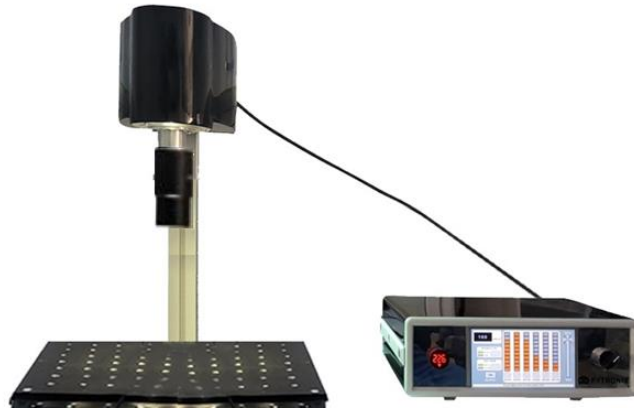

FULL AUTOMATIC SOLAR SIMULATOR

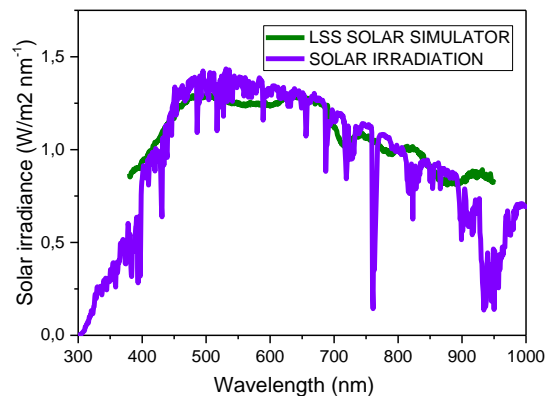
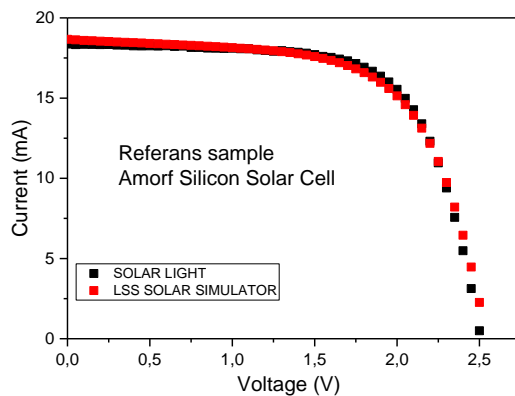
FYTRONIX SM 9600

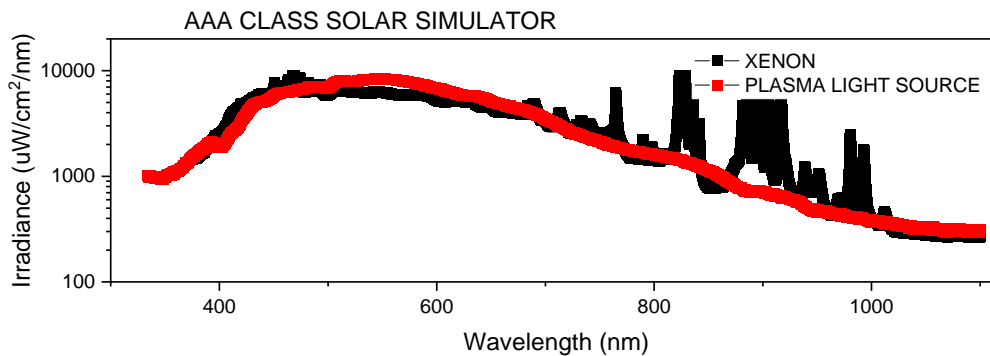


Solar Simulator system automatically measures power-voltage (P-V) under various light intensities from 0 to 2 SUN

TECHNICAL DATA AND CALIBRATION RESULTS

PHOTOVOLTAIC I-V TEST RESULTS





LSS SOLAR SIMULATOR SPECTRAL SOLAR IRRADIANCE MATHING

SPECTRAL SOLAR IRRADIANCE OF LSS SOLAR SIMULATOR

SOLAR SIMULATOR

- Testing of solar cells.

2. specifications

- Spectral match (each interval): 0.75 – 1.25 (class A)
- Irradiance Spatial Non uniformity: <2% (class A)
- temporal instability: <2% (class A)
- effective irradiance: 0- 2000 W/m² (2 SUN)
- Emission bandwidth: 400 - 1100 nm
- irradiance aperture: 50 mm dia and illumination area: 50 mm
- Compliance standard: EN 60904-9, ASTM9712
- Working distance: 20-30 cm
- cooling system: internal fan
- power supply adapter: input 230 VAC, 50 Hz, output 12 VDC, 5A
- Light source: Plasma light (life time: 8000h). It can be dimmable from 0 to 2000 W/m² (200mW/cm², 2SUN)
- Touch screen solar controller (automatically calibrate intensity on screen)

LED Solar Simulator provides illumination approximating natural sunlight (AM1.5G) in the wavelength range of 400 to 1100 nm. It assures controlled and repeatable laboratory conditions

of spectral content, spatial uniformity and temporal stability for photo-electrochemical experiments meeting class AAA specification.

Unlike traditional solar simulator based on Xenon short-arc lamp and metal halide discharge lamp, this concept is using high-power LED technology.

The sun spectrum is matched using 6 LED wavelengths, sufficiently spaced apart to provide a uniform light.

The main advantages of such a solution are:

- (i) low operating costs due to instant on/off
- (ii)** low maintenance costs because of the extended life of the LEDs;
- (iii)** small size and low weight;
- (iv)** low price
- (v)** Long life time of light source more than 10000 h

SPECIFICATIONS

- compliance standard: EN 60904-9
- spectral match (each interval): 0.75 – 1.25 (class A)
- Irradiance Spatial Non uniformity: <2% (class A)
- temporal instability: <2% (class A)
- effective irradiance: $100 \text{ mW/cm}^2 \pm 2 \text{ mW/cm}^2$
- emission bandwidth: 400 - 1100 nm
- irradiance aperture: 30 mm dia.
- working distance: 10 mm
- number of high-power LEDs: 6
- weight: 1673 g
- cooling system: internal fan
- power supply adapter: input 230 VAC, 50 Hz, output 12 VDC, 5A

OPTIONAL

SOLAR IV CHARACTERIZATION SYSTEM has the following capabilities

SOLAR SIMULATOR
I-V CHARACTERIZATION SYSTEM, SOURCEMETER
SAMPLE HOLDER
CONNECTIONS

SOFTWAREs

Solar IV characterization Software
Solar Life-Time Software
Transient photocurrent software
Photovoltaic mechanism analysis 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 various solar light intensities from 0.1 W/cm^2 to 1500 W/m^2 .

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

The system contains the following elements:

- Maintenance Free Solar Simulator (FSS)

I-V system, source meter

Light source: Hybrid Light source, LED source

Voltage range: -20 V to +20 V

Current range: 10 nA to 500 mA

- I-V Solar IV software

- Solar cell probes

- Solar cell probes

- Calibrated Reference solar cell

Factory calibrated AM1.5G spectral match

Factory calibrated intensity

Front panel LED Fault indication

USB Communications

Meets Class AAA specification for IEC 60904-9, JIS C 8912, and ASTM E 927-05

2" X 2" illumination area at 1 sun

PV Cell Placement Indicator

Easy adjust light adjustment

Can be mounted pointing up, down, or to the side with 90° rotational accessory

Temperature controlled for stable output

FULL AUTOMATIC SOLAR SIMULATOR

	LSS SOLAR SIMULATOR
Bands	400-500, 500-600, 600-700, 700-800, 900-1100 nm 6 BANDS
Light control	USB
Automatically intensity light Control	0.1 to 1000 W/m ² (0.1 to 1.0 sun or more) by a certain step
Power Requirements	100-240 VAC, 50-60 Hz, 300W
Operating Temp Range	20°C to 30°C
Humidity	<85%, relative, non-condensing
Certificate	ISO 9001 :2015, CE CERTIFICATE
Illumination Area	2"X2" (51mmX51mm)
Total Power Output	(1.0 sun)
Uniformity Classification ¹	A - IEC 60904-9 2007, JIS C 8912,

Temporal Stability ²	ASTM E 927-05
Spectral Match ³	
Operating Temp Range	20 ^o C to 30 ^o C

LSS solar simulator generates a continuous light spectrum corresponding to a class AAA spectrum. This system is designed to illuminate any type of solar cell up to 25 x 25 mm or more. LSS solar simulator generates a continuous light spectrum whose intensity varies from 1 W/m² to 1000 W/m². The simulator and I-V measurement system are controlled by the computer.

Common Measurements made in I/V Characterization of photovoltaic devices

Dark I/V measurements are commonly used to analyze the electrical characteristics of solar cells. Dark I/V measurements are more sensitive than light I/V measurements in determining parameters such as series resistance, shunt resistance, diode factor, and diode saturation currents.

Solar simulator automatically determine the photovoltaic parameters as follows

Open circuit voltage (V_{oc})

Short Circuit current (I_{sc})

Fill factor (FF)

Voltage at P_{max} (V_{max})

Current at P_{max} (I_{max})

Maximum power output (P_{max})

Shunt resistance (R_{sh}) •

Series resistance (R_s) •

Characteristic resistance of solar cell (R_{ch}) •

Photoreponse (RR)

Solar cell efficiency (η)

Solar simulator automatically determine the photovoltaic mechanism like monomolecular recombination mechanism, supra linear mechanism and etc.

LSS SOLAR SIMULATOR SYSTEM measures the followings

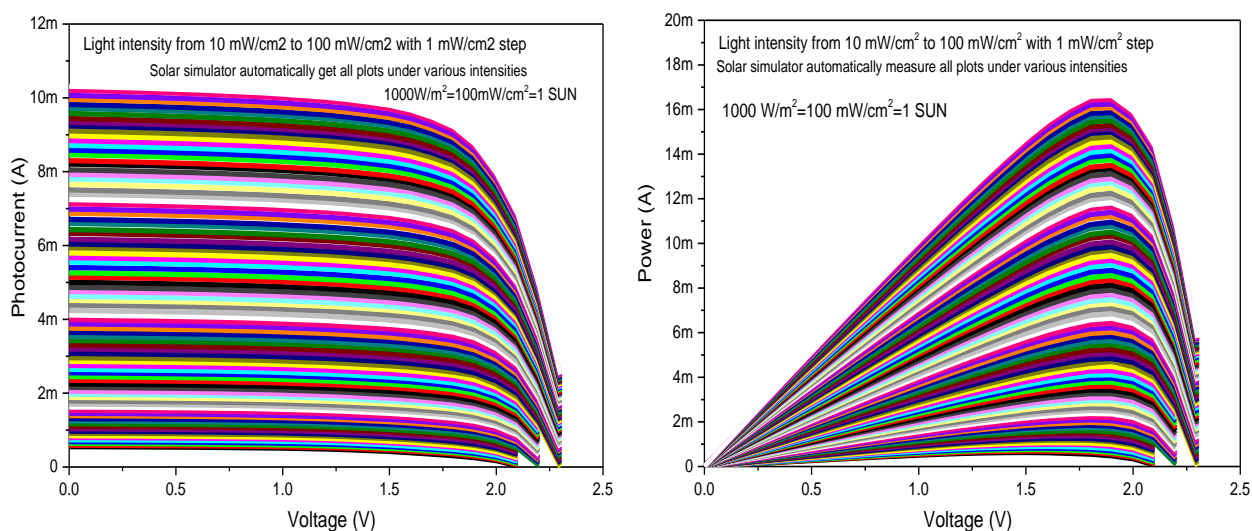
Solar Simulator system is controlled automatically by computer

Solar Simulator system adjusts automatically the intensity of light 0.1 W/m^2 - 1000 W/m^2 by any step, for example from 1 W/m^2 to 1000 W/m^2 with 1 W/m^2 .

Solar Simulator system automatically measures current-voltage (I-V) under various light intensities

Solar Simulator system automatically measures power-voltage (P-V) under various light intensities

Solar Simulator system automatically analyses photovoltaic mechanism (I-V) under various light intensities



TECHNICAL SPECIFICATIONS OF LSS AUTOMATIC SOLAR IV CHARACTERIZATION SYSTEM

1. Solar Simulator system automatically is controlled by computer.
2. Solar Simulator system automatically measure I-V characteristics from 1 W/cm^2 - 1000 W/cm^2 by adjusting light intensity with step of 1 mW/cm^2 .
3. The intensity of solar simulator should automatically adjust by solar IV system
4. Solar simulator system should simultaneously measure I-V characteristics curve of the device, Solar Cell I-V characteristic curve, Power-voltage curve, I_{sc} -Solar light intensity curve and photovoltaic mechanism curve and should analyze photovoltaic mechanism and write type of the mechanism on computer screen.

5. Solar Simulator should automatically measure open circuit voltage V_{oc} and short circuit current, I_{SC} , Shunt resistance (R_{sh}) • Conversion efficiency (η), Maximum power output (P_{max}), Voltage at P_{max} (V_{max}), characteristic resistance, R_{ch} , Fill factor (FF) • Series resistance (R_s)
6. Solar Simulator system measures automatically current-voltage (I-V) of solar cell under various solar lights
7. System should have a source meter having the specifications
Voltage range: -20 V to +20 V
Current range: 10 nA to 150 mA
8. System should have an automatic shuttering system which automatically changes solar light from 1 W/m^2 to 1000 W/m^2 .
9. System should have sample holder and it is comprised of two probes. Holder size should have $132.5\text{mm} \times 132.5\text{mm}$.
10. System should have software to control measurements and analysis of data.
11. Installing and training

SOFTWARE OF THE SYSTEM

System has two software, first characterize all photovoltaic parameters

Software measure all photovoltaic parameters of solar cells by computer. The system determine all photovoltaic parameters. Software of Solar Simulator system determine the following photovoltaic parameters such as short circuit current I_{SC} , open circuit voltage V_{oc} , maximum power P_{max} , maximum current I_{max} , maximum voltage V_{max} , efficiency η , shunt resistance R_{sh} and series resistance R_s .

Also ,system analyze the automatically the photovoltaic mechanism analysis.