Analysis of potential induced degradation at the micro-cracked regions for p-type crystalline Si solar cells using microwave photoconductance decay technique

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In this report, potential induced degradation (*PID*) that has occurred at the micro-cracked regions of p-type crystalline silicon solar cells was detected by electroluminescence (*EL*) and lock-in thermal (*LIT*) techniques as shown in Fig.1. The "×" symbol-like micro-cracked region as the dark region of EL image corresponding to the hot-spot region of LIT image has been severely affected after a PID stress test for 100 hours. Their local electrical deterioration at the micro-cracked region was analyzed and evaluated by normalized electrical characteristics extracted from one-sun-illuminated current density-voltage (*J-V*) curves before and after PID stress tests as shown in Fig. 2. The decrease of open circuit voltage (V_{oc}), maximum power (P_{max}), fill factor (*FF*) and, especially, shunt resistance (R_{sh}) revealed that the micro-cracked region acts as PID related shunt [1]. The significant increase of series resistance (R_s) is the evidence to predict that the high concentration of acetic acid from the encapsulant of solar modules and the electrolytic corrosion after PID stress test are other reasons to cause PID at the micro-cacked regions [2]. In particular, the micro-wave photoconductance decay (*μ-PCD*) technique, a promising method for analyzing the micro-cracked related PID shunt defect was used in this report. The mechanism causing PID at the micro-cracked region could be more clarified with minority carrier lifetime and the μ-PCD signal curves as shown in Fig. 3.

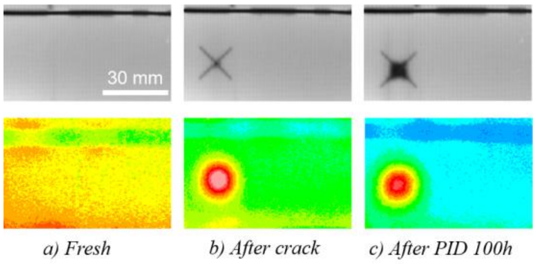

Fig. 1. Micro-crack related PID region

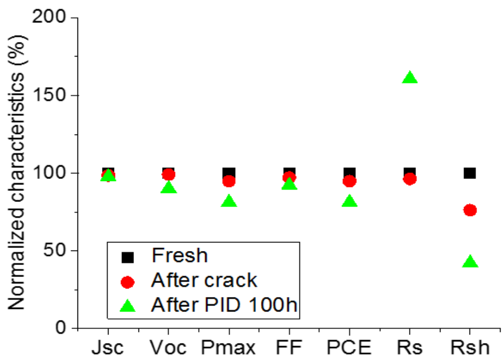

Fig. 2. Local electrical deterioration at the micro-cracked region after PID stress test

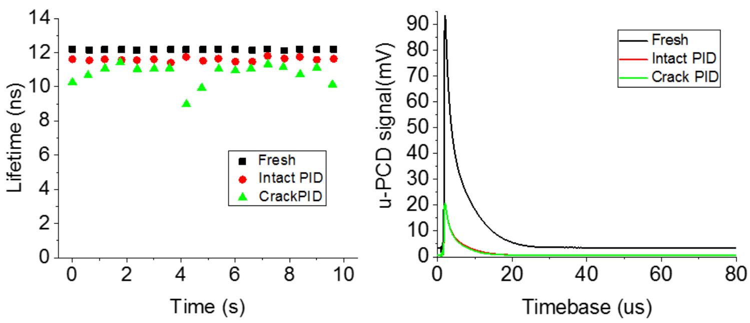

Fig. 3. Minority carrier lifetime and μ-PCD signal curves

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[2] Atsushi Masuda at al., *Japanese Journal of Applied Physics*, vol. 54, pp. 04DR04: 1-5, 2015

