



EL Imaging as a Quality Assurance Tool

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Claire Kearns-McCoy



Module Quality Assurance: From Manufacturing to Installation

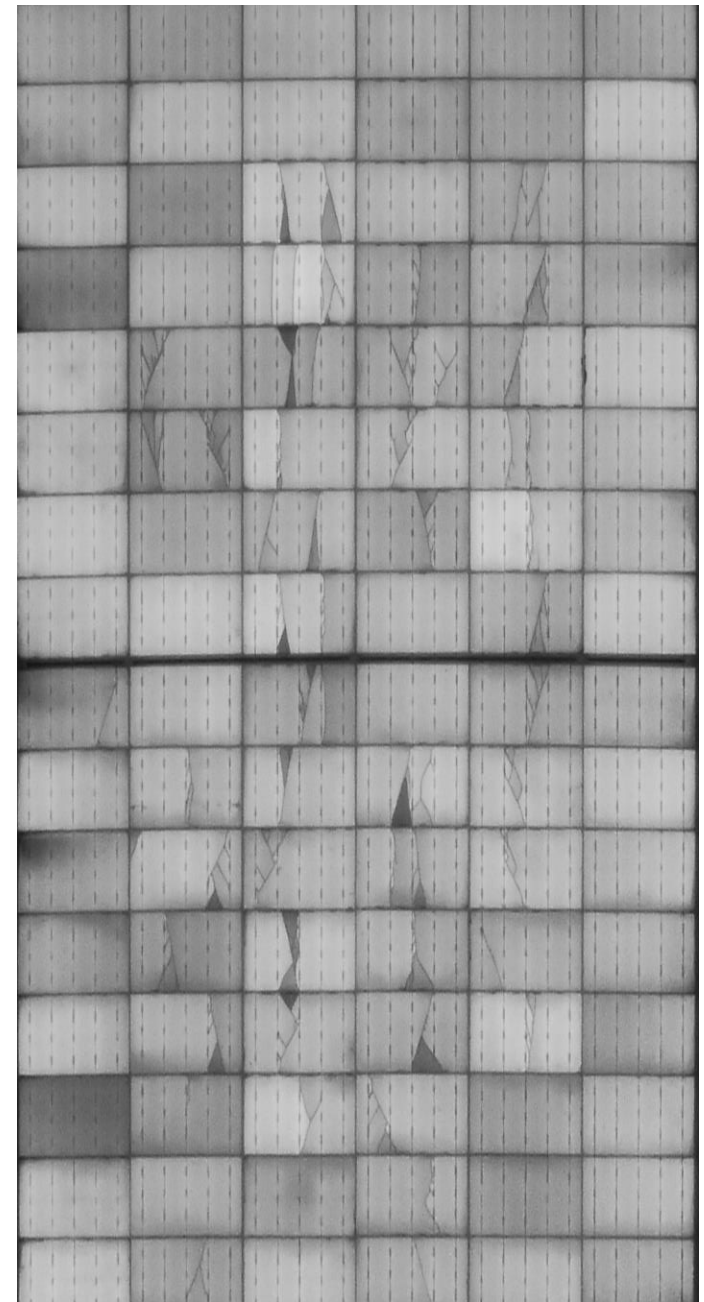
- Module quality is important to prevent plant underperformance
- Quality assurance (QA) is an integral part of the module manufacturing process
 - Manufacturers implement QA programs as part of the manufacturing process
 - Many purchasers choose to add 3rd party QA to augment the manufacturer QA.
- Good manufacturing QA ensures that the modules are in good condition when they leave the factory
- Condition when leaving the factory is not what determines module performance. **Condition after installation is what matters.**
- Currently, less attention is given to assuring module quality after the modules leave the factory, despite the potential for damage to be induced during transportation and installation



Electroluminescence Imaging: Important QA Tool

- Electroluminescence (EL) imaging is a technique which can be used to detect defects that are not visible to the naked eye.
 - This includes defects which will affect performance in the future but are not yet detectable with other methods
- EL imaging is already an integral part of factory quality assurance for modules.

Use of EL in the field can provide quality assurance for the transport and installation of PV modules



Benefits of EL for Field Quality Assurance

- EL imaging can be used to check the quality of the modules between the time that the modules leave the factory and the commissioning of the site
- The benefits of EL for field QA are similar to the use of EL for factory QA
 - Gives reassurance that modules have not been damaged
 - It is easier to remove and replace defective modules the earlier they are detected
 - Multiple steps of field EL allow the cause of the damage to be determined and remedied, preventing damage to additional modules

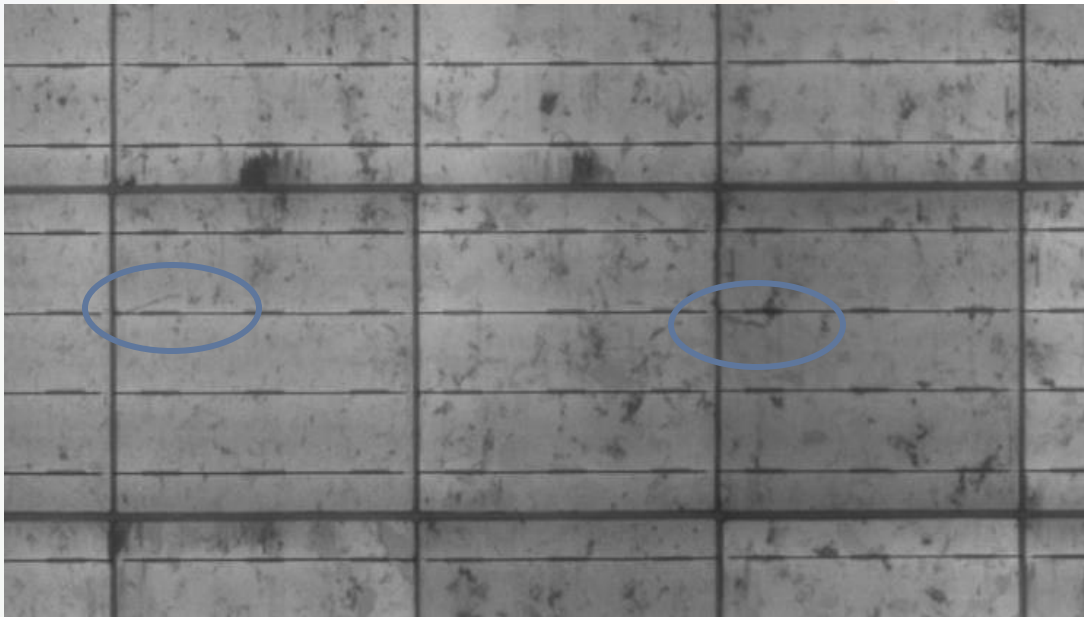


Transportation/Shipping Modules: What Are the Risks?

- Pallets of modules are handled multiple times between packaging and reaching the project
 - Each handling has a risk of damage to the modules
- Modules are also exposed to vibration and thermal stresses during transportation

Most common module damage during transportation

- Formation of new microcracks
- Growth and/or opening of existing microcracks
- Glass breakage
- Frame Damage



Factor in the

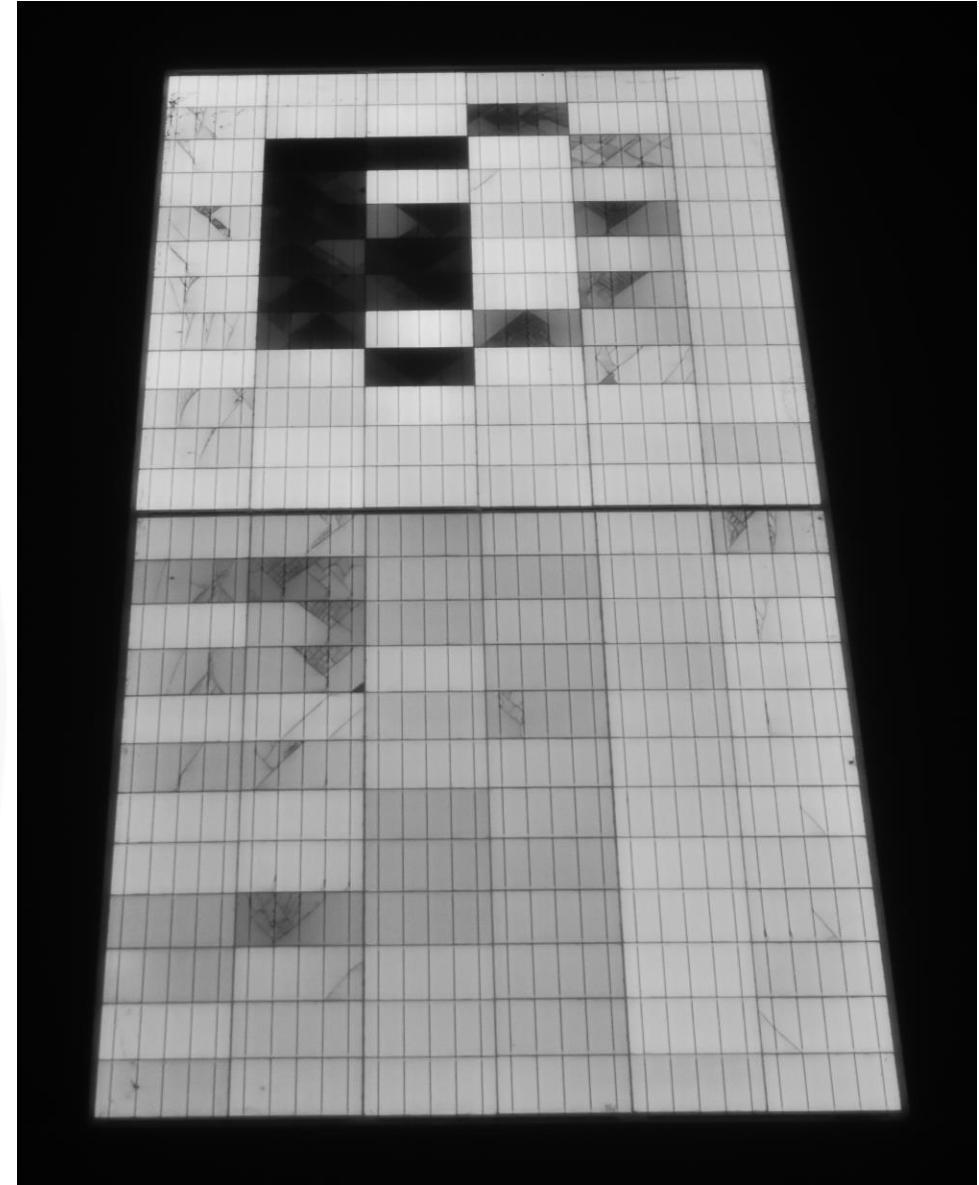
EL Imaging Can Detect Module Damage Caused in Transportation

- There are many opportunities to assure quality during transportation including validating the following
 - Selection of packaging
 - Container loading procedures
 - Ground transportation method to the site
 - Unloading of pallets at the site procedure
- Validating that the choice of packaging and procedures are appropriate reduces risk to the modules, but the best way to determine if modules were damaged is through an EL image.



Improper Installation: Leading Cause of Module Damage

- Improper installation procedure is one of the leading causes of poor module condition in new modules.
- Improper installation can result in severe module damage.
- Most common types of installation damage
 - New microcracks
 - New branch cracks
 - Rear impacts
 - Backsheet damage
 - Cell damage
 - Backsheet scratches



Module Installation: How to Prevent Damage

- Crew training and adherence to installation procedures is the best way to prevent installation damage
- Conducting EL on the same modules before and after installation is the best way to conduct quality assurance for installation procedures
 - Allows for the detection of new or worsening damage
- Conducting EL early in the project's installation phase allows procedures and/or training to be remedied before MWs of modules are damaged.
- For large projects, periodic EL checks can be used to ensure quality is consistent as installation occurs across the project.



Benefits of Including EL for Field Quality Assurance

- Identify damaged modules before they are installed
- Identify when damage occurred to modules
- Check the quality of modules after installation and correct installation processes as necessary
- Post-installation testing can serve as a baseline in the event of a severe weather event
 - Establish condition of modules after installation
 - Increase likelihood of successful insurance claim





Thank You

Company: Clean Energy Associates

Website: www.cea3.com

Email: info@cea3.com

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