SOLAR SIMULATOR IV CHARACTERIZATION SYSTEM

FYTRONIX 9800 AAA CLASS SOLAR SIMULATOR

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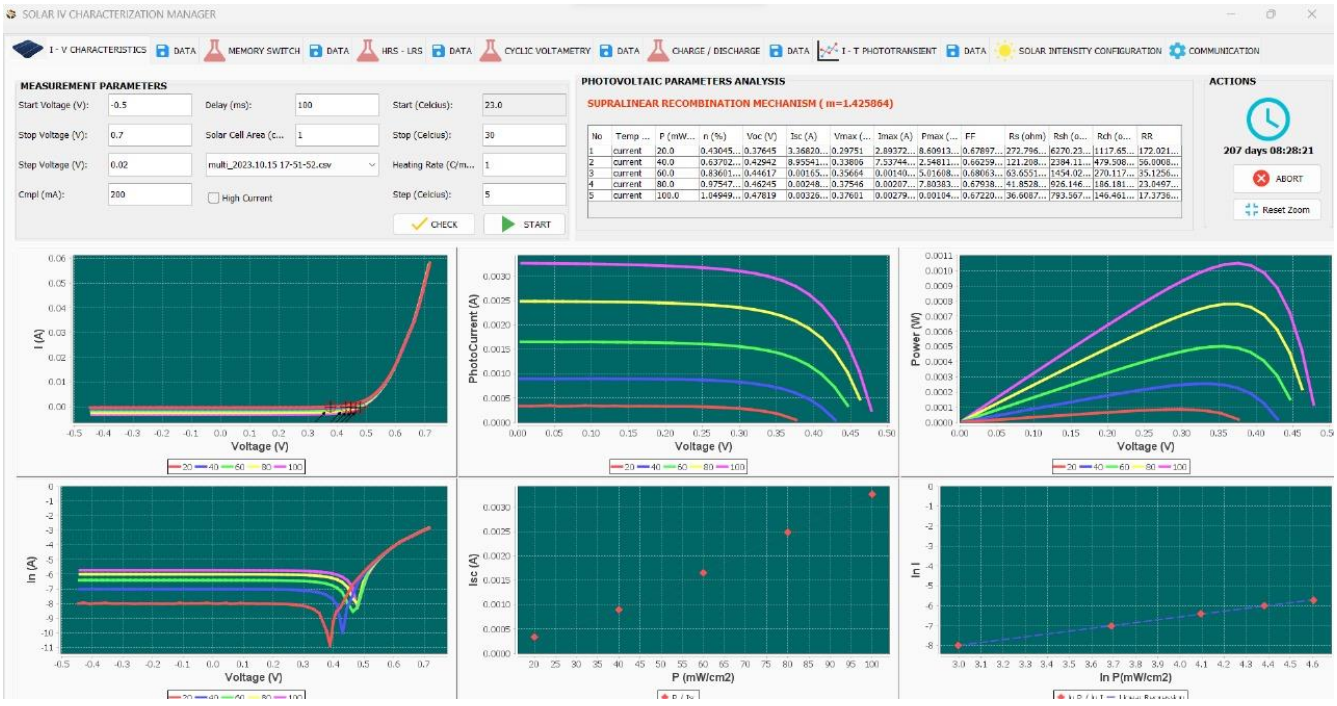
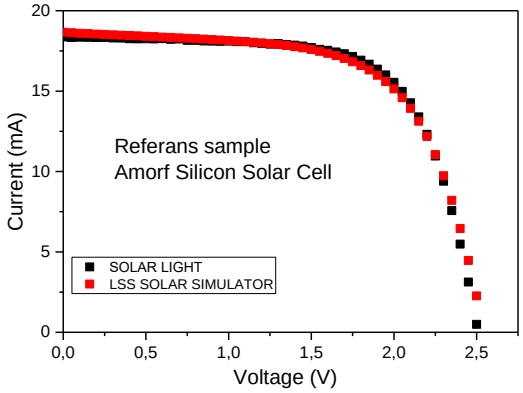


PHOTOVOLTAIC MEASUREMENTS UNDER MULTI SUNS

SOLAR SIMULATOR automatically perform IV characterictis and photoransient characteristics of solar cell , JUST you need to click START

TECHNICAL DATA AND CALIBRATION RESULTS

PHOTOVOLTAIC I-V TEST RESULTS



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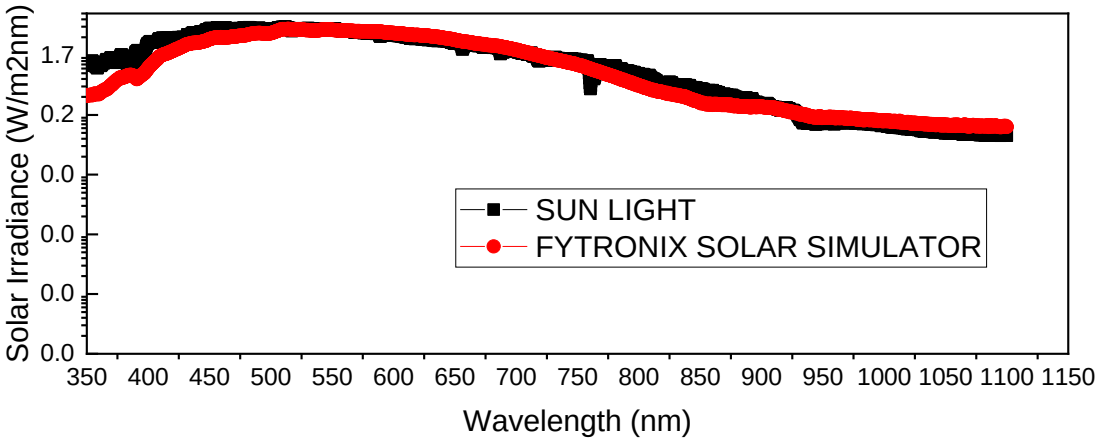
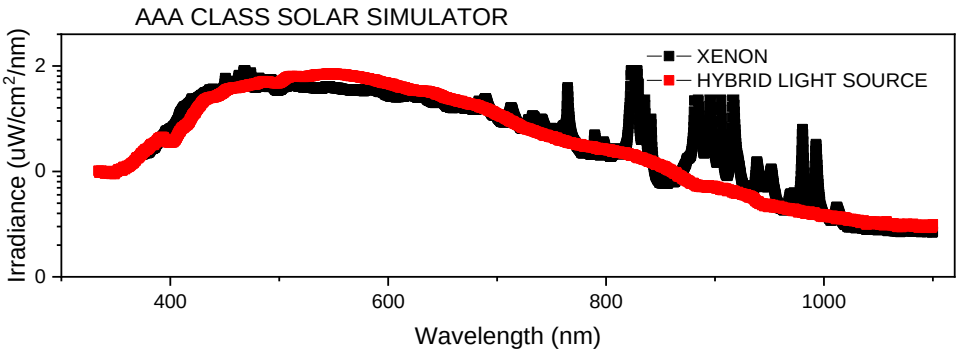


SPECTRAL MATCHING OF FYTRONIX SOLAR SIMULATOR



SOLAR IV CHARACTERIZATION SYSTEM includes

SOLAR SIMULATOR

I-V CHARACTERIZATION SYSTEM, SOURCEMETER

SAMPLE HOLDER

CONNECTIONS

SOFTWAREs

Solar IV characterization Software

Solar Cell I-V Characterization System

This system analyze all photovoltaic and photoconducting characteristics of all solar cells such Dye sensitized solar cells, Quantum dots solar cells, Organic solar Cells, Perovskite Solar Cells, Solar Silicon Solar cells, Thin films solar Cells under 1000 W/m^2.

This system is a complete current-voltage (I-V) and power-voltage (P-V) measurement environment.

SOLAR SIMULATOR SYSTEM

- Solar simulator has 7 inch touch screen of the device.

- Solar spectral spectrum is observed on the screen of the solar simulator controller when the measurement is performed.

- The solar simulator has 2 inch 90 degree light guide and the light is turned 360 degrees to the desired direction.

- The illumination area of the device is circular with a diameter of 5 cm.

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SOURCEMETER

- The sourcemeter must have a sourcemeter. The sourcemeter have an automatic current range and the current range should be in the range 200 nA-50 mA.

- The voltage range of the sourcemeter is ranging from -20 V to +20 V.

- The intensity of solar simulator is 1000 W/m^2,0-2 SUN

- The solar simulator measures the IV characteristics of all solar cells (Dye sensitized solar cell, perovskite Solar Cells, Quantum dots solar cells, Organic solar cell, Silicon solar cells) and be able to perform the IV characteristics of the batteries under computer control.

- The solar simulator measures the current-voltage characteristics of the solar cell under 1

- The current-voltage (I-V) characteristics of the solar cell are measured with the software in the system. The solar cell's open circuit voltage V_{oc}, short circuit current I_{sc}, filling factor FF, maximum current Imax, maximum power P_{max} and efficiency η, series resistance R_s, shunt resistance Rp and characteristic resistance R_{ch} should be measured automatically. •

- A reference solar cell should be given with the solar simulator.

- The probe holder of the device should be measured in a way that the measurements of the solar cell

SPECIFICATIONS OF SOLAR SIMULATOR SYSTEM

The device comply with the ASTM E 927-05 for uniformity classification, temporal stability and spectral match

Light illumination intensity range is adjustable 1000 W / m^2

Device is automatically measure;

a. open circuit voltage (Voc)

b. short circuit current (Isc)

c. fill factor (FF)

d. voltage at Pmax (Vmax)

e. current at Pmax (Imax)

f. maximum output power (Pmax)

g. shunt resistance (Rsh)

h. series resistance (Rs)

i. solar cell characteristics resistance (Rch)

j. photoresponse (RR)

k. solar cell efficiency (n)

Solar system automatically perform I-V and P-V measurement under 1 SUN.

FYTRONIX ELECTRONIC TECHNOLOGIES

Certificate Compliance 07.082.021

Product: Solar Simulator Model: FY SM 9000 SN: 112

Applicable Standards: ASTM E 72-10, EIC 60904-9, JIS C 8912

Spectral Fit

Spectral Match

Band/Band	Class A limits	Error	Status
400-500nm	%25	-4.30%	Pass

500-600nm	%25	2.20%	Pass
600-700nm	%25	1.02%	Pass
700-800nm	%25	-2.50%	Pass
800-900nm	%25	-1.80%	Pass
900-1100nm	%25	3.40%	Pass

Non-uniformity

Area	**Class A limit**	**Non-uniformity**	**Status**
40 mm diameter	**2%**	1.8%	Pass

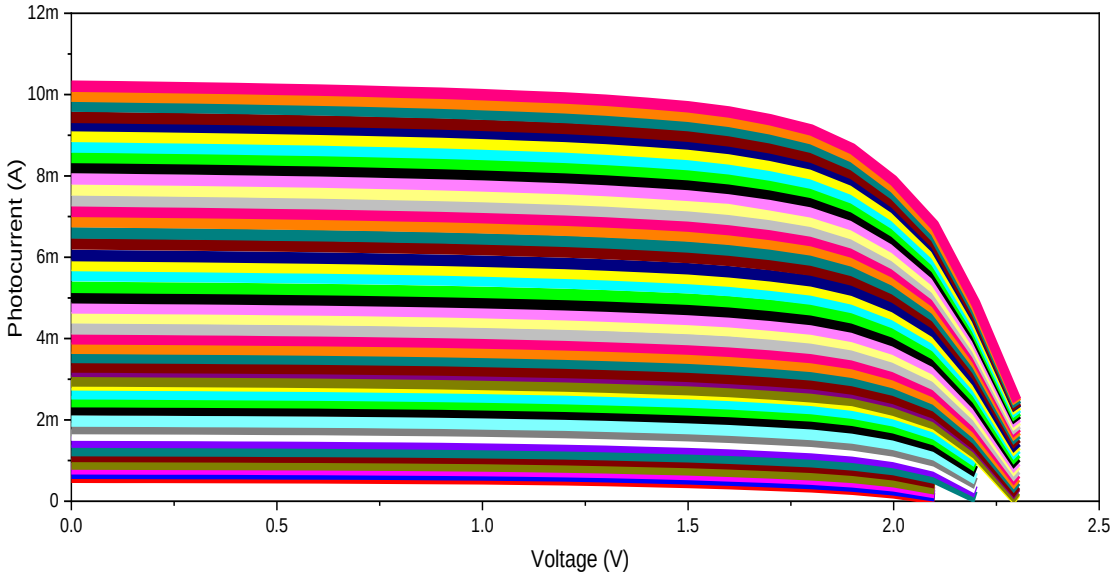
Irradiance instability

	Periyot/Period	**Instability**	**Class A limit**	**Status**
STI	0.5s	0.36%	0.5%	Pass
LTI	10Min	0.98%	2.0%	Pass

Approved
By National Acrrediation Center (NAC)

SOLAR SIMLUATOR perform the following tests (OPTIONAL)

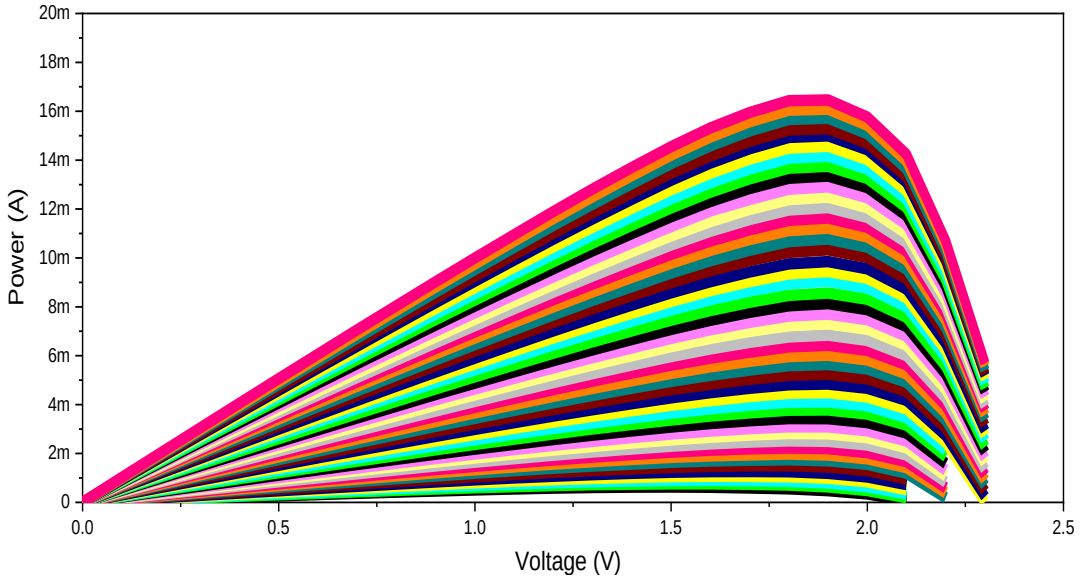
1. Solar simulator automatically measure current –voltage (I-V) characteristics of solar cell from 10 W/m2 to 1000 W/m2 with any step of intensity in W/m2



Current-voltage characteristics of solar cell under various solar irradiances

2. Solar simulator automatically measure current –voltage (I-V) and power-voltage (P-V) chracteristics of solar cell from 10 W/m2 to 1000 W/m2 with any step of intensity in W/m2

   JUST YOU CLICK START BUTTON on software

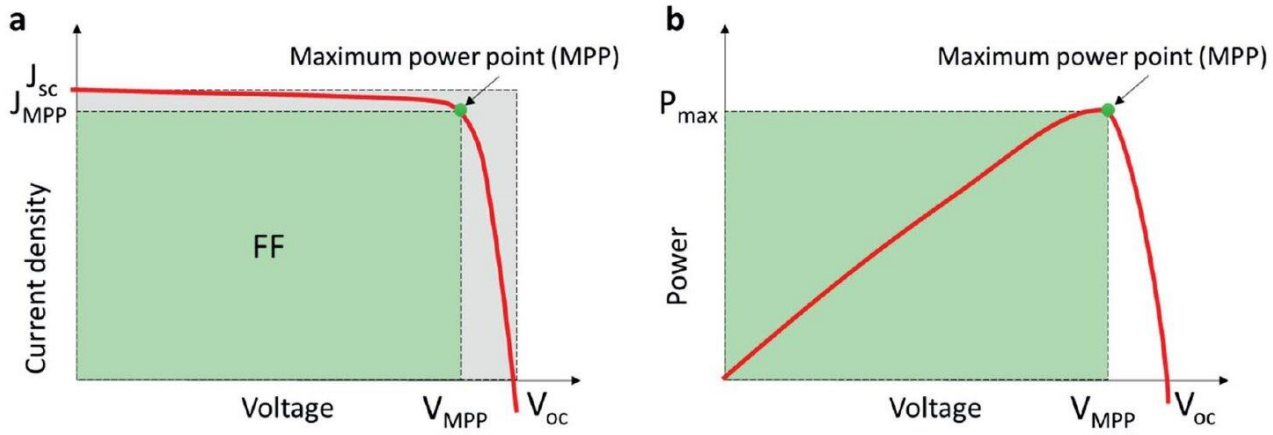


Power-voltage characteristics of solar cell under various solar irradiances

2. IV Curves - Power Conversion Efficiency of solar cell

The power conversion efficiency (PCE) of a solar cell is determined by performing a current−voltage (I−V) sweep under 1−sun intensity (1000 W m^{-2} illumination at AM1.5G).

The result is a curve, which crosses the voltage, x−axis at the point called **open−circuit voltage** (Voc) and the current, y−axis at the point called **short−circuit current** (Jsc). As clear from the figure below, the solar cell JV characteristics is not a square, which indicated that the power extracted from the device **is less than the product of Voc and Jsc**.



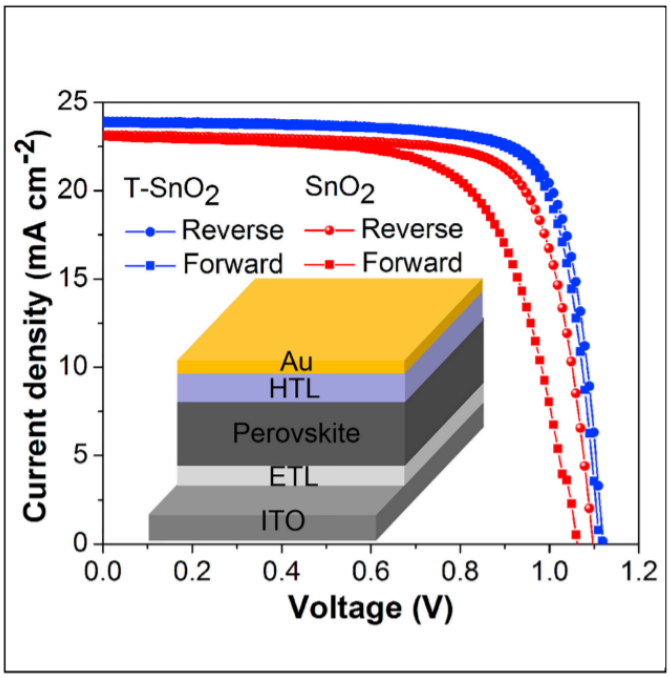
(a) Current-voltage (I-V) curve of a solar cell characterized under constant illumination. (b) power output as a function of the voltage

Instead, one has to determine the so−called **maximum power point (MPP)** − the point, at which voltage and current result in maximum power (Pmax) extracted from the device. FF, Voc, Jsc, and PCE are the most commonly used performance metrics to characterize solar cells.

$$PCE = \frac{P_{max}}{P_{in}} = \frac{V_{MPP}J_{MPP}}{P_{in}} = FF\frac{V_{oc}J_{sc}}{P_{in}}$$

This way of extracting PCE from a solar cell is normally independent of I−V scan direction and it works accurately as long as the measured solar cell is under **quasi-steady-state conditions**. This requires the device to be in equilibrium under each applied potential during the measurement.

Researchers found almost immediately that depending on the J−V scan direction, the result of the measurement was different. This phenomenon is called **J−V hysteresis**.



Hysteresis curve of solar cell