INFLUENCE OF LARGE PERIODS OF DC CURRENT INJECTION IN C-SI PHOTOVOLTAIC PANELS

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ABSTRACT: Nowadays, electroluminescence imaging (Eli) appears as an emerging technique in the maintenance of photovoltaic (PV) plants. There is a concern about how the current injection needed in ELi measurements can affect the PV modules service life, and how these periodical inspections can affect the long term life of the modules. In order to give a practical answer to this problem, a series of tests consisting of long periods of current injection on several monocrystalline silicon modules has been carried out. The modules tested had already fulfilled their useful life and present multiple defects. In order to analyze how the current injection affects the state of the module, images of infrared thermography (IRT) and ELi were acquired during the current injection period. The subsequent analysis of these images shows only a small effect during the heating period in the EL intensity results at the beginning of each test, not affecting the module performance.
Keywords: Electroluminescence, photovoltaic thermography, photovoltaic current injection.

1 INTRODUCTION

In recent years, electroluminescence imaging (ELi) has become a powerful diagnostic tool to evaluate photovoltaic (PV) panels. EL images allow to detect several defects and degradation modes in the solar cells (PID, snail-trails, inactive cells, cracks, etc.), making of this technique a powerful tool for the predictive maintenance of photovoltaic plants. The cell failures are observed as dark contrasted areas in the images [1] [2].

2 MATERIALS AND METHOD

We have checked the effect of the current injection in the state of the modules by analyzing the results obtained on different panels. The modules tested are mono crystalline, from two different manufacturers (EOPLLY and TYNSOLAR), and present different kinds of defects. Their nominal parameters are presented in Table 1. All the measurements have been carried out in a dark chamber (Fig. 1), with controlled temperature and humidity conditions.

Table I: Standing waves ratio

Model	Power (W)	Type	Cells	V_{oc} (V)	V_{mpp} (V)	I_{sc} (A)	I_{mpp} (A)
Tynsolar	175	Mono	72	43,99	36,72	5,17	4,77
Eoplly	175	Mono	72	44,35	36,26	5,45	4,83

Figure 1: Temperature and humidity controlled chamber at the EIFAB in Soria, Spain.

Inside the dark chamber, each module has been continuously biased (using a laboratory source) giving a current equivalent to its short circuit current, during more than 72 hours. The EL images are captured with a pco. 1300 Solar camera, every 30 minutes, with an exposure of 5,000 ms. Thermal images have been captured with a Workswell Wiris Pro camera every minute, with a 640x512 pixels resolution, a thermal sensitivity of 0.05ºC and an accuracy of ±2 % o ±2 °C.

3 RESULTS AND DISCUSSION

Electroluminescence and IRT images were acquired in the same module (Tynsolar) in order to analyze the effect of the current injection (during 96 hours). IRT images (taken every minute), with low resolution, were only used to observe the evolution of the module's temperature. On the other hand, ELi images (taken every half an hour), with a high resolution, allow to observe dark contrasted areas associated with defects in good detail [3][4][5].

In this way, the possible evolution of the defective areas with the injection current was analyzed by the inspection of the EL images. Fig. 2 shows the EL images of the module taken before and after 96 h of Isc current injection. As observed, it is impossible to detect, by a visual inspection of the images, any change in the module. For this reason, a detailed inspection of the EL and IRT images was performed. The mean values of the EL and IRT intensity over the full images were calculated, Fig. 3. For a better understanding of the results, the current injection was switched off after 24 h, allowing the module to be cooled, after which the current injection was reestablished for a total time of 96 h.

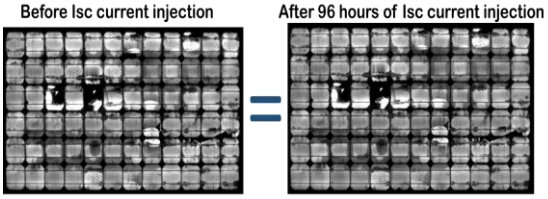

Figure 2: EL images taken before (a) and after 96 h of

Isc current injection of the module (b).

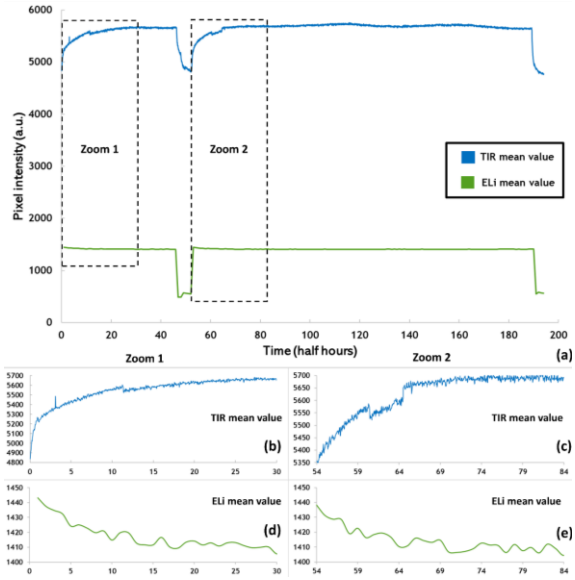

Figure 3: Evolution of the IRT and EL mean value intensities with the current injection in the module (a). Detailed evolution after the initial current injection in two periods are depicted in (b-e).

The mean value obtained from the IRT images shows an initial increase followed by a stabilization. Once the current injection is stopped the IRT mean value drops down, recovering the initial value, followed by the rise and stabilization sequence once the current injection is restored. Thus, the IRT mean value is directly correlated to the temperature of the module, which changes in the first hours of the current injection, reaching a stabilization value. On the other hand, the EL mean value also changes in the firsts hours of the current injection (as observed in Fig. 4 d and e), showing a total correlation with the changes in the average temperature of the module. A slight decrease in the EL intensity is observed with the increase of temperature. It is worthnoting that the change in the EL mean value intensity is only of the order of 2%.

In order to corroborate this behavior, several modules were tested. The EL mean value intensity is plotted versus the time, for long current injection periods (of 72 h), Fig. 4. A similar behavior to that previously described is always observed, with a very slight decrease (lower than 3.5%) of the EL intensity during the first 10-15 hours, reaching then the stabilization.

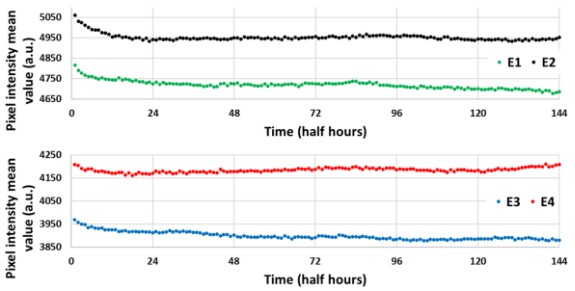

Figure 4: Evolution of the EL mean value intensity with the current injection in four different modules.

In this way, the only change in the EL image is a very slight decrease of the EL mean value intensity, which is due to a thermal effect as demonstrated by its with the IRT data rather than a degradation effect. This effect disappears once the current injection is switched-off. It should be taken into account that the EL inspection of a module is very fast, taken only a few minutes, therefore, the current injection of the module necessary to perform the EL inspections is appears innocuous for the module.

4 CONCLUSIONS

In the tests carried out in this work it is not appreciated that the current injection in ELi measurements has any negative effect on the performance of damaged modules.

On the other hand, it has been observed a direct relationship between the heating of the module and the decrease of the electroluminescence signal. Furthermore, that decrease is very small (≤3.5%) and stops when the module temperature stabilizes.

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