Qualitative analysis of daylight photoluminescence imaging compared to daylight electroluminescence imaging

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Introduction

Photoluminescence and electroluminescence imaging (PLi/ELi) allow to carry out in-situ maintenance actions on photovoltaic modules even under high levels of solar Irradiation.

Daylight PLi

- Uses sun light as the excitation source.
- The excitation light reaches all areas of the module.
- Needs high radiation levels (>800 W/m^2).

Daylight ELi

- Excitation is done by directly biasing the modules.
- The injected current do not reach isolated areas of the module.
- It can be carried out under any level of background radiation.

Daylight ELi and PLi reveal dark contrasted areas, The non carrier recombination reduces the cell efficiency.

Methods

The set up for PLi measurements is simpler than ELi, by not needing a DC power supply,

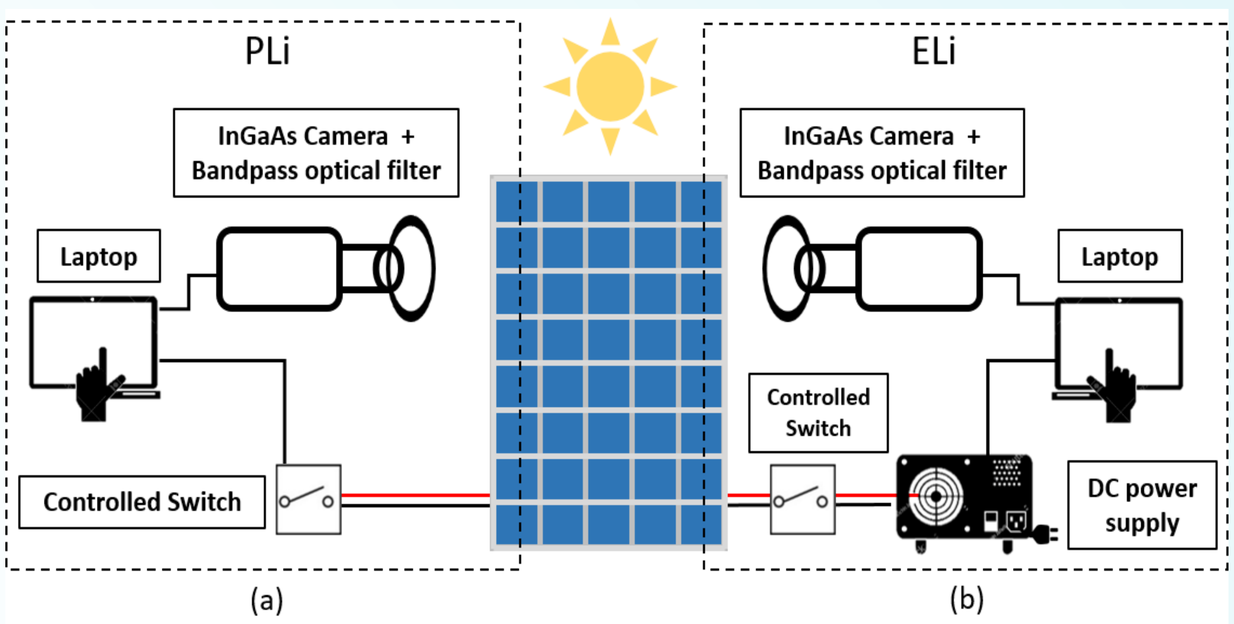

Figure 2. Set up for carried out Daylight PLi measurements (a) and for Daylight ELi measurements (b).

Results II

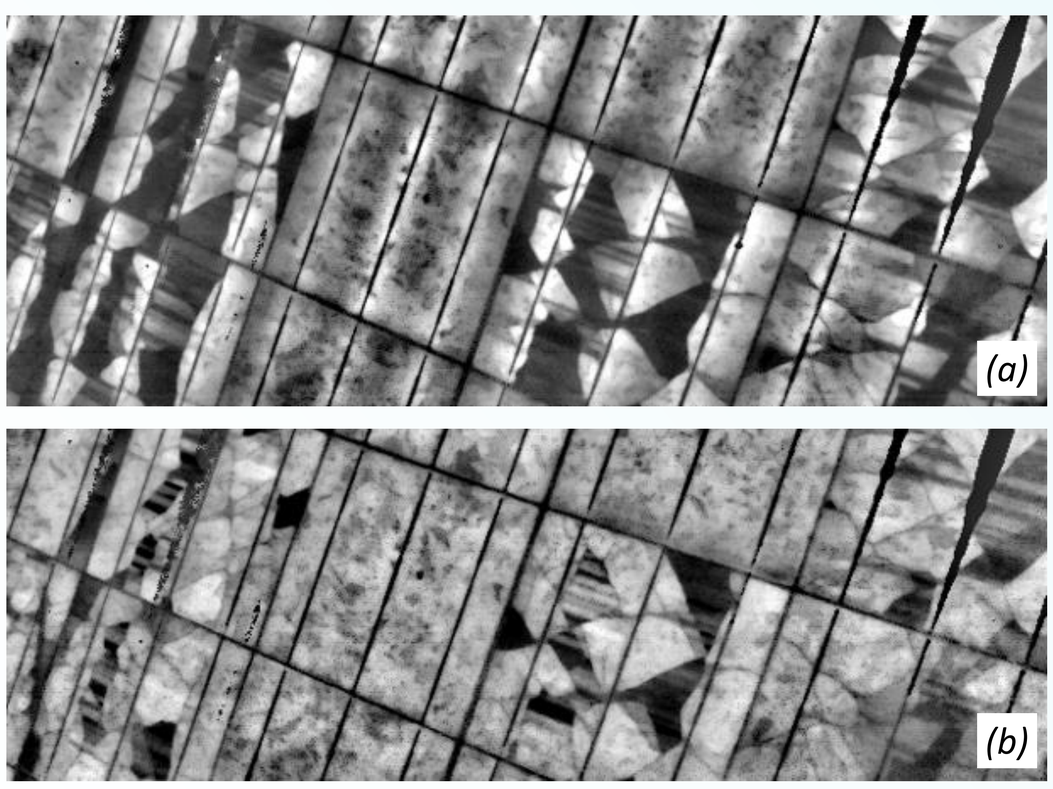

Figure 4. Daylight EL (a) and PL (b) images of some solar cells of a damage module.

EL image, figure 4a, shows some parts of the cells with dark contrast, associated with defective areas.
The PL image, figure 4b, presents contrast differences with respect to the EL image.

Materials

, Several modules were tested. to compare both techniques Those modules had already fulfilled their useful life and present multiple defects.

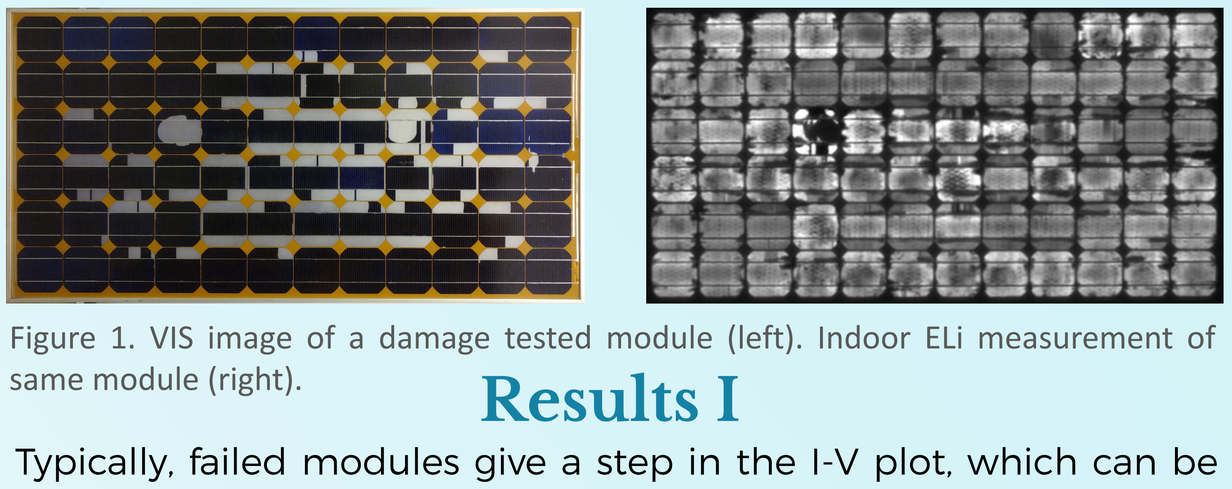

Figure 1. VIS image of a damage tested module (left). Indoor ELi measurement of same module (right).

Results I

Typically, failed modules give a step in the I-V plot, which can be due to either a malfunction of the bypass diode, or the presence of damaged cells in the module (Fig. 3b and 3d)

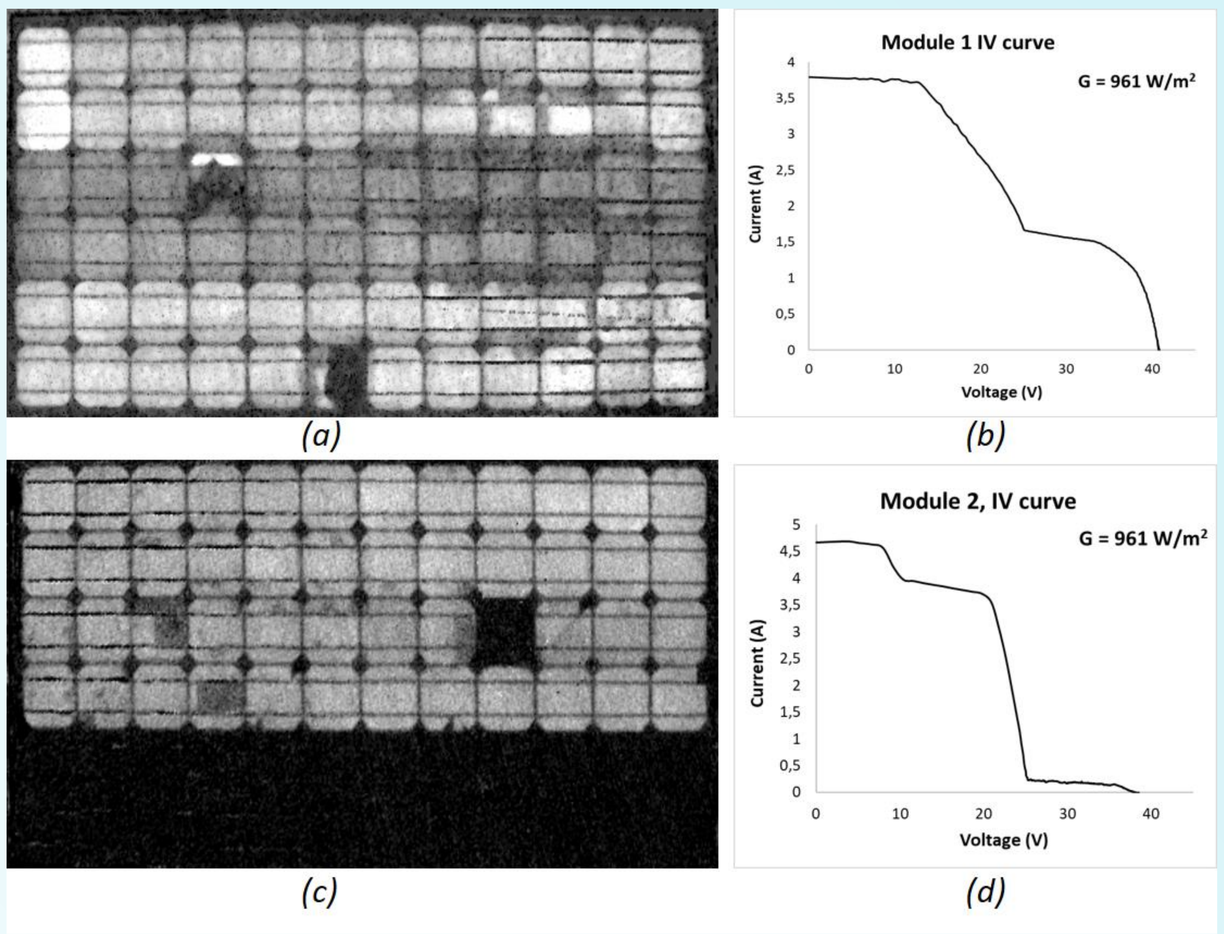

Figure 3. Daylight PL images of two damage modules (a, c), and corresponding I-V curves (b, d).

The partial darkening of the central cell array in Figure 3 corresponds to low performance of these cells. in Figure 3c, the darkening is total, and it means that these cells do not produce energy.

Conclusions

- Daylight PLi measurements allow to test diode failures in PV modules.
- Some of the dark regions in the EL images are not quenched in the PL images.
- The different areas of dark contrast between images of EL and PL are not only due to non-radiative recombination of carriers.
- Dark contrast can also be associated with current leakages that change the carrier distribution during the direct biasing of the cell.

The combination of the EL and PL images can help to elucidate the causes of the module malfunction.

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