Area 7: Performance and Reliability of PV Modules

DETECTION OF PREMONITORY SYMPTOM IN DEFECTIVE MODULES BY DARK I-V CHARACTERISTICS WITH EL DIAGNOSIS

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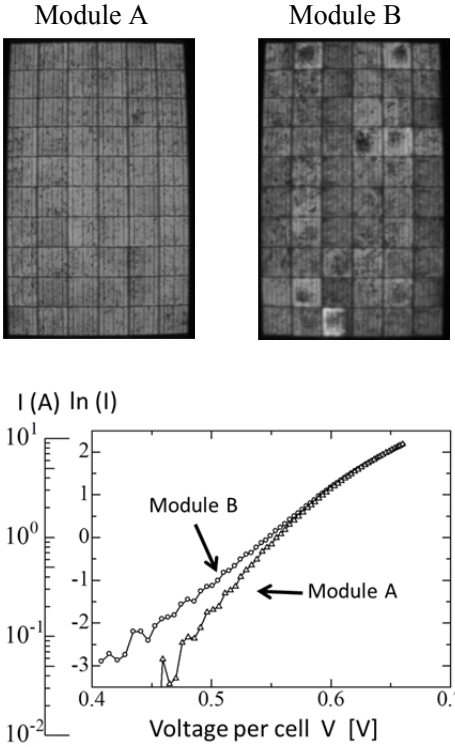
Highly reliable performance of PV modules is strongly requested to establish mega-solar systems as one of the trunk energy sources. Durability of PV module has been intensively investigated for many years to reveal the failure mechanisms and prevent the degradation. Important subject is how to detect defective modules in the early stage after installation. Electroluminescence (EL) diagnosis [1] is an effective tool to reveal deterioration photographically. In this report the symptom of degradation of PV modules can be monitored in the early stage by analyzing dark current voltage (I-V) characteristics with the combination of EL diagnosis. Simple criteria will be proposed to detect degradation.

Two typical poly-Si sample modules were picked up from the installed PV system (10 kW, 5 years after installation). Nominal output power Pmax of reference module was about 230 W (Isc=8.5A, Voc=37V, F.F.=74%). Module A kept its performance but module B showed 6% degraded Pmax. Conventional I-V analysis under illumination did not show clear difference in their photo-responses (within a few % difference in each factor of Isc, Voc, etc.). EL image of module A showed uniform emission with no generation of degraded areas, but in module B there occured several defective cells as shown in Figures 1. Dark I-V analysis showed evident difference between module A and B in the lower current region less than 1A (applied voltage per cell:V < 0.55V) as shown in Figure 2. Figure 3 showed the dependence of the ideality factor n (=q/kT $\Delta V/\Delta \ln I$) upon the applied voltage. The defective module B has larger value of n with comparison of module A (*e.g.,* 1.1 for module A and 1.7 for module B at V=0.5V). Minute analysis of dark I-V characteristics will give clear numerical criteria to check the degradation of PV modules, and EL diagnosis will help to reveal the origin of possible defects photographically.

Reference

[1] T. Fuyuki, H. Kondoh, Y. Kazi , A. Ogane and Y. Takahashi, J. Appl. Phys. 101 023711 (2007)
"Analytic findings in the electroluminescence characterization of the crystalline silicon solar cells".



Figures 1:EL photographs of poly-Si modules selected from PV systems installed for 5 years.

Module A: Average Module B : Degraded

Figure 2 Dark I-V characteristics of selected modules.

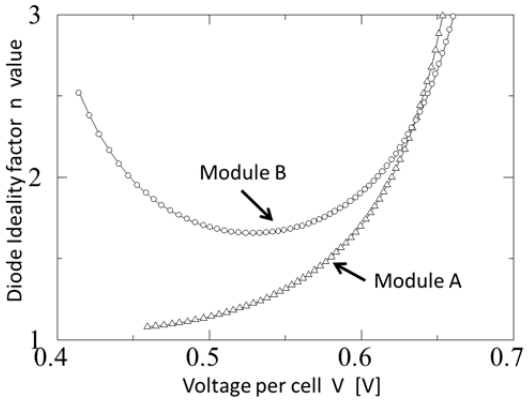


Figure 3 Dependence of ideality factor n on V.