Fraunhofer CSP

Investigation – Characterization – Testing

Soiling

Motivation

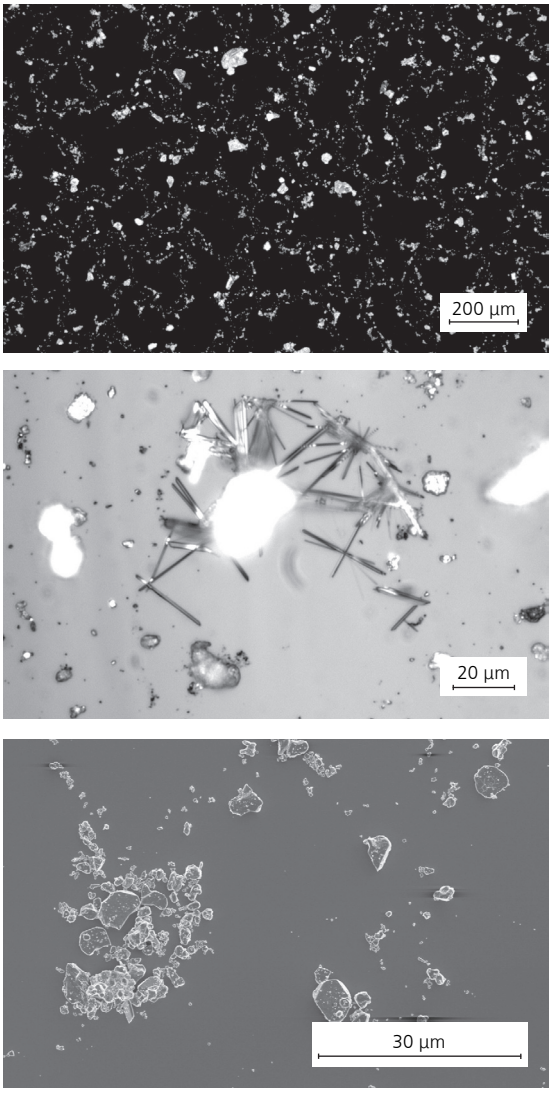
Accumulation of dust and dirt on PV modules and solar reflectors leads to significant power losses due to shading or scattering of sunlight. Especially in arid and semi-arid regions like deserts, output power losses of more than 1% per day can be observed – a severe PV module performance issue.

The use of functional glass coatings with self-cleaning and dust-repellent properties is seen as a promising approach to prevent these losses.

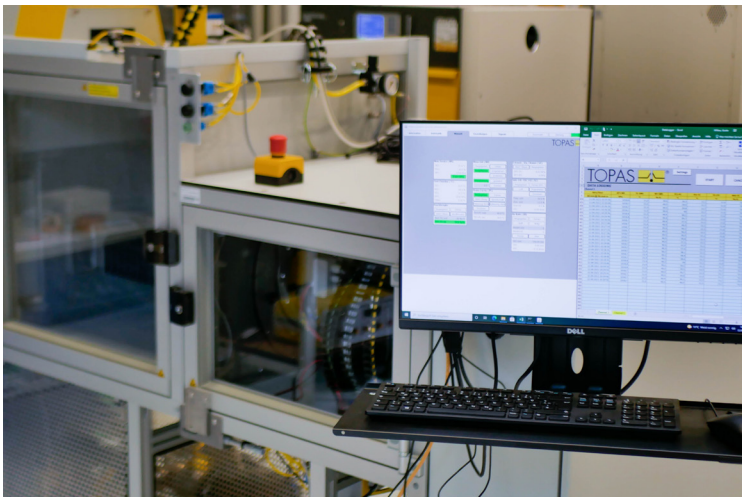
Root Cause Diagnostics

The adhesion of particles to glass surfaces can be strongly enhanced by the so called cementation process, which is attributed to frequent humid/dry-cycles like dew in the morning and surface temperatures up to 80 °C during midday.

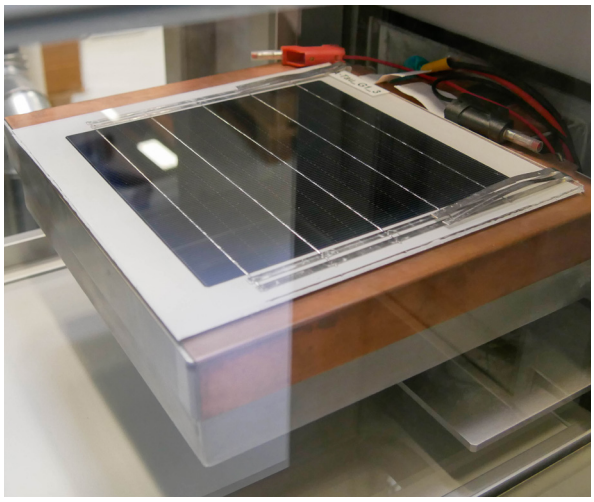
To develop appropriate mitigation strategies against soiling, fundamental understanding of cementation processes at microstructural level is necessary. Fraunhofer CSP conducted studies of the soiling process on glass surfaces from the desert region of Qatar. Within these, fibrous clay minerals in the sub-micron size were identified as a main reason for particle cementation.



Light microscope (top, middle) and SEM (bottom) images of dust particles under the influence of dew.



The CST 117 soiling test bench, developed in cooperation with Topas, enables semi-automated test procedures according to VDI 3956-1.



Samples up to 20 x 20 cm in size can be exposed to temperatures from -10 to 50°C.

Dust Chamber at Fraunhofer CSP

Beside the surface properties of Anti Soiling Coatings (ASC), there are many other factors strongly influencing the dust deposition on surfaces, e.g. particle size, shape and chemistry, humidity, temperature, wind speed and direction. For an evaluation of ASC in laboratory, Fraunhofer CSP designed a test setup which is capable of adjusting sample temperature, tilt angle, humidity, wind speed and illumination. Thus, we are able to provide accelerated soiling tests with standardized measurement procedure as well as defined and reproducible test conditions (VDI 3956).

Features

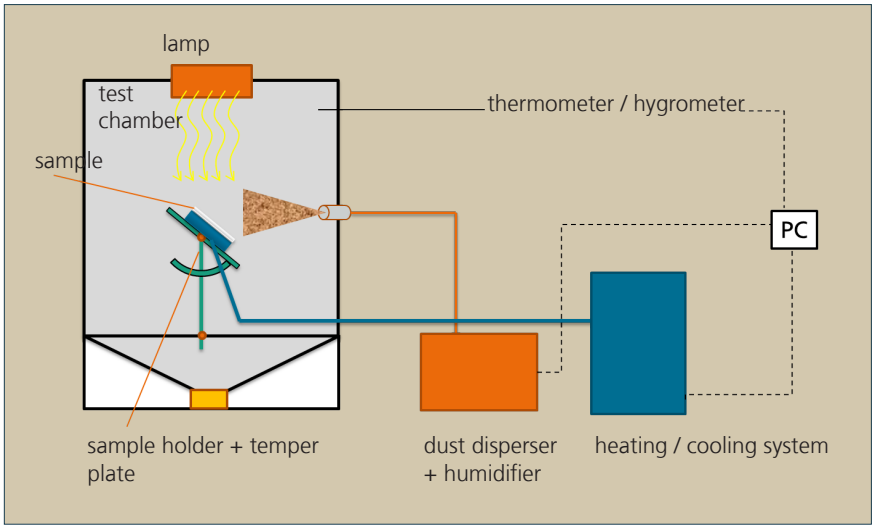
- Semi automated test procedure according to VDI 3956-1
- Sample holder 20 x 20 cm -10 to 50°C, angle of attack up to 60°
- Dust dispersing unit for particle sizes up to 200µm
- Air Knife flow velocity up to 15m/s above the sample
- Humidity control, relative humidity up to 90%
- Complete recording of test data

Soiling Quantification

Light Microscopy
- Samples up to module size
- Surface coverage
- Homogeneity
- Particle size distribution

Optical Spectroscopy
- Loss in transmission due to shading
- Reflectance and scattering
- Angle-dependency

Mini-PV Modules
- Characterization at STC conditions
- Translation of loss in transmission into energy yield
- Angle-dependency



Schematic illustration of the test method developed at Fraunhofer CSP for the dust-related soiling behavior of solar energy systems (VDI 3956).

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