity
1.	Powder coated MS enclosure with drawer	1x2sets=2
2.	Truncated pyramidal reflector for 5" sq and 6" sq size Si wafers	2x2sets=4
3.	Halogen light sources (Bulbs with reflector) 50W (4 pieces) and 100W 4 pieces	8x2sets=16
4.	Collimating lens arrangement with facility to move barrels to adjust the position of lens w r t light source.	1x 2sets =2
5.	SMPS for the light source	2x 2sets =4
6.	Spirit level with levelling screws	1x2sets
7.	Arrangement to fix eight detectors on a plate which in turn has to be suspended from the top of the enclosure with a facility to adjust the height of the detector plate from outside. The detectors are not in the scope of supply of the vendor and will be provided by BHEL.	1x2sets
8.	O&M Manual	2 No.
9.	Warranty	1 year
10.	Installation & commissioning at BHEL-ASSCP, Gurgaon.	

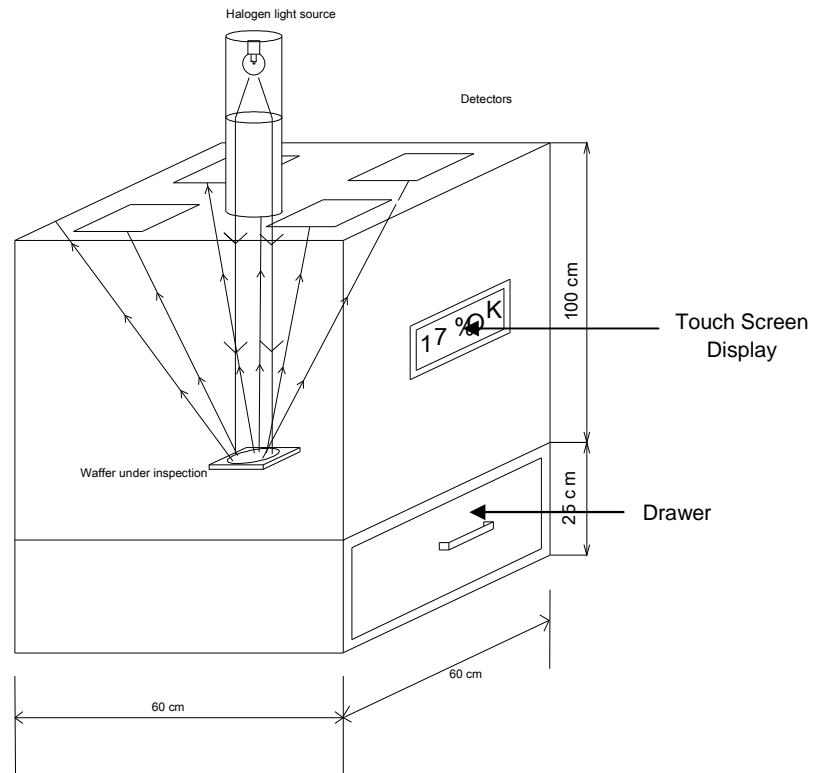


Fig 1. Sketch of diffused reflectance setup (not to scale)

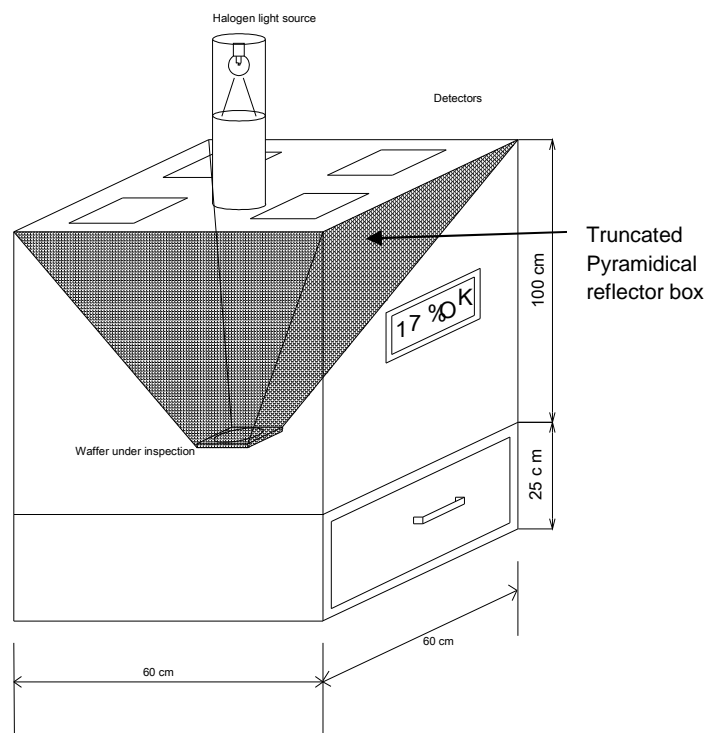


Fig 2. Sketch of diffused reflectance setup with truncated pyramidal (TP) box (not to scale)

Section ii: Automation

Detailed specifications of Automation (including Software (SW) and associated components) required for Diffused Reflectance Measurement System (DRMS)

This system (DRMS) will be required for measuring the intensity of the diffused reflected light from the silicon wafer under inspection. The automation will control the operation of the system in the following sequence:

1. The system will be put ON by pushing a hard switch on the Box panel.
2. The system will initialise and the User Login screen will be launched in which provision of selection of user is there (Administrator or operator).
3. After logging in with the operator login ID and password, the main user interface will be displayed. It should have four window options namely 1. Model, 2. Teach, 3. Production, 4. Report.
4. In the Model window, user will have to select the predesigned model (Created in teach window) which has to be run for testing of samples.
5. After selection of model, user will have to go in Production window to start the test.
6. Drawer (as shown in fig 1) will be opened manually and "Drawer is open" should be displayed on screen.
7. Silicon wafer will be placed manually in the place assigned and the presence of wafer will be confirmed on the user interface screen with the help of a sensor inside the drawer.
8. Drawer will be closed manually and the screen will display "Drawer is closed".
9. System will check the presence of wafer, locking of drawer, lamp is ON and then display the message "System is Ready for Inspection".
10. With a single push on the "Start Test" button on the Display, test will start and record the value from ampere meter with sample number and display the value on the screen. It will also Display PASS/FAIL message with Audio depending on the value settings entered in teach window.
11. For every Test, data will be recorded with the model no. and sample details.
12. For another test, open the drawer manually and repeat the steps from 6 to 10.
13. On the Report Window these test reports can be viewed in tabular or graphical form with selection of models/sample numbers and dates details with user or operator details who conducted the test.
14. On the Teach window, user can enter all the settings and values required for testing of samples.

List of items in the scope of supply of the vendor (for two sets)

S.No.	Item	Specification	Quantity						
1.	Touch Screen Display	15 inches colour, Capacitive type, Touch Screen	1x2sets=2						
2	Controller (Industrial PC)	Intel core 2 duo 2.2 Ghz; 2 GB RAM, 320 GB Hard Disk.	1x2sets=2						
3.	Provision for Display & controller Mounting	Should be incorporated in the setup such that it is a single table mount equipment.	1x2sets=2						
4	Software	As per Software detail/description	1x2sets=2						
5	Current Meter	<table border="1"> <tr> <td colspan="2">6½-digit resolution</td> </tr> <tr> <td>Max Current</td> <td>0 to 1A</td> </tr> <tr> <td>Maximum Current Range Sensitivity</td> <td>1 µA</td> </tr> </table>	6½-digit resolution		Max Current	0 to 1A	Maximum Current Range Sensitivity	1 µA	1x2sets=2
6½-digit resolution									
Max Current	0 to 1A								
Maximum Current Range Sensitivity	1 µA								
6	Miscellaneous electronic items required for the proper operation of the set-up such as relay cards, proximity sensors, limit switches.		1x2sets=2						
7	Required Wiring for sensors and limit switches.		1x2sets=2						
8	O&M Manual		2 No.						
9	Warranty		1 year						
10	Installation & Commissioning at BHEL-ASSCP, Gurgaon								

Acceptance criteria

Please read the acceptance criteria for the commissioning of the software at ASSCP, BHEL Gurgaon carefully. These are very important and the commissioning of the set-up will be evaluated by committee of experts from BHEL

1. The vendor will have to demonstrate the flawless operation of the drawer for placing the Si wafers of 5" sq 6" sq on the jig with an accuracy of ± 1 mm
2. Uniformity of the collimated light within $\pm 5\%$ will have to be demonstrated over the area of the spot (Diameter of 125mm or 156mm).
3. The enclosure will be tested for zero leakage of ambient light from outside.
4. Flawless operation of the software and its incorporation in the Diffused reflectance setup hardware as per the sequence given above.

5. Graphical display of complete Diffused Reflectance Setup showing Light Source status (ON/OFF), process steps and all process parameters on HMI screen.

IMPORTANT NOTES

1. The development of this set-up has very special features which are required for measuring very low diffused reflectance accurately and non-destructively on full size Si wafers. The vendors are advised to visit BHEL-ASSCP, Gurgaon for clear understanding the technical requirement before sending their offer.
2. The development of the second set-up may require minor modifications which will depend on the feedback of the development of first set-up. Vendors are advised to give due consideration to this in their offer.