PERFORMANCE LOSSES OF PV-MODULES CAUSED BY CLEANING AGENTS

Benchmark of commercially available cleaning agents

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PERFORMANCE LOSSES OF PV-MODULES DUE TO CLEANING AGENTS

Test procedure for benchmark

Six different PV cleaning agents investigated:

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

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

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/)

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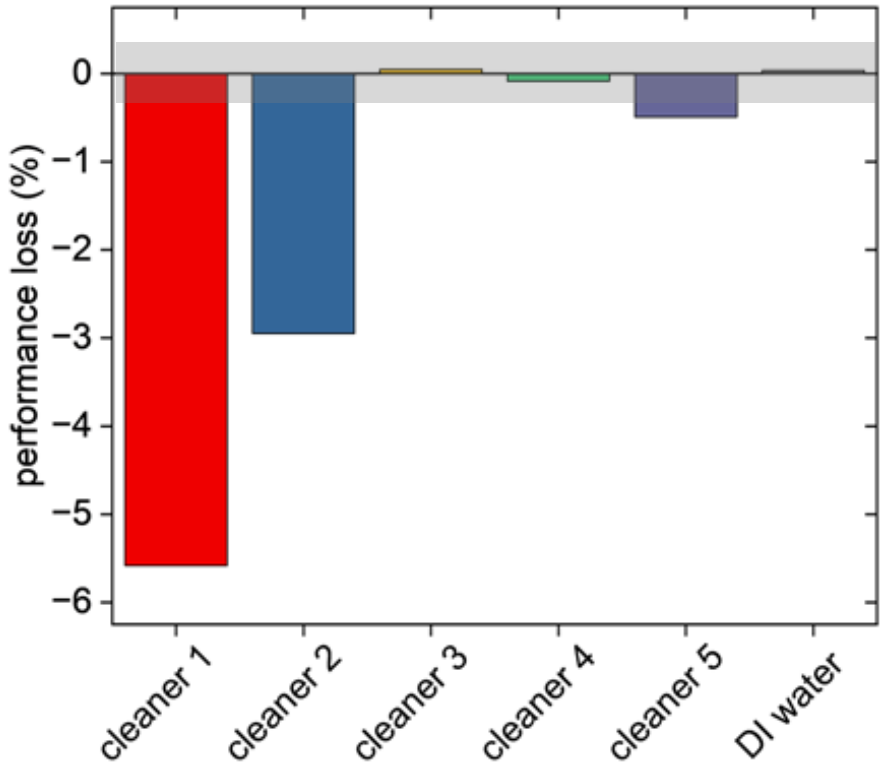
Cleaning agents can cause significant damages and performance losses

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 significnat losses (cleaning agents **3** and **4** with pure **DI water** as reference)

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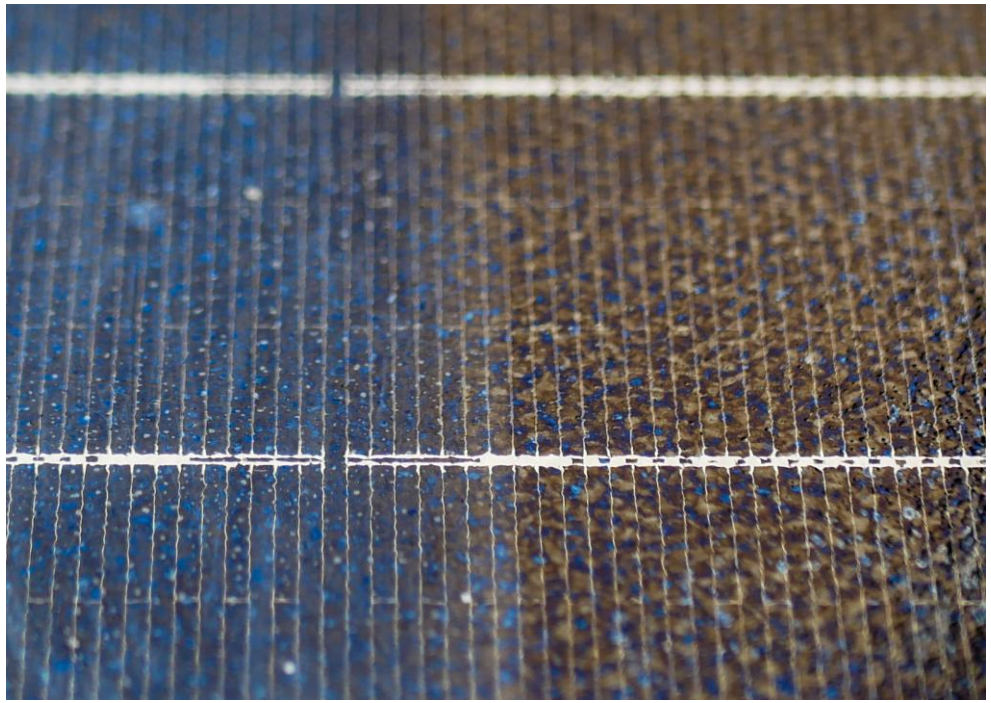
Cleaning agents can cause significant damages and performance losses

The exposure can lead to visible ARC degradation due to agents



- **Change in appearance**: The damage of the ARC coating becomes visible, when only on part of a glass is tested. The cleaning solution leads to a loss of performance of the ARC which is also reflected in a different color being sometimes visible even by bare eye.

Photograph of an ARC glass that was partially exposed to a cleaning solution that causes a performance loss. On the right side (exposed part of the glass) the damage of the ARC coating is clearly visible.

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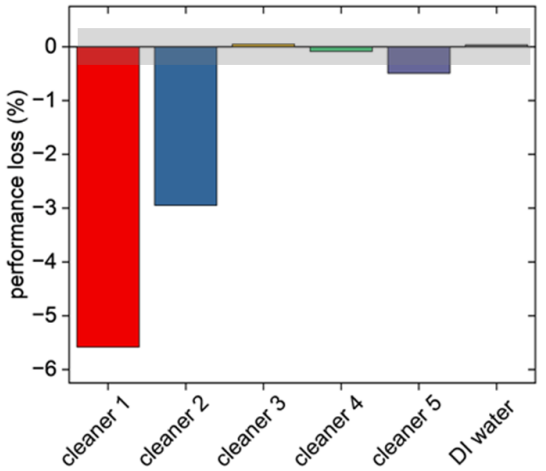
Summary

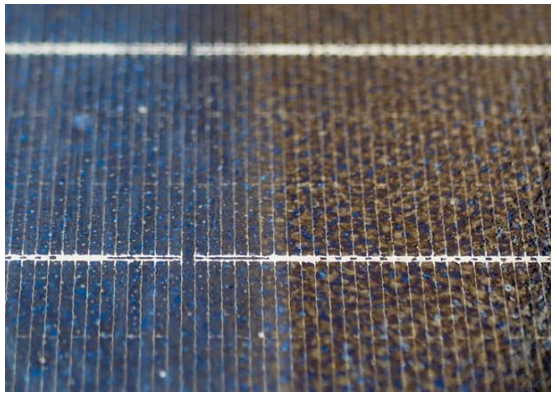
Key results:

- Benchmark of five PV cleaning agents and DI-water as reference
- Three out of five cleaners show significant performance losses
- Two cleaners are damage-free (comparable to DI-water)
- ARC degradation (partially visible to the eye) is the main reason 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



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