Fraunhofer
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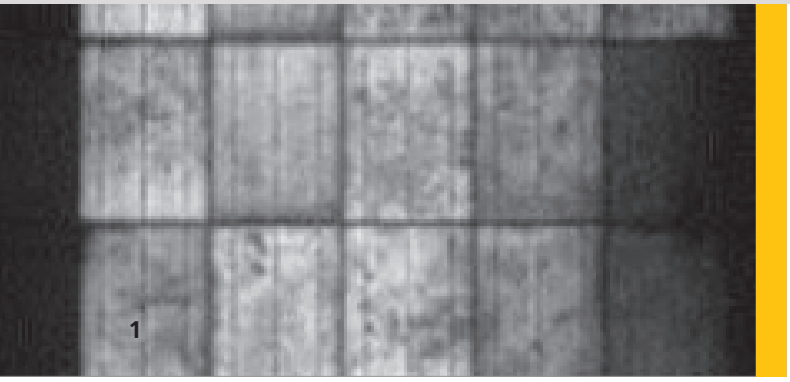
FRAUNHOFER CENTER FOR SILICON PHOTOVOLTAICS CSP



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1 *Electroluminescence image of a solar module suffering from PID-s.*
2 *PIDcon.*

# PID – POTENTIAL INDUCED DEGRADATION

## TESTING – ROOT CAUSE ANALYSIS – CHARACTERIZATION

HUGO JUNKERS PREIS FÜR FORSCHUNG UND INNOVATION AUS SACHSEN-ANHALT 2017 FINALIST INNOVATIVSTE PROJEKTE DER ANGEWANDTEN FORSCHUNG

inter solar award 2015 finalist

### PID Test for Cells and Foils

Since every solar cell has to be resistant to PID, a quick and direct process control is required. For this, Fraunhofer CSP has developed a PID test working on cell level. Based on this development, the PIDcon device by Freiberg Instruments (Freiberg, Germany) is commercially available. With this tool it is possible to test solar cells to PID resistance at low cost. In addition, the PID susceptibility of module components such as polymeric encapsulant foils or glass can be tested.

### Features

- Suitable for PID testing of solar cells or encapsulant materials (polymers, glass)
- Quick PID tests without manufacturing of test modules
- Cells can be inspected after PID-testing without breakage
- Testing temperature freely adjustable
- Safety housing chamber with interlock switches
- Can handle cells and materials up to 8" edge length

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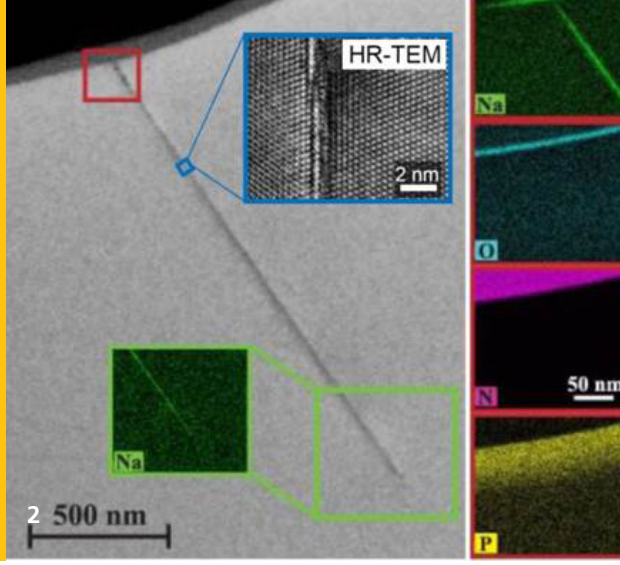


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## PID Test of Modules

In conventional photovoltaic (PV) systems under working conditions, a voltage difference of a few hundred volts between the framing and the solar cells of a module can occur. If the modules/cells are not PID resistant, this can lead to the so called Potential Induced Degradation (PID) effect resulting in yield losses of 20 percent or more.

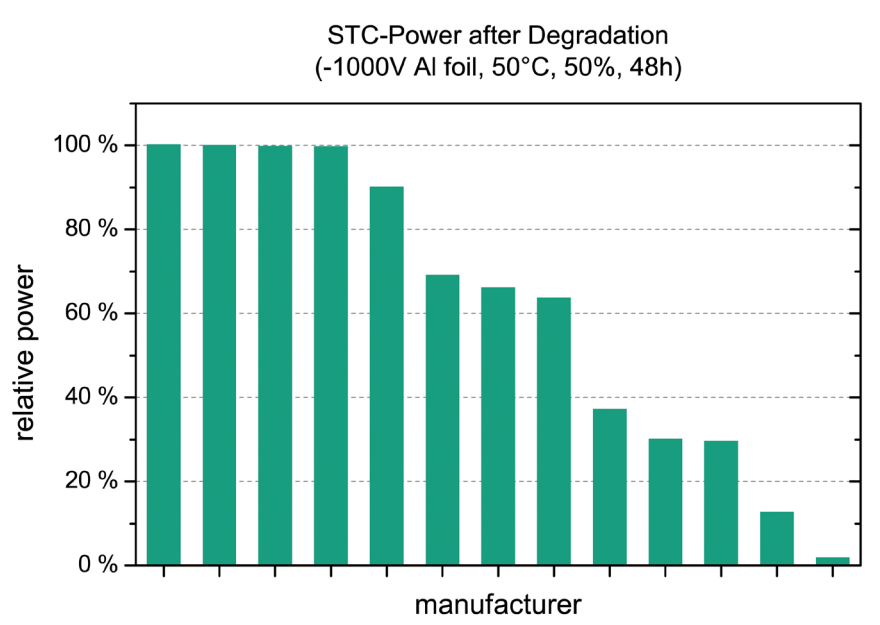
At Fraunhofer CSP accelerated high voltage tests are performed on standard PV module scale as well as on mini-module scale in climate chambers and also for non-encapsulated solar cells.

## PID-s Root Cause Analysis

The physical mechanism of potential-induced degradation with shunting of solar cells (PID-s) remained unclear for a long period. Microstructural investigations on cell level with substantial contributions of Fraunhofer CSP revealed important facts regarding the origin of PID-s. Investigations revealed that stacking faults decorated with sodium cause PID-s. Based on this, a physical model for the shunting mechanism in PID-s affected solar cells is developed.

1 *Experimental setup of the voltage stress test in the climate chamber.*

2 *Transmission electron microscope characterization of a PID shunt in cross section.*




3 *Relative module power at the modules' operating point after the test.*