TUeV Rheinland Japan Research Update

Recent papers and presentations by Mr. Kengo Morita

■ Degradation and Failure Analysis of Crystalline Si PV Modules of 8 Asian PV Manufacturers through Repetition of Qualification Test Based on IEC61215
The target of this research is to observe if the universal failure modes that occur in the field can be reproduced by the current qualification test base. Qualification tests based on IEC61215 were sequentially repeated for 8 types of crystalline Si PV modules of 8 Asian PV manufacturers in order to identify the degradation and failure modes which are triggered in accelerated testing. The test samples were 56 commercial PV modules taken from the market. The performed tests were damp heat test, temperature cycling test, and combination of UV test / temperature cycling test / humidity freeze test, which are main long-term qualification tests in the standard. The test will be continued until failure occurs. The results will be reported focused mainly on the performance (Pmax) change, degradation and failure modes.

Presented at the 28th EU PVSEC, Paris, France, 2013

■ Impact of Calibration Methodology into the Power Rating of c-Si PV Modules in Industrial and Laboratorial Conditions
The measurement uncertainty of power rating has significant economic impact for the PV industry. This paper reviews the calibration practices commonly applied for industrial and laboratory power rating of c-Si modules and the influences from the performance of the measurement equipment. Specifically, the reviewed methods are: i) calibration against a reference cell based on short-circuit current (ISC), ii) calibration against a reference module based on ISC and iii) calibration against a reference module based on the maximum power point (PMAX). It is shown that measurement practices commonly applied in the industry may introduce errors up to 3% on ISC and PMAX. The work suggests that the optimum procedure for industrial calibration relates to the given ISC and PMAX measurement uncertainties of the reference device, the light non-uniformity of the solar simulator and the employed temperature control process. It is suggested to calibrate the solar simulator irradiance maintaining a reasonable agreement between ISC and PMAX certificate values within 1%.

Presented at the 28th EU PVSEC, Paris, France, 2013

■ Solutions for Performance Measurement Error due to Multiple-Reflections between Reference Solar Cell and Output Lens of Solar Simulator
The performance of amorphous silicon is not stable because of the light-soaking and annealing effects. Therefore a stable pseudo-reference solar cell (in WPVS or JIS package) with a similar relative spectral response to the amorphous silicon or multi-junction cell is generally used for performance (Pmax) measurements. Its structure is composed of a stable crystalline silicon cell and an optical filter. However this structure is the reason for different optical characteristics from the actual tested sample and hence measurement errors are introduced. One of the errors is caused by multiple reflections between the photovoltaic (PV) device and the output lens of a solar simulator. The effect may become significant under a short-distance type solar simulator used for solar cell evaluation. The difference of the multiple-reflection level between reference cell and tested sample directly introduces systematic errors on the Pmax measurement. The magnitude of the multiple-reflections can
be determined by measuring the incident light angle characteristics. Therefore a correction for those multiple reflections can be applied based on measurements of the incident light angle characteristics. A correction method will be proposed and the verification results for the correction will be reported in this paper.

*Presented at 27th EU PVSEC, Frankfurt, Germany, 2012*

**Measurement error and solution due to reference cell’s structure**
A pseudo-reference solar cell (WPVS or JIS package) is generally used for a performance (Pmax) measurement of amorphous type’s PV cells & modules. However, it was understood that measurement errors are introduced due to the reference cell’s structure. A new type of the reference cell was made and the degree of the measurement error was verified by measuring the incident light-angle characteristics. One of the solutions to reduce the errors will be reported in this paper.

*Presented at the 21st International Photovoltaic Science and Engineering Conference November 28th - December 2nd, 2011, Fukuoka, Japan*