Measurement of Solar Cell Using LED-based Differential Spectral Responsivity Comparator under High Background Irradiance

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Summary

The spectral responsivity of solar cells has been measured under high background irradiance using an LED-based differential spectral responsivity Comparator (DSR-C). The comparator developed is fully automated and has some advantages: It does not need a chopper to modulate the light. Unlike the conventional method, it does not require a monochromator to select wavelength. It covers a wavelength range up to 1200 nm. The wavelength range of the comparator is limited by the spectral power distribution of the LEDs and the spectral responsivity of the standard detector. An active temperature control was utilized to meet the specified standard conditions of solar cell test. This work shows the effect of different levels of background irradiance on the spectral responsivity and the importance of same background irradiance for solar cell test as specified by the corresponding standard.

1. Introduction

The objective of solar cell calibration and/or test is to determine its conversion efficiency. This parameter is directly related to the output current of the solar cell when being exposed to spectral irradiance like the sunlight which is dependent upon the solar cell spectral responsivity and the solar spectral irradiance. It is impossible to have an ideal solar simulator and rare to have natural solar radiation same as the standard condition. Spectral mismatch correction is usually used to fix this problem. However, the spectral mismatch correction is based on the assumption that a solar cell has a linear current-irradiance characteristic, which is not always true. Therefore, an accurate determination of solar cell output current, and hence its conversion efficiency, can be made by taking the non-linearity issue into consideration without neglecting other requirements.

This work describes the development of a system to measure spectral responsivity of solar cell by taking into account the non-linearity of the solar cell.

2. Measurement Set up

The system setup is schematically shown on Figure 1. Forty light emitting diodes (LEDs) are used to cover a wavelength range of 250 nm to 1500 nm. The selected LED is aligned to a beam splitter by rotating its mount. The LED is switched on and modulated electronically via a PC. This avoids the use of a monochromator and optical chopper. The light beam from the LED is split using the beam splitter. One portion of the light beam is directed to a DUT. The other portion of the light beam is directed on a monitoring detector through a focusing lens. This enables monitoring of change in irradiance level of the LED. Baffles are used to block stray light.

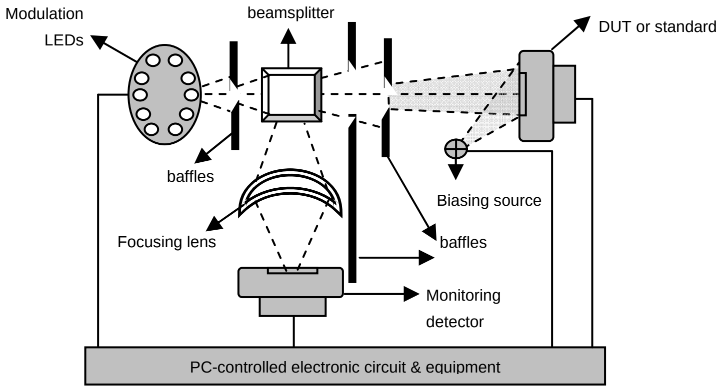

Figure 1. Measurement Set up

The modulated signals of the monitor detector and the DUT are measured by using two sets of lock-in amplifiers of which outputs are acquired through the PC-board. The board modulates the LEDs as well. The basing source is controlled by the PC. The whole system is fully automated by a program.

3. Results

Figure 2 shows differential spectral responsivity of a solar cell at different levels of background irradiation. It shows an increase in the spectral responsivity with the increase in background irradiation. The graph also shows the non-linear behavior of the solar cell.

Now, validity of the measurement is under investigation by taking the uncertainty components into account.

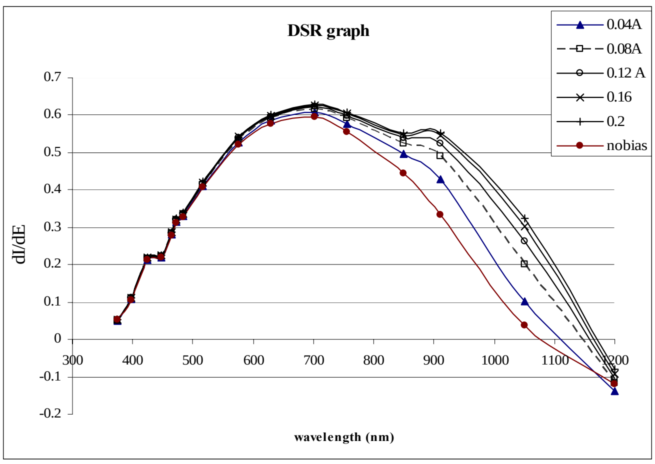

Figure 2. Differential spectral responsivity at different background irradiation levels

Reference

1. Metzdorf J., et.al., Principle and Application of Differential Spectroradiometry, Metrologia, , 28, 247-250, 1991.
2. Metzdorf J., Calibration of Solar Cells. 1: The differential spectral responsivity method, App. Opt., 26, 1701-1708, 1987.