

Standard Operating Procedure

Sinton WCT 120 Photo-conductance Lifetime tester & Suns- V_{OC} Stage

The system consists of two stages one for Lifetime tester and another for Suns- V_{OC} measurement.

Assembly Equipments

- **Stages : WCT-120 & Suns-Voc**
- **Flash Lamp Assembly**
 - ✓ Bulb & Reflector
 - ✓ Power Supply
 - ✓ Flash Lamp Trigger
 - ✓ Flash Lamp Tower
- **Filters**
 - ✓ Neutral Density Filters
 - ✓ IR Pass Filter
 - ✓ Visible Pass blue filter
- **Adjustable height Stand**
- **Data Acquisition System**
 - ✓ Connector Box
 - ✓ BNC Cables , thermocouple & other Probes
 - ✓ PCI Card connection with Computer

Precautions:

1. Do NOT touch the filters or the filter tray which has glass diffuser glued into it, with bare hands. Use gloves or tissue paper for the same.
2. Make sure that the filter tray/flash mount assembly does NOT fall down while sliding it over the flash tower for adjusting height of the flash.
3. Ensure that the BNC cable and flash trigger connections are in place based on the measurement to be done i.e. to lifetime tester stage or Suns V_{OC} stage.
4. Note down the height of the flash from the stage, the setting on the flash (1/1 or 1/64) and the filter being used during measurement. Different users tend to change this according to their requirements.
5. Make sure that the reference cell is NOT covered during the measurement.
6. Do NOT start the measurement on Lifetime tester until it is thermally stabilized i.e. Red LED is OFF.

7. During chemical passivation, ensure that solution does NOT spill on the stage.
8. For Suns V_{OC} measurement, ensure that sample consists of P-N junction and both P N sides can be probed properly.
9. Ensure that proper action is taken for addressing error messages in the measurement:
 - i. Saturated reference cell: Height of the flash is adjusted to change the intensity of light to avoid saturation of reference cell.
 - ii. $\text{Min MCD} < \text{Specified MCD} < \text{Max MCD}$: Change the specified minority carrier density to fit in the measured range of minority carrier density.
 - iii. Remove the sample on lifetime tester stage during zeroing of the instrument: No sample in the vicinity of stage during zeroing of the instrument.
10. Ensure that SUMMARY file is NOT cut pasted during the data transfer.

A. Sinton WCT 120 Photo-conductance Lifetime tester

Introduction to the system:

The system is used for carrier lifetime measurement of samples after different processing steps during solar cell fabrication, as a step by step monitoring tool. The photo-conductance based contactless measurement technique makes use of RF sensor to measure sheet conductivity of the sample and light sensor to measure intensity of the flash to which sample is exposed. These measurements are then used to calculate the effective carrier lifetime of the samples.

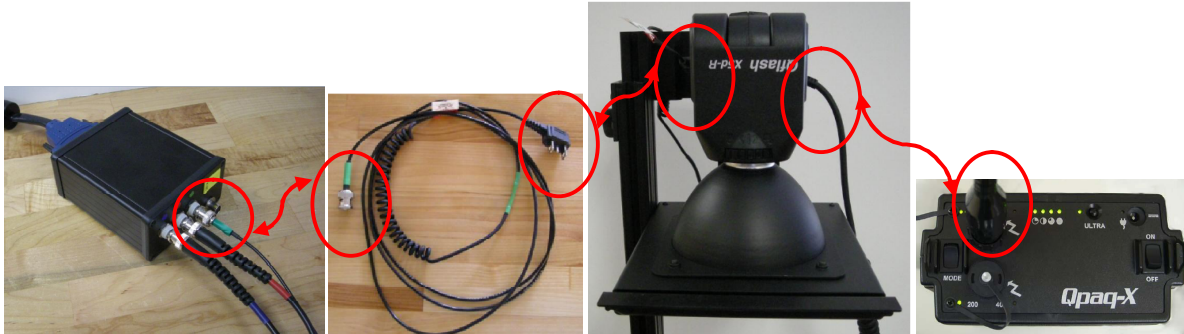
Assembly of the Equipments:

1. The flash consisting of the bulb and reflector has already been installed in the filter tray /flash mount assembly.
2. The flash lamp controller trigger and the outputs of the instrument are connected to the computer through connector box.

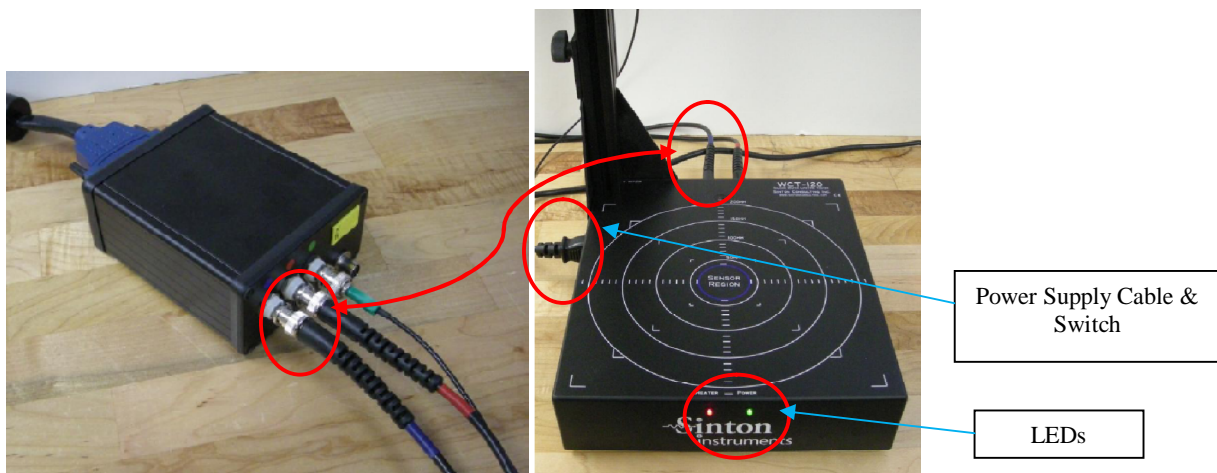
Connections to the Equipments:

1. Insert the appropriate filter in the filter tray assembly, if required. IR pass filter is used for general usage and is already placed in the tray.
2. Connect the trigger cable to the side of the flash and other side of it into the connector box (as shown in figure)

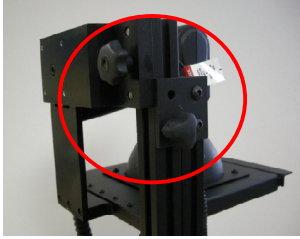
3. Connect the cable from the flash lamp into the flash power supply. Turn ON the power supply with switch on right. Set the MODE to 200Ws with MODE switch on the left.



4. Make sure that Red & Blue BNC cables are connected to the Lifetime tester stage to the connector box.
5. Switch on the Power Supply of Lifetime tester stage. Make sure that the two LEDs (Green & Red) on the stage are ON. Green LED indicated power supply is ON, which should stay ON during the entire course of measurement. Contrarily Red LED indicates thermal stabilization of the stage with respect to the ambient temperature and the measurement should be done once it is OFF.



6. Adjust the flash tower height using the two knobs on the flash stand and sliding it up or down, if required.



Setting the flash Options:

1. Set the flash head to the manual (Man4) mode and “1/1” (QSS) or “1/64” (transient) mode as per the requirement.
2. To set the mode to the manual :
 - i. Press Mode button. Mode will blink.
 - ii. Use the Up (^) or Down (v) button to change the mode until Man4 or Man2 appears.
 - iii. If Man2 appears, press OPT twice, then SET 3 times and change settings to 400Ws. When screen returns, it should read Man4.
 - iv. Push SET button once.
 - v. Use Up/Down buttons till 1/1 (or 1/64 as per the requirement) appears on the display.
 - vi. The other settings on the flash have no effects.



General Procedure:

1. Turn on the computer system and open the “Lifetime Measurement” Spreadsheet in Excel saved on the desktop.

2. Enter the Values of ***Sample Parameters***

- i. Sample Name: Give the unique name describing the characteristics of the sample since your measurement will be saved with this filename.
- ii. Thickness (cm)
- iii. Resistivity(Ωcm) : Base resistivity
- iv. Sample type: Select P/N type from the dropdown.

3. Enter the Values of ***Analysis Parameters***

- i. **Optical Constant:** (Use the value 0.7 for the bare wafer. Refer to the procedure in the Appendix I, to find out the correct value of the optical constant.)
 - ii. **Specified Minority Carrier density:** The minority carrier density (MCD) in $/\text{cm}^3$ at which the lifetime value is expected for comparing it with other samples at the same MCD.
 - iii. **Bias light:** Use value “0” for general usage. It is used in the Software Model if effect of trapping or Depletion region modulation (DRM) is seen. (To understand the significance of this parameter in more detail, please refer to the Sinton manual/ Appendix II)
 - iv. **Analysis Mode:** Enter the proper mode “Generalized/QSS ($<100\mu\text{s}$)/ Transient ($>100\mu\text{s}$)” based on the expected lifetime range.
4. **Zeroing of the instrument:** Do NOT keep any sample in the vicinity of sensor & click “Zero Instrument” button. Zero the instrument whenever new measurement session begins or whenever new lifetime measurement spreadsheet template is reopened.
5. Place the Sample on the stage, centered over the Sensor.
6. Make sure that light sensor is NOT covered during measurement.
7. Click on the “Measure Wafer” button.

8. The flash will trigger and raw data will be displayed in pop-up graph, with both the photo-conductance sensor voltage & light sensor voltage as a function of time.
9. Click on the Zoom “In” / Zoom “Out” buttons in “Taking Data” window to fit the traces. Click on buttons appearing in blue until all of them become Grey. Wait approximately 5 seconds between the flashes so that flash has time to recharge. Once all the Zoom In/Out buttons become grey, this is considered as a correct reading.
10. The Excel file will be saved with the name of “Sample Name” input parameter, in the C:/Wafers, by default. Also each reading is logged into the Summary file in the same folder.
11. Maintain the excel files generated as a part of your measurements under “C:/Users/{Your Name}/ date/...”. This can be done after completing the measurements by Cut-Paste from the default path to the User folder. This will help us to track the results in convenient way.
12. Use CD/DVD to transfer your data from the system for your analysis. Use of USBs is NOT permitted.
13. Maintain the log book with the complete details: Name/Department/Supervisor/Sample details/Start Time/End time/Signature.

B. Sinton Suns- V_{OC} Measurement system

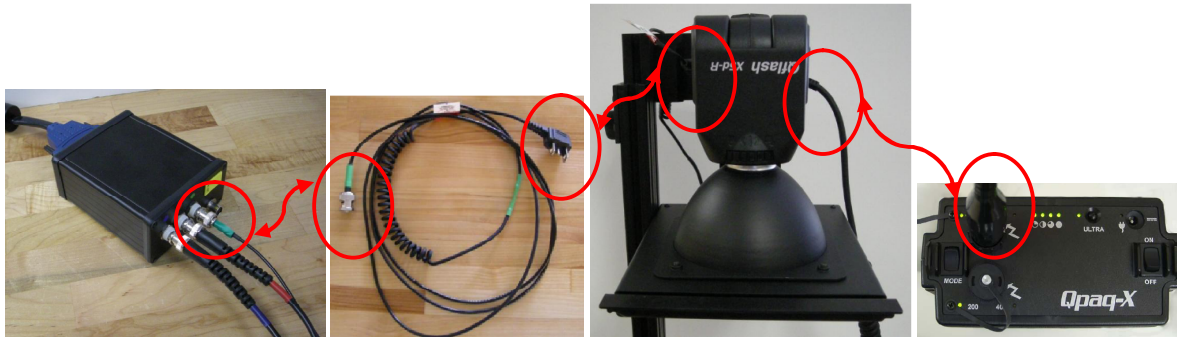
Introduction to the system:

The principle of Suns- V_{OC} technique is to measure the open circuit voltage as a function of light intensity. The Suns V_{OC} measurement can be performed on the samples with P-N junction and it is essential to be able to make contacts on both the sides of the junction. Being an open circuit measurement, it is free from effects of series resistance and hence can be used to characterize shunting. Also comparison of the Suns V_{OC} curve (or implied I-V curve at open circuit voltage) with the final I-V curve can give an idea about series resistance.

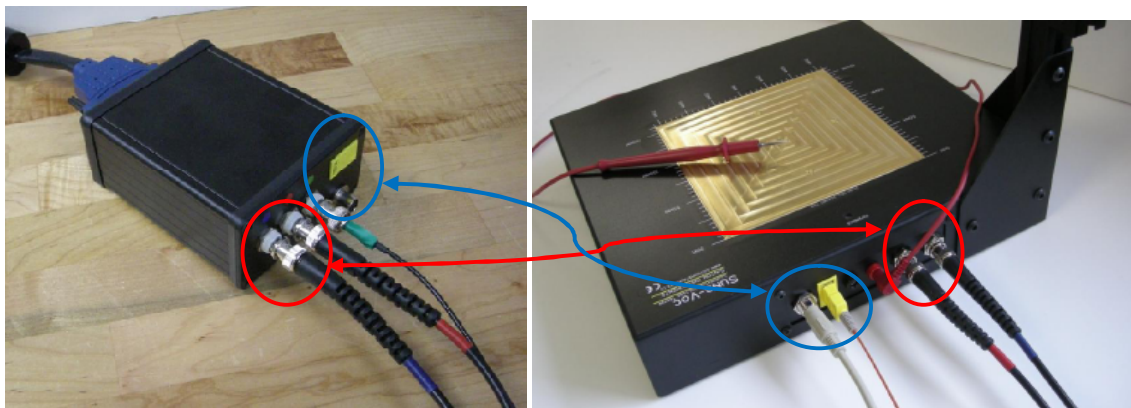
Connections to the Equipments:

1. Insert the appropriate filter in the filter tray assembly, if required. Neutral density filter is used for general usage and is already placed in the tray.
2. Connect the trigger cable to the side of the flash and other side of it into the connector box (as shown in figure)

3. Connect the cable from the flash lamp into the flash power supply. Turn ON the power supply with switch on right. Set the MODE to 200Ws with MODE switch on the left.



4. Make sure that Red & Blue BNC cables are connected to the Suns VOC stage to the connector box. Also ensure that the DIN heater cable, the yellow thermocouple and the red voltage probe are connected to the stage.



5. Adjust the flash tower height using the two knobs on the flash stand and sliding it up or down, if required.

General Procedure:

1. Open a Suns V_{oc} analysis Spreadsheet in Excel. (See the example sheet attached)
2. Enter the Values of ***Input Parameters***
 - i. Sample Name
 - ii. Short Circuit Current density(measured independently or estimated)
 - iii. Thickness : in cm
 - iv. Resistivity : Base resistivity in Ωcm

- v. Substrate type : P/N
3. Place the sample on brass chuck
4. Use the Voltage probe to make a contact with front side of the sample
5. Click on “Measure Cell’ button.
6. The Excel file will be saved with the name of “Sample Name” input parameter, in the C:/Wafers, by default. Also each reading is logged into the Summary file in the same folder.
7. Maintain the excel files generated as a part of your measurements under “C:/Users/{Your Name}/ date/...”. This can be done after completing the measurements by Cut-Paste from the default path to the User folder. This will help us to track the results in convenient way.
8. Use CD/DVD to transfer your data from the system for your analysis. Use of USBs is NOT permitted.
9. Maintain the log book with the complete details: Name/Department/Supervisor/Sample details/Start Time/End time/Signature.

Appendices:

- I. Optical Constant Calculation Using PC1D (provided by Sinton Instruments as Application Note).
- II. Chemical passivation procedure
- III. Small Size sample calibration
- IV. Sinton Lifetime Measurement Manual.
- V. Application Note for measurement on Sample Area Samples

Note: PC1D has been installed in the computer system for easy reference for User.

SOP Prepared By- System Owner: Amruta Pravin Joshi

Faculty In-charge: Prof. B.M.Arora