Research Center for Photovoltaics

連続加速試験によるフレーミング現象の再現

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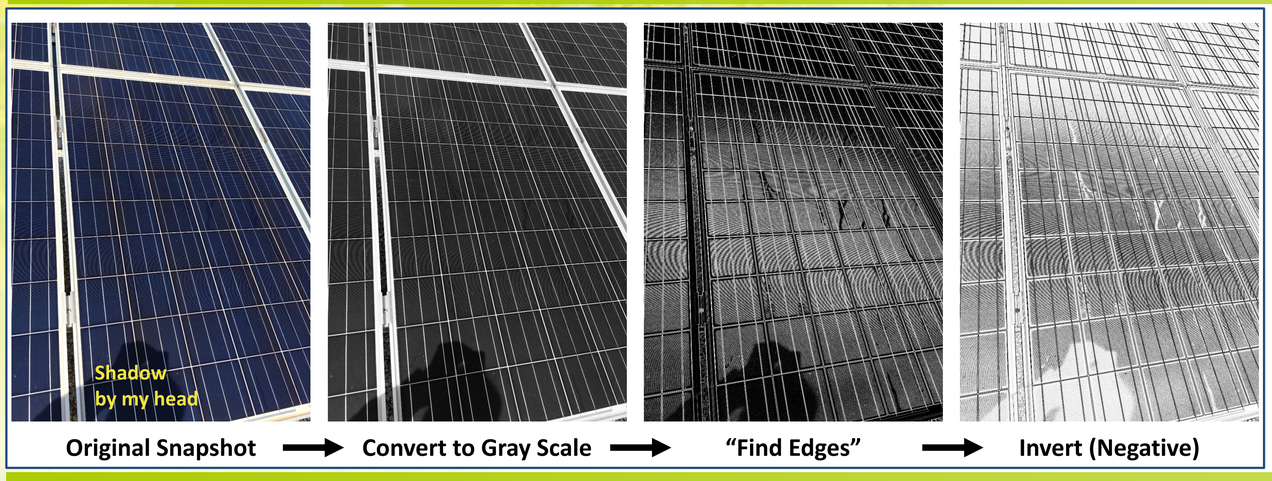
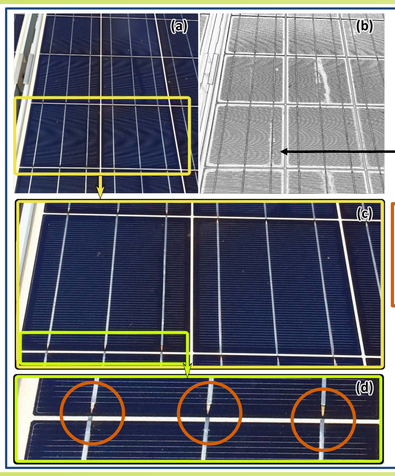
Field Observations



Find Edges:
The edge-detection function to highlight changes in intensity in a gray-scaled image

Framing:
Local discoloration along cell edges

Snail Trail:
Discoloration of front metallization along cell cracks



Cell Crack under busbar

Strong discoloration at the end of the front busbar

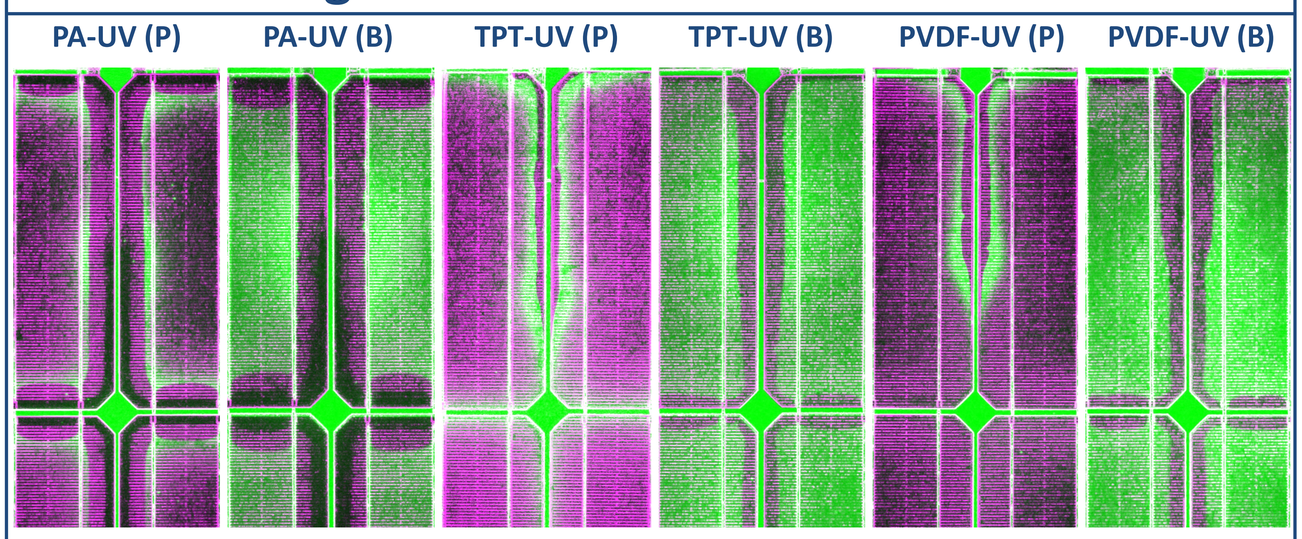
This discoloration is directly involved in the "Framing", not just in a cell crack.

Summary

The **"Framing"** (local discoloration along cell edges) was induced by a simple sequential accelerated stress test (consisting of hygrothermal- and UV-stressors: **Panel 1**) applied to the PV modules with high OTR (oxygen transmission rate) backsheet, irrespective of the inclusion of UV-absorber in poly(ethylene-co-vinyl acetate) (EVA) encapsulant.

UV-fluorescence (UV-FL) imaging of the PV modules suggests that the spatially-inhomogeneous degradation of EVA material under UV-irradiating conditions is correlated to this "Framing" indicating an underlying common mechanism. These findings would contribute to the development of test procedures to broadly mimic the actual failures observed in fielded PV.

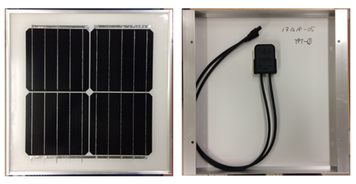
Overlaid Images



Results

Panel 1: Experimental Procedures

(a) Mini-Module with PERC Cells



(c) Sequential Testing

DH Stress (85/85) 1000 h

UV Stress (Xe: 70°C) UV-1

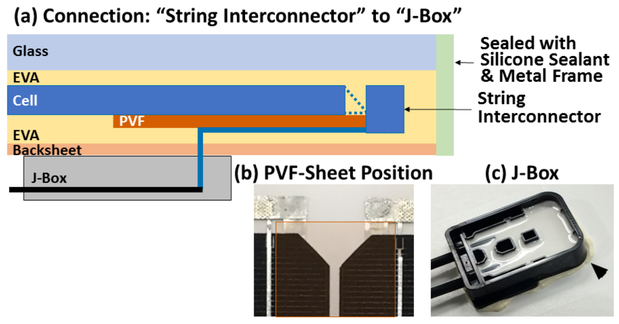
UV Stress (Xe: 70°C) UV-2

UV Stress: 60 kWh/m² x 2 (at 300 – 400 nm)

(b) Matrix of Material Combination

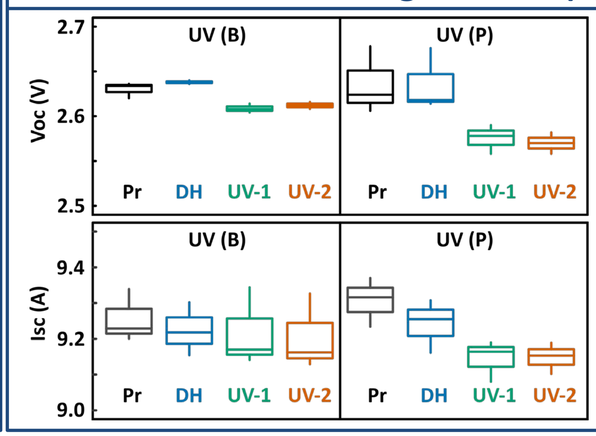
EVA | Backsheet	PA	PVDF	PVF / PET / PVF
- UV absorber	PA-UV (P)	PVDF-UV (P)	TPT-UV (P)
+ UV absorber	PA-UV (B)	PVDF-UV (B)	TPT-UV (B)

Panel 2: Gas/Moisture Protection

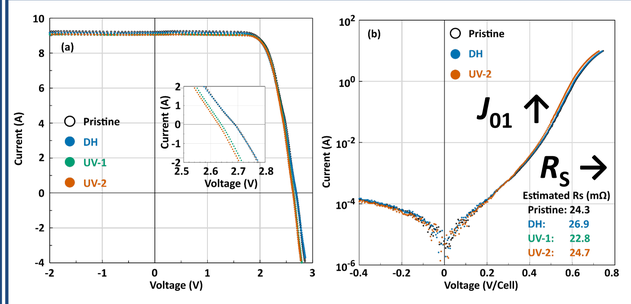


J-Box was glued with a silicone sealant (▲), and a silicone potting agent filled the inside of the J-Box.

Panel 3: UV-induced Degradation (1)



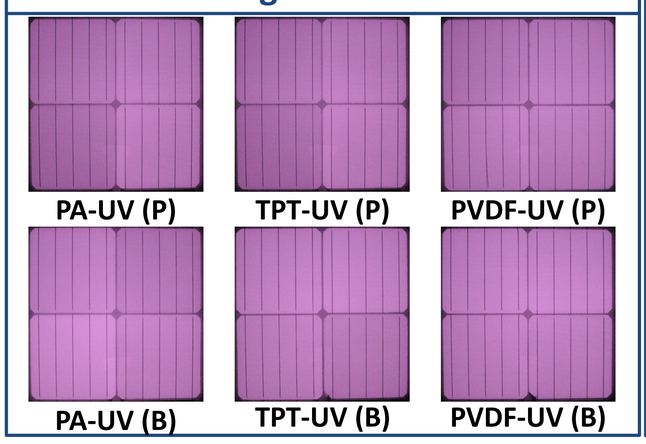
Panel 4: UV-induced Degradation (2)



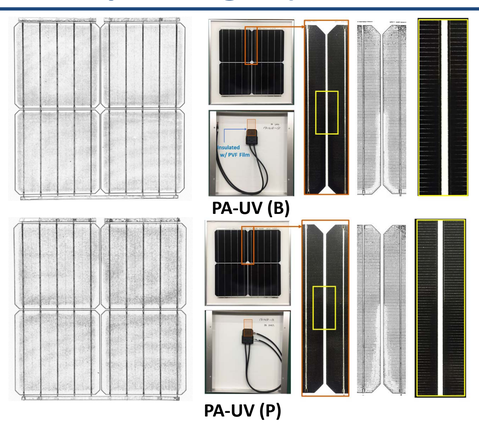
References (UV-induced degradation in p-PERC / n-PERT modules):

R. Witteck *et al.*, *Prog. Photovolt. Res. Appl.*, **25** (6): 409–416, 2017.
R. Witteck *et al.*, *Phys. status solidi - Rapid Res. Lett.*, **11** (8): 1700178, 2017.
F. Ye *et al.*, *Sol. Energy*, **170**: 1009–1015, 2018.

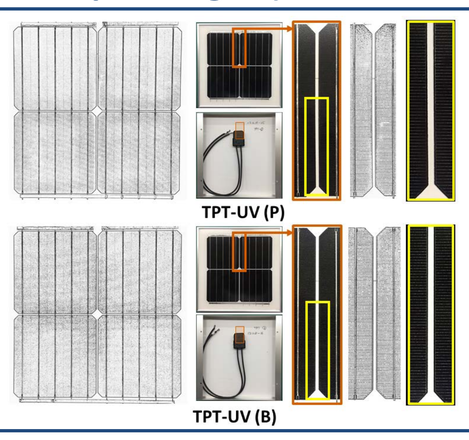
Panel 5: EL Images



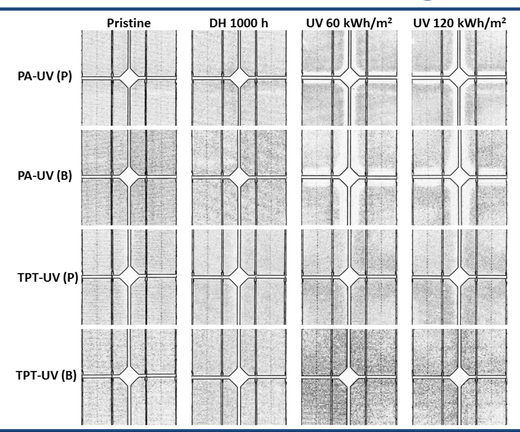
Panel 6: Opt. Images (PA Backsheet)



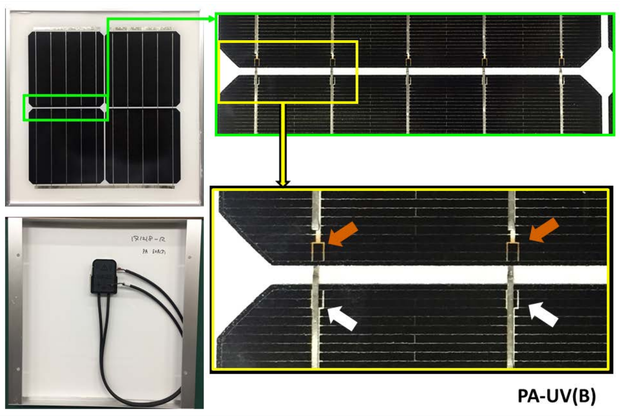
Panel 7: Opt. Images (TPT Backsheet)



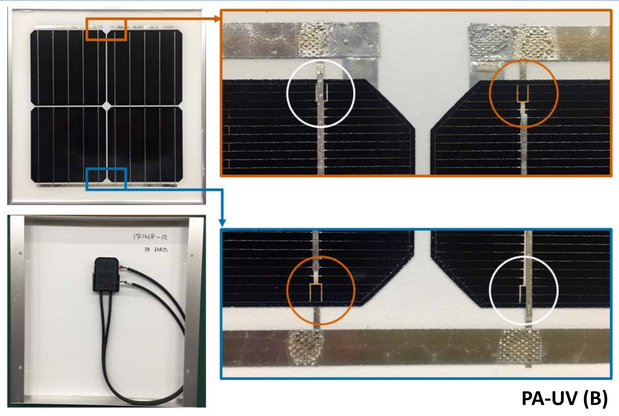
Panel 8: Evolution of Framing



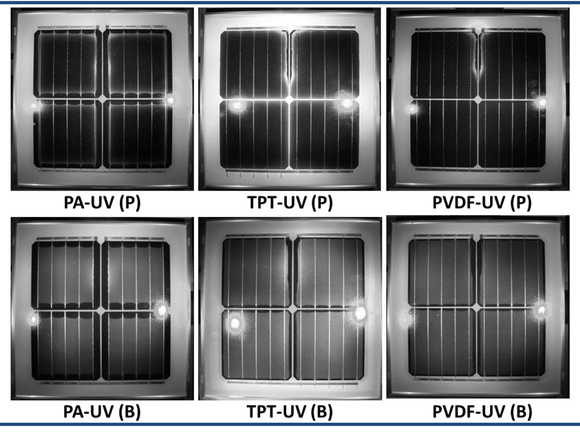
Panel 9: Discoloration (One End of Busbars)



Panel 10: Discoloration (One End of Busbars)



Panel 11: UV-FL Images



Panel 12: Appendix & References

References (Framing / Snail Trail / UV-FL…)

[1] J. Berghold *et al.*, *Proc. 27th Eur. Photovolt. Sol. Energy Conf. Exhib.*, 2012, pp. 3511–3517.
[2] S. Meyer *et al.*, *Energy Procedia*, **38**: 498–505, 2013.
[3] N. Kim *et al.*, *Sol. Energy*, **124**: 153–162, 2016.
[4] J. Fan *et al.*, *Sol. Energy Mater. Sol. Cells*, **164**: 80–86, 2017.
[5] I. Duerr *et al.*, *Energy Procedia*, **98**: 74–85, 2016.
[6] J. C. Schlothauer *et al.*, *Sol. Energy Mater. Sol. Cells*, **159**: 307–317, 2017.
[7] G. C. Eder *et al.*, *Energies*, **11** (5): 1053, 2018.

G. Oreski *et al.*, *Polym. Test.*, **60**: 374–380, 2017.

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