

Imaging techniques (1)

oSole is equipped to perform both **on-site and laboratory EL-, UV-F and IR imaging (termography)**.

1. Electro-luminescence (EL)

EL allows detecting defects generally not visible to the human eye, as **cell cracks**. Cell cracks might impact both performance & safety. Cracks may in fact evolve over time to form “**hot spots**” (localized overheating spots), which eventually may endanger the reliability and operational safety of PV panels.

Cracks may be generated by: poor-manufacturing, transport, poor handling, bad installation practices, hail events.

Several **other defects** may be detected by employing EL: poor contact resistances, problems with by-pass diodes, potential-induced degradation (PID), etc.

EL can be performed both at the **module and string level**. The modules/strings must be connected to a generator.

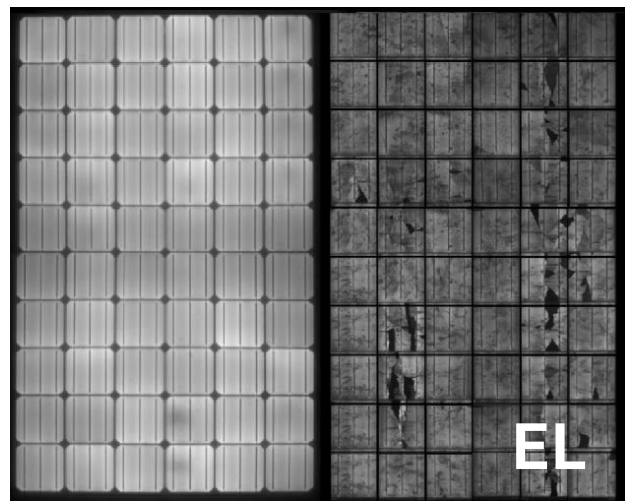
2. UV-Fluorescence (UV-F)

UV-F imaging often provides complementary information to EL, particularly in case of hail events. It also allows detecting cell cracks, as well as delamination (poor adhesion) and accelerated polymer degradation.

It has the advantage that the modules need not being connected to a power source. It requires a UV source.

Both EL and UV-F imaging are performed in the dark.

3. Termography (IR) – see next page >>>



EL



UV-F

AT A GLANCE

CHALLENGES

- Many failures may not be visible to the human eye
- Performance and safety hazards

BENEFITS

- Rapidly detect nonvisible failures
- Classify and prioritize failures
- Restore PV system's performance
- Avoid safety hazards



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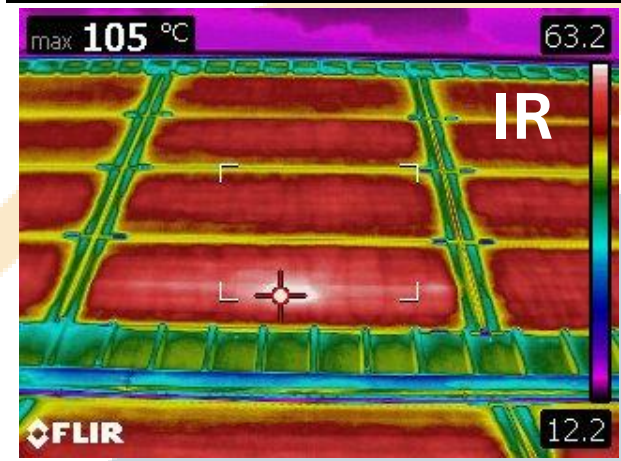
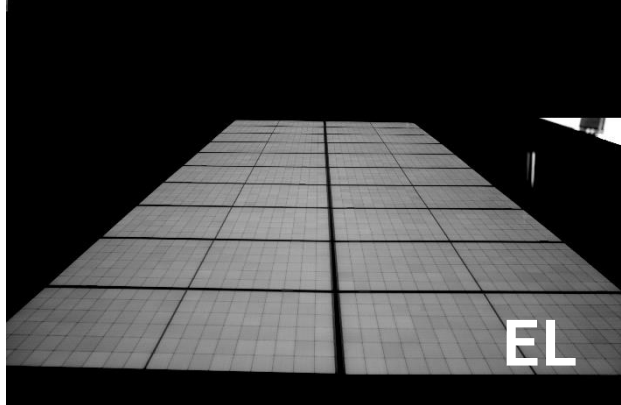
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3. Infra-red (IR) imaging or termography

IR imaging allows detecting temperature anomalies due to the presence, as an example, **of hot-spots, disconnected bypass diodes, or shunted cells**.

It can be performed on-field or indoors on select modules. When the modules are exposed to sunlight no generator is required.

For large ground-mounted or commercial & industrial (C&I) PV plants, IR imaging can be performed assisted **using drones** (UAV: unmanned aerial vehicle).

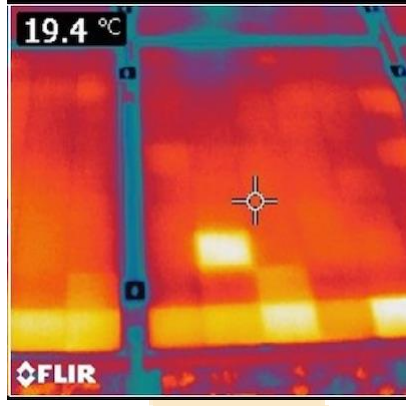
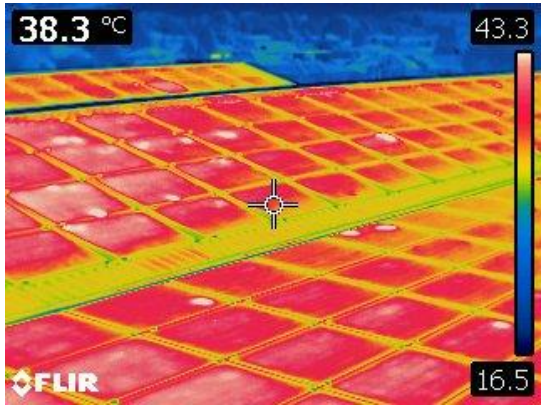


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(a) **Termography image** showing the presence of multiple localized hot-spots (attributed to poor installation practices) and (b) a pattern indicating the presence of PID (potential-induced degradation).



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