Invited Paper

Measurement Challenges Related to Photovoltaic Device Characterization under Simulated Indoor Lighting Conditions

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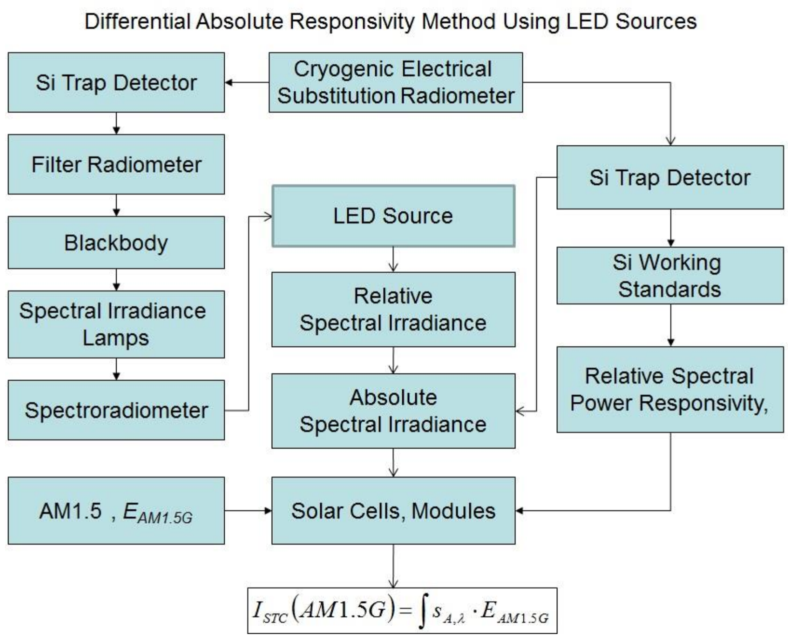
One of the main objectives in the measurement and characterization of photovoltaic cells and modules under simulated indoor lighting conditions is to accurately predict the electrical performance of the devices outdoors under the standard testing conditions (STC). The two most common electrical performance measurements are the current-voltage (I-V) characteristics under the global AM 1.5 standard reference spectrum and the spectral response (SR) measurement of the solar cell under appropriate light bias conditions. The differential SR measurements in irradiance mode are not only used to calculate the spectral mismatch factor (M) between the reference cell and the test cell, but are also used to determine the short circuit current (I_{sc}) of the cell under any light spectrum, including the AM 1.5. Although seemingly straightforward, there are still a significant number of outstanding issues related to highly accurate measurements of solar cell parameters based on indoor characterization techniques, particularly the SR method. The degree of the collimation of the indoor light source, the nonlinearity of the solar cells with injection level, the material nonuniformity particularly with thin film and 2^{nd} and 3^{rd} generation PV technologies and large area cells, encapsulation of reference cells and a number of other issues introduce complexities in the measurement methodologies.

In this presentation, a number of these issues will be discussed in detail and the uncertainty introduced by each component will be outlined. More specifically, a method for determining the accurate irradiance-mode spectral response curve of a large area cell with material nonuniformity will be presented. It will be shown that the curve can then be used to predict the I_{sc} of the cell under the STC. Furthermore, the effect of a diffuse-light solar simulator on the electrical characterization of various types of devices will be discussed. Finally, the significant effects of the spectral composition and the intensity of the light bias on SR curves will be demonstrated.



NIST SI traceability route for PV spectral responsivity