

NEW ACCELERATION TEST FOR PV MODULES SUCH AS BURNS OR INTERCONNECTOR FAILURES

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Introduction

Motivation: Comparing to popular consumer electronics, longer lifetime and bigger size as sample make it difficult to estimate its lifetime; we have to develop the special lifetime evaluation technique for PV-modules.

Target: Interconnector failure and surroundings.

Goal: To develop new test method which evaluates PV module life in 30yrs over.

Conclusion

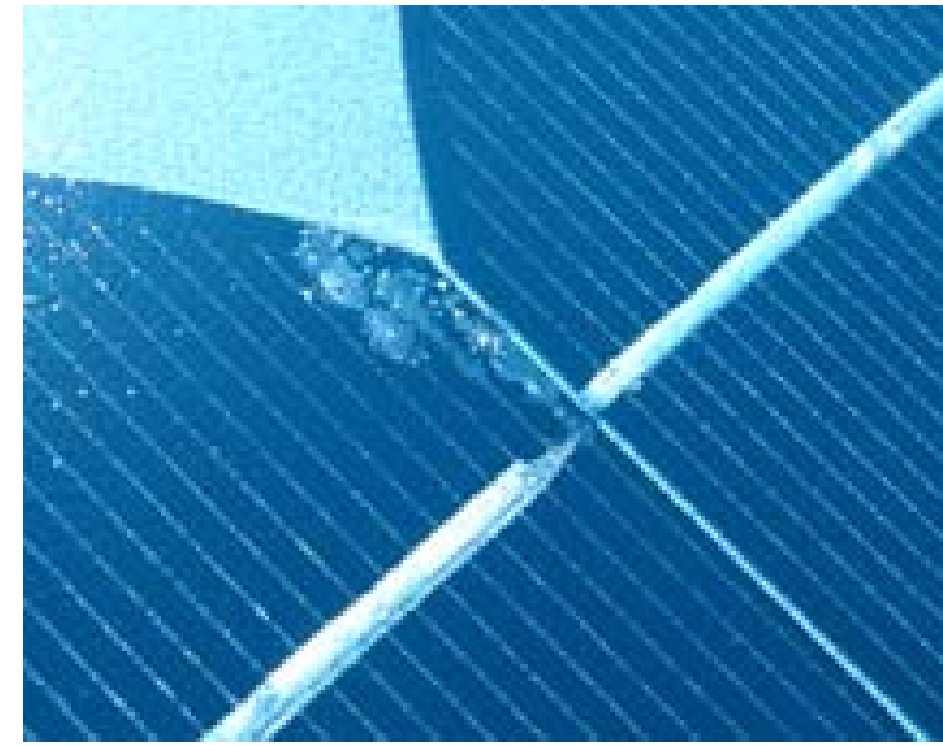
- ☆ Phenomena having analogies to the failure in the outdoor PV modules is observed.
 - ☆ Confirm the possibility of cyclic test.
 - ☆ Proposal of new acceleration method to PV module deterioration such as cell burn or interconnector failure.
- Future tasks: Expansion to full size modules, then study whether it is applicable to acceleration test.

Materials and Methods

Failures of PV modules



burnt edge of cell



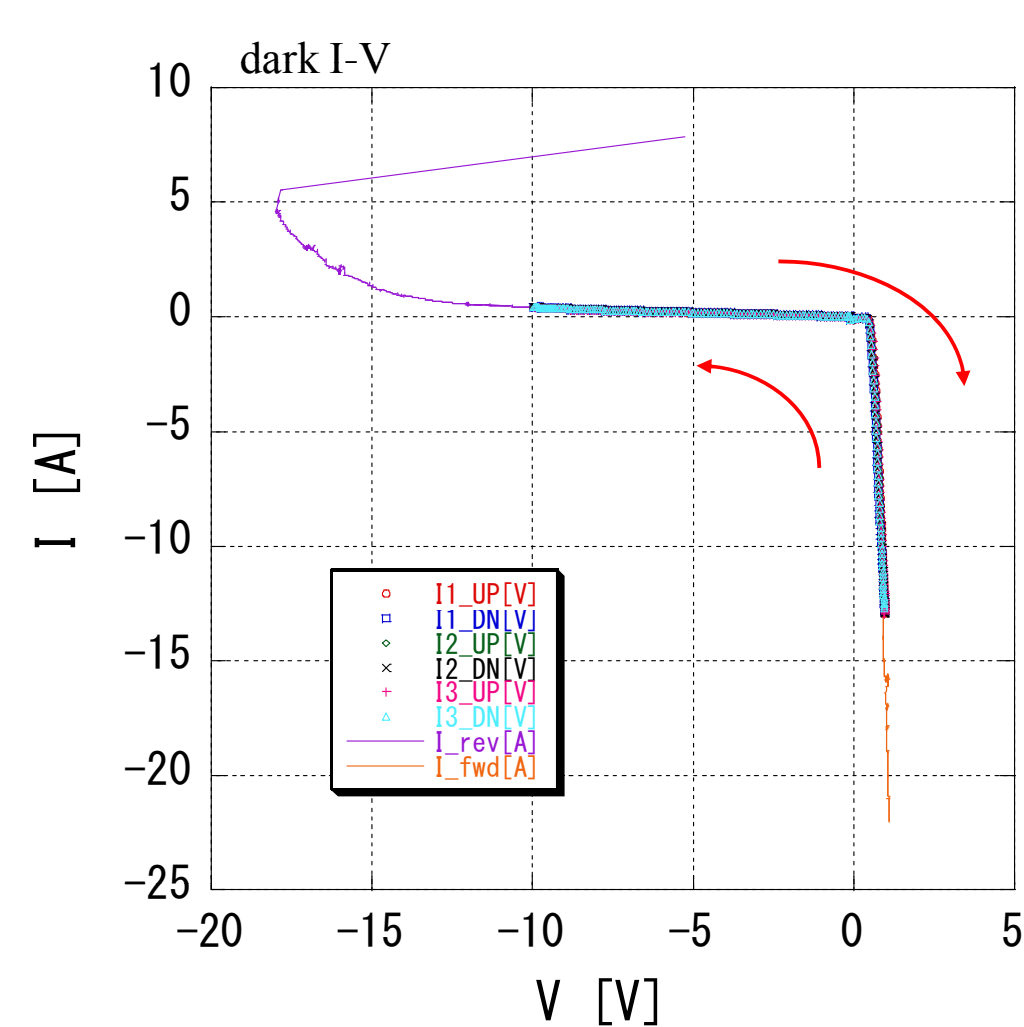
bubbles in EVA



burnt back sheet

These phenomena are observed in the AIST's mega solar system in 2009. It is a grid-connected system and has been operating since 2004. How do you think about these failures occurred within 5 years operation. I wonder why these failures occur and how to simulate this in acceleration test.

Proposal: concept of cyclic test



Supposing acceleration test: periodically changing (=cyclic) voltage, forward and reverse

Goal = No breakdown test!

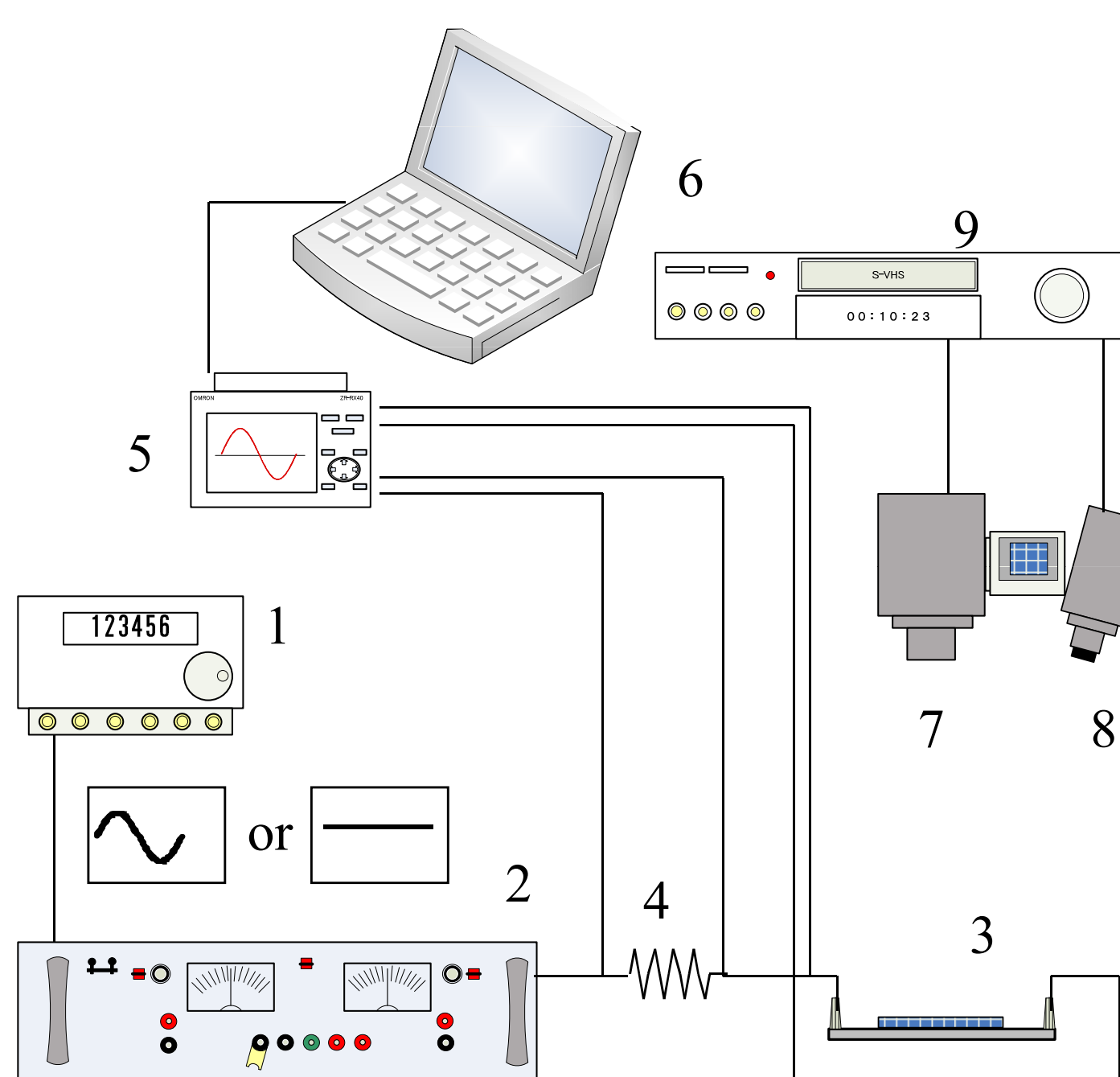
As the first step;

- reverse biased breakdown test
- wave voltage cyclic test

Samples: Single-cell PV modules

We intend to add cyclic voltage indicated in light blue curve.

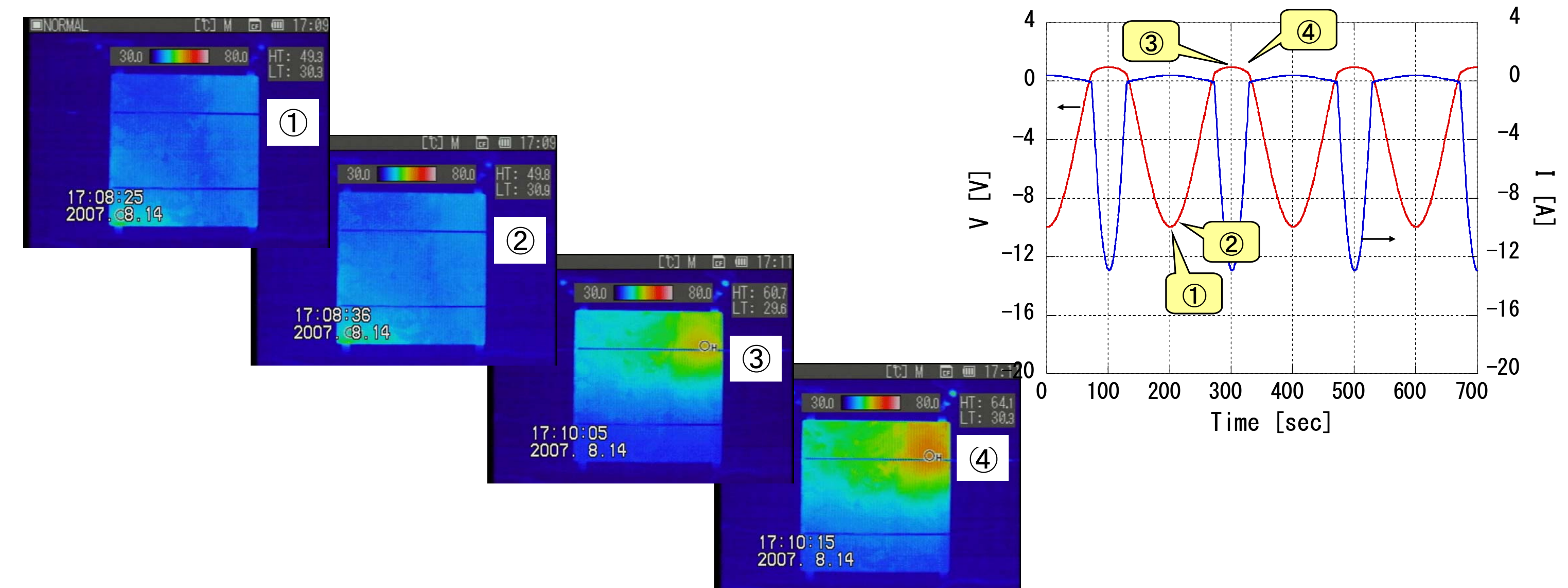
Experimental apparatus



- 1: DC or wave voltage source
- 2: Bipolar power supply
- 3: PV cell and sample stage
- 4: Resistance
- 5: Data logger
- 6: PC
- 7: IR thermographic camera
- 8: Visible Ray camera
- 9: Videocassette recorder

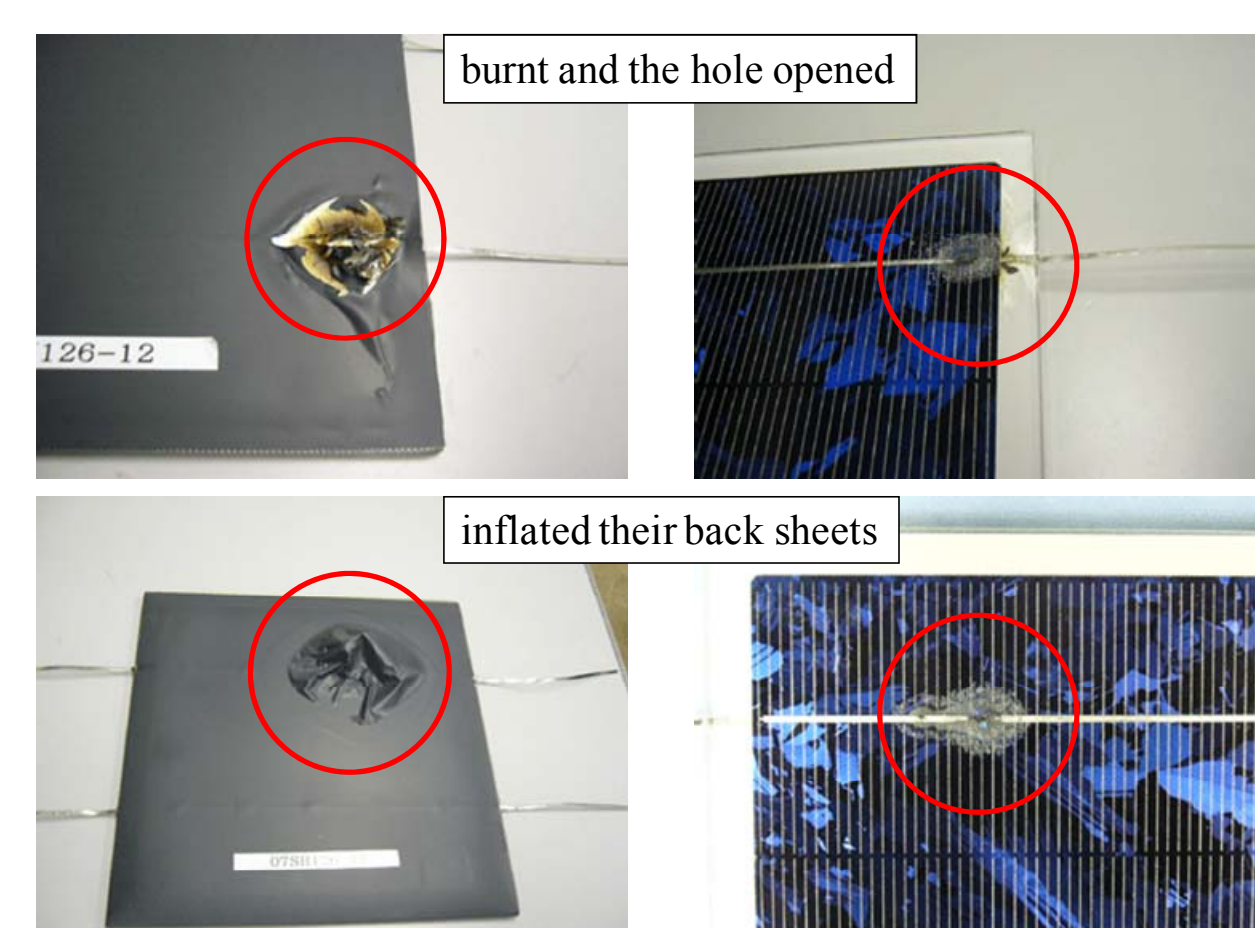
Results

Wave voltage cyclic test



Right graph shows the time changes of voltage and current. Red line is voltage and blue line is current. The numbers in pictures are corresponding to the same number in the graph. There are 4 points of two peaks of the voltage and two peaks of the temperature. It was observed that the peak of temperature delays 7 to 11 seconds from the peak of voltage. You can see the warm area is different according to the direction of the voltage. This is the skeleton of proposed method.

Reverse biased breakdown test

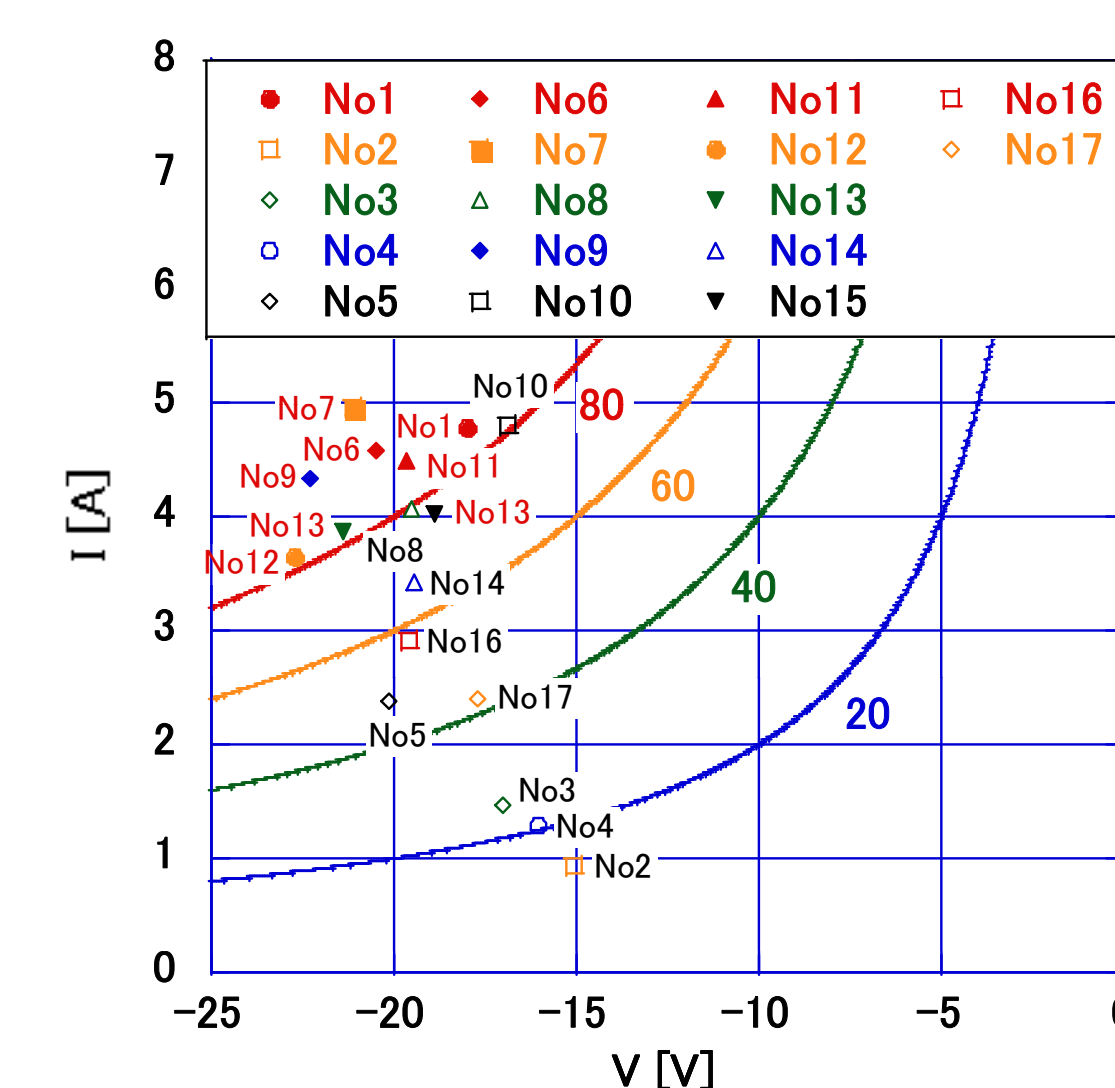


We used two type of EVA, that is, EVA-A and EVA-B. This breakdown test is so-called destructive test.

At the moment of the destruction, each sample group using different EVA has the following characters; all test samples of the EVA-A burnt and the hole opened (4 of 4), on the other hand, as for the EVA-B, 3 test samples inflated their back sheets and burst (3 of 5), one test sample burnt and the hole opened and one test sample only blew smoke out because the breakdown occurred at the edge of the single-cell module.

Phenomena having analogies to the failure in the outdoor PV modules

Wave voltage cyclic test



- * Contour line indicates the level of power stress : S [w]
- * Filled marks : breakdown occurred in certain experiment duration
- * Open marks: breakdown not occurred in certain experiment duration
- * V for forward was fixed at 0.6 [V].
- * V for reverse was adjusted as the power stress S [W].

It was found that there are certain threshold levels around 80 watt for whether the breakdown breakage occurs or not.

From the IV measurement after the experiment, degraded samples had increased series resistance.

Proposed method is useful for new acceleration test to the cell and interconnector failure.

Acknowledgments

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