

# Efficiency Measurement Facility of Organic Solar Cells



## CSIR-National Physical Laboratory

National Metrology Institute (NMI) of India

New Delhi-110012, INDIA



In India, the research on solar cells is being pursued in the scientific laboratories and industries; however, there is no center for the validation of solar cell efficiency. Globally there are three recognized centers available for validation of solar cell efficiency namely NREL (USA), PTB (Germany) and AIST (Japan). In order to validate the efficiency of the fabricated solar cells, these have to be sent to one of the mentioned centers and this process is not only expensive but also time consuming. For the validation of efficiency of such devices it requires calibration of various individual parameters involved in measurement of efficiency such as light source, current/voltage meter, temperature sensors and active area of device. Being 'National Metrology Institute' (NMI) of India, CSIR-National Physical Laboratory (NPL) has standards and traceability to all units used in solar cell efficiency measurement. The 'facility for validation of solar cell efficiency with the maximum possible accuracy available at CSIR-NPL is a potential service to the nation, including the academic institutions & research laboratories and industries across the country.

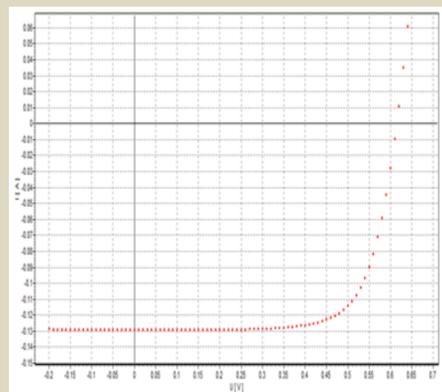
The individual parameters involved in the efficiency measurement of a solar cell have been traced, as given below;

Parameters	Capabilities in measurement uncertainty at CSIR-NPL
Spectral irradiance	0.001 to 0.2 W/(m <sup>2</sup> -nm) in the spectral window of 280-2500nm (uncertainty 1.9 to 6%)
DC Voltage	1V (± 1μV), 1 mV (± 1μV), 1μV (± 0.1 μV)
DC Current	1mA (± 5nA), 1μA (± 7pA), 1nA (± 0.1pA), 1 pA (±0.01pA)
Temperature	±0.17 x10 <sup>-3</sup> °C at triple point of water (0.01 °C)
Dimension (Active Area)	1.0 mm (± 0.16 μm)

Efficiency measurement facility (CLASS AAA) is created in clean room (ISO Class 7) for organic solar cells

### Measurement of Standard Silicon Solar Cell

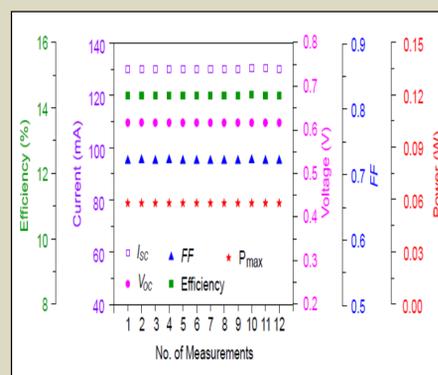
Typical I-V characteristic



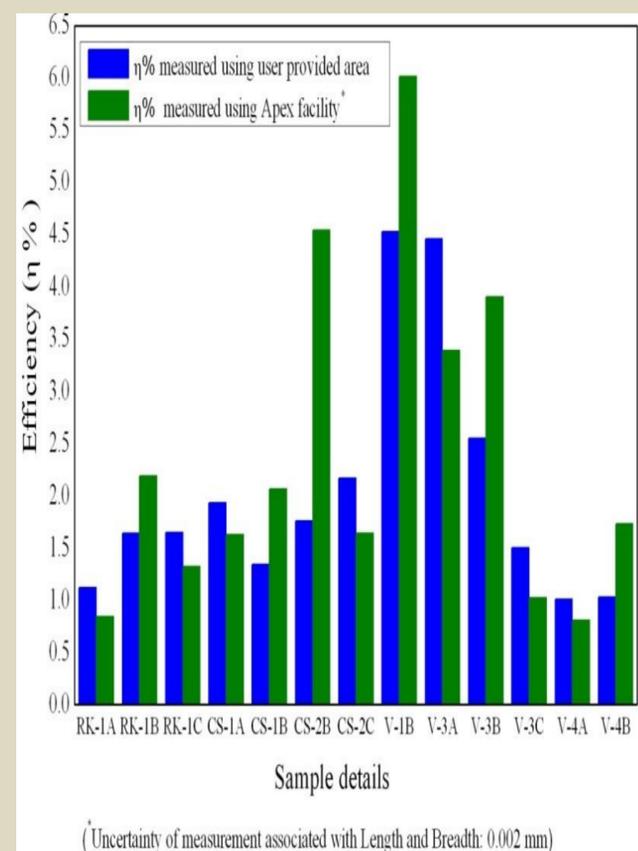
Uncertainty in the measurement

Solar Cell Parameters	Measured values
I <sub>sc</sub>	130.04 ± 0.11 mA
V <sub>oc</sub>	616.14 ± 0.13 mV
Fill Factor	0.721
Area	4.00 ± 0.048 cm <sup>2</sup>
Efficiency	14.38 ± 0.01 %

Reproducibility of measurements

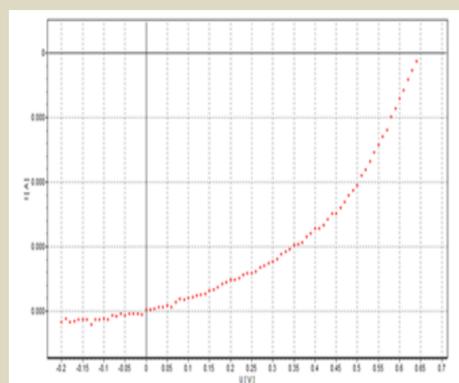


Efficiency of organic solar cells using active area measured at apex facility



### Measurement of organic solar cells

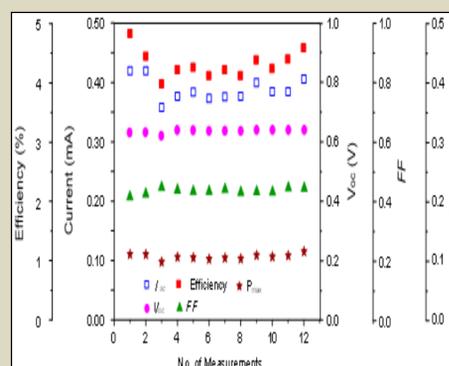
Typical I-V characteristic



Uncertainty in the measurement

Solar Cell Parameters	Measured values
I <sub>sc</sub>	387.95 ± 0.01 μA
V <sub>oc</sub>	635.95 ± 5.6 mV
Fill Factor	0.436
Area	0.025 cm <sup>2</sup>
Efficiency	4.27 ± 0.22%

Reproducibility of measurements



CSIR-NPL records more than ten measurements for the estimation of uncertainty in the efficiency of organic and other similar solar cells. Please follow structure of the contacts pads as provided.

Researchers across the country are welcomed to utilize this facility at CSIR-NPL