# ECN solar cell I/V measurement

# ECN

#### www.ecn.nl

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#### Solar cell I/V measurement

**Cell performance depends on various aspects** 

Spectrum and intensity of the incoming light

#### **Spectral sensitivity**

• different solar simulators -> different lamps -> different spectra -> different measured currents even if same calibrated cell is used!

- AM1.5 and 1000 W/m<sup>2</sup>
- Temperature (25 °C!)
- Quality reference cell
  - Calibrated @ Calibration Institute and comparable to test cell
- Geometry contacting probes
- Chuck reflection and conductivity
  - Should be minimised



• To compare currents -> correct the measured current for the differences in the lamp spectra.





#### **Calibration lamp spectrum solar simulator**

- Calibrated lamp (lifetime 50 hr)
- Spectrophotometer is calibrated with calibration lamp
- Solar simulator spectrum is measured with calibrated spectrophotometer



### Mismatch (MM) correction

- IEC norm: correct current for standardized spectrum: AM1.5
- Goal: determine current of test cell for AM1.5 spectrum: *I*<sub>test,AM1.5</sub>
- Use reference cell with calibrated AM1.5 current: *I*<sub>ref,AM1.5</sub>
- Calculate current test cell and calibrated cell for lamp spectrum: I<sub>test,lamp</sub> and I<sub>ref,lamp</sub>
  - need spectral response of the cells
  - need spectrum of the lamp
- MM is determined by:

$$M = \frac{I_{ref,AM1.5} * I_{test,lamp}}{I_{ref,lamp} * I_{test,AM1.5}}$$

• Corrected current is calculated by:  $I_{test,AM1.5} = \frac{I_{test,lamp}}{MM}$ 

#### **Measurement contacting geometry**



5BB PERT solar cell

Triplet

Tandem 1

Tandem 2a 30 mm

Large deviations between different contacting geometries

20 mm

20 mm

Black pin: current

## **Chuck reflection and conductivity**

- Current of cell depends on reflection chuck.
- Same chuck for test and reference cell.



#### Taken from a presentation by C. Kruse-ISFH



5 mm

Isc anod.: 8.94 A  $\Delta\eta$ :0.1% absolute

Isc black.: 8.90 A



#### Conclusion

- Complete calibration sequence at ECN
- Accuracy ISE @ CalLab: 1.9%
- Total accuracy ECN: 2.0%
- Reproducibility ECN (measured): 0.25%
- ECN joins round robins on a regular basis to verify results with other institutes.

More information can be obtained at: weeber@ecn.nl