

PERFORMANCE LOSSES OF PV-MODULES CAUSED BY CLEANING AGENTS

Benchmark of commercially available cleaning agents

Dr. Charlotte Pfau and Dr. Marko Turek
Contact: charlotte.pfau@csp.fraunhofer.de

PERFORMANCE LOSSES OF PV-MODULES DUE TO CLEANING AGENTS

Test procedure for benchmark

Material compatibility test using corrosion testing standards:

- Accelerated exposure tests of industrial solar glass with anti-reflective coating (ARC)
- Exposure / wetting time of 24 h at temperature 55°C

Six different PV cleaning agents investigated:

- Five commercially available cleaning agents in application concentration
- Pure DI-water as reference

Quantification of performances losses:

- Optical transmission spectroscopy: Quantification of optical performance
- Light microscopy after exposure: Imaging damages



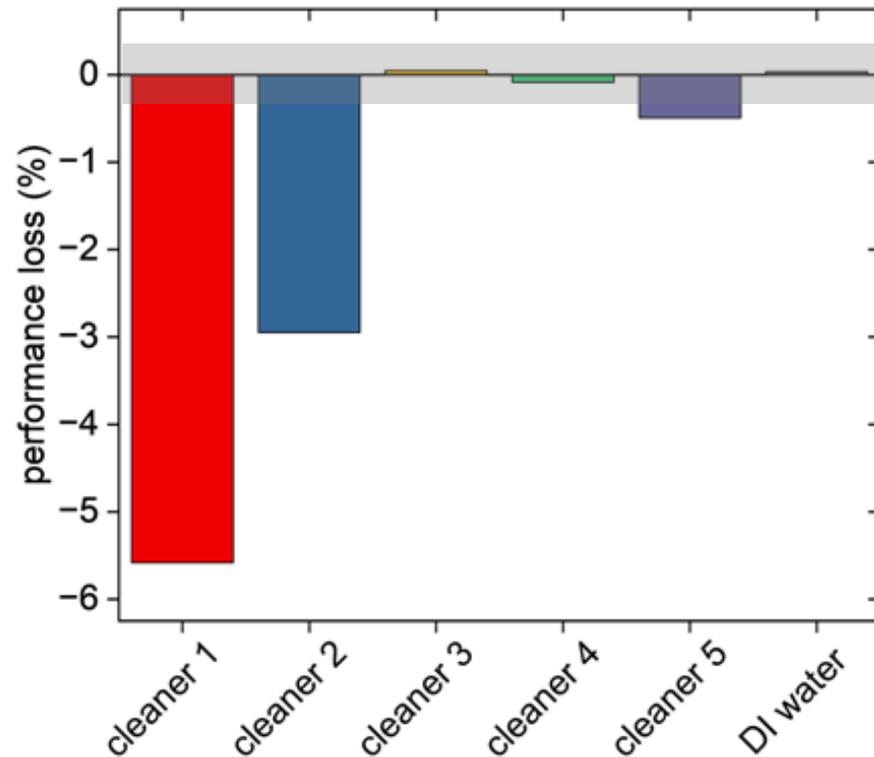
PV module cleaning

(symbolic image, <https://can-solar.de/>)

PERFORMANCE LOSSES OF PV-MODULES DUE TO CLEANING AGENTS

Cleaning agents can cause significant damages and performance losses

Severe surface damages resulting in losses up to 5.6% for some cleaners while others cause no losses

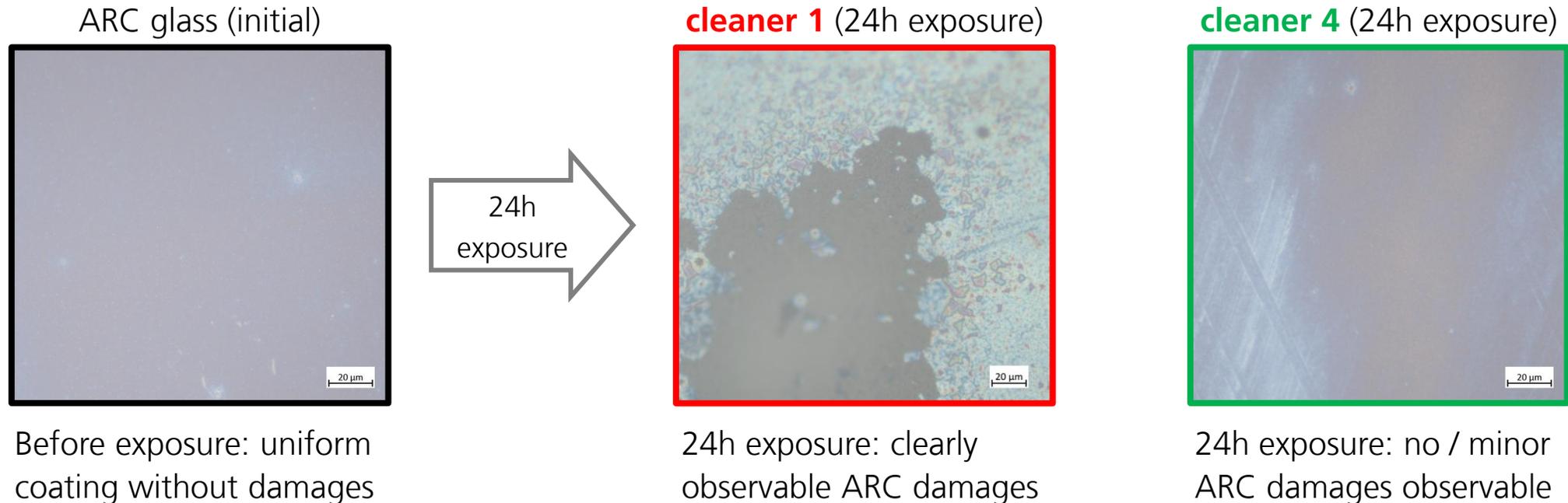


- **Approach:** Quantification of optical performance losses by calculation of solar cells' current before and after exposure for each cleaner using optical transmittance data
- **Results:**
 - Half of tested cleaning agents cause significant performance losses of ARC-glass (cleaning agents **1**, **2** and **5**)
 - Other half of cleaning agents do not cause significant losses (cleaning agents **3** and **4** with pure **DI water** as reference)

PERFORMANCE LOSSES OF PV-MODULES DUE TO CLEANING AGENTS

Cleaning agents can cause significant damages and performance losses

Microscopy images of ARC glasses before and after exposure show ARC degradation due to agents



PERFORMANCE LOSSES OF PV-MODULES DUE TO CLEANING AGENTS

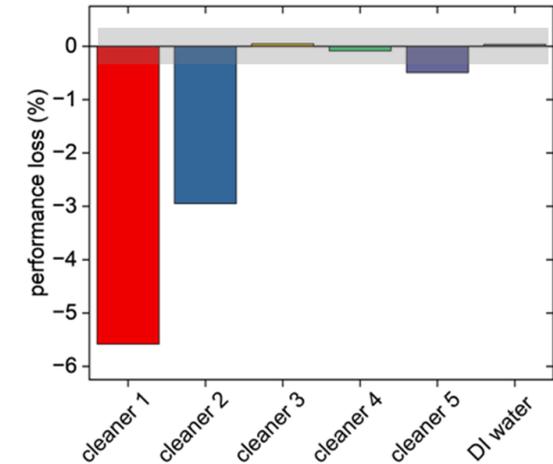
Summary

Key results:

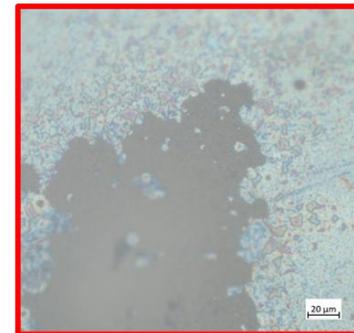
- Benchmark of five PV cleaning agents and DI-water as reference
- Three out of five cleaners cause significant performance losses
- Two cleaners cause no losses (comparable to DI-water)
- Microscopy shows ARC-degradation as cause for performance losses

FHG CSP services:

- Test of existing cleaning agents
- Development support for new products (cleaning agents, coatings)
- Comparison of cleaners to already tested products



cleaner 1 (24h exposure)



cleaner 4 (24h exposure)



Contact

—

Dr. Charlotte Pfau
Diagnostics and Metrology
Phone +49 345 5589-5217
Fax +49 3455589-5999
charlotte.pfau@csp.fraunhofer.de

Fraunhofer CSP
Otto-Eißfeldt-Str. 12
06120 Halle (Saale)
www.csp.fraunhofer.de