

ICS 27.160

Reinigungsprüfverfahren für die Abrasionsbeständigkeit von Glasbeschichtungen für solare Anwendungen; Text Englisch

Cleaning test methods for the abrasion resistance of glass coatings for solar applications;
Text English

Méthode d'essai de nettoyage pour la résistance à l'abrasion des revêtements en verre pour
les applications solaires; Texte en anglais

Gesamtumfang 26 Seiten

Dieses Dokument wurde durch die im Vorwort genannten Verfasser erarbeitet und verabschiedet.

Contents

	Page
Foreword	4
Introduction.....	6
1 Scope	7
2 Normative references	7
3 Terms and definitions.....	7
4 Symbols and abbreviations.....	8
4.1 Symbols	8
4.2 Abbreviations	8
5 Apparatus	9
5.1 Test apparatus	9
5.2 Samples	10
5.3 Brushing parameters for coating abrasion resistivity testing (working mode 1).....	11
5.4 Auxiliary material and dust-water suspension	12
5.4.1 Working mode 1: coating abrasion resistivity testing	12
5.4.2 Working mode 2: brush and brushing parameter assessment.....	13
5.5 Reflection measurement equipment.....	13
6 Test procedure	14
6.1 Preparation of samples and apparatus	14
6.2 Test parameters	14
6.2.1 General	14
6.2.2 Working mode 1: coating abrasion resistivity testing	15
6.2.3 Working mode 2: brush and brushing parameter assessment.....	15
6.3 Procedures	15
6.3.1 Working mode 1: coating abrasion resistivity testing	15
6.3.2 Working mode 2: brush and brushing parameter assessment.....	16
7 Measurement	17
7.1 Sampling parameters	17
7.2 Measurement parameters	18
8 Evaluation of the reflectance data	19
9 Test report	20
Annex A (normative) Calibration	22
A.1 Calibration of the washing equipment.....	22
A.2 Determination of the deposited dust quantity in g/m ²	24
Annex B (informative) Example for the integral reflection change	25
Bibliography	26

Figures

Figure 1 — Schematic of test setup	9
--	---

Figure 2 — Scheme with reflectance measurements positions for samples with a minimum size of 0,8 m × 1,6 m	17
Figure 3 — Scheme with reflectance measurement positions for samples with a size < 0,8 m × 1,6 m	18
Figure A.1 — Schematic top view of the cardboard positioning procedure for the detection of the right side of the spray pattern	23
Figure A.2 — Example spray pattern and dimensions that shall be achieved during calibration of the washing equipment	23
Figure B.1 — Median absolute (left) relative (right) integral effective reflectance change value vs. number of brushing strokes	25

Tables

Table 1 — Symbols	8
Table 2 — Predefined particle diameter distribution of feldspar test dust for coating abrasion resistivity testing	12

Foreword

This DIN SPEC has been developed according to the PAS procedure. The development of a DIN SPEC according to the PAS procedure is carried out in DIN SPEC (PAS)-consortiums and does not require the participation of all stakeholders.

This DIN SPEC (PAS) is the result of the WIPANO ROSE project funded by the German Federal Ministry for Economic Affairs and Energy (BMWi), funding code 03TNH022H.

This document has been developed and adopted by the initiators and authors named below:

- Fraunhofer Center für Silizium Photovoltaik (CSP)
Dr. Charlotte Pfau, Dr. Volker Naumann, Dr. Klemens Ilse, Dr. Marko Turek
- SunBrush mobil GmbH
Franz Ehleuter
- KSL staubtechnik GmbH
Dr. Stefan Grob
- Glasmanufaktur Brandenburg GmbH
Dr. Carsten Horch
- TÜV Rheinland Energy GmbH
Michael Slawik
- Dubai Electricity and Water Authority (DEWA)
Dr. Gerhard Mathiak
- Amtec Kistler GmbH
Leo Sonntag
- Technische Hochschule Ulm
Prof. Dr. Gerd Heilscher, Felix Schulz
- Deutsches Zentrum für Luft- und Raumfahrt e.V. (DLR)
Dr. Florian Wiesinger
- Fraunhofer-Institut für Silicatforschung ISC
Mark Mirza

At present, there are no standards covering this topic in the body of German Standards.

DIN SPEC (PAS)s are not part of the body of German Standards.

A draft of this DIN SPEC (PAS) has not been published.

Despite great efforts to ensure the accuracy, reliability and precision of technical and non-technical information, the DIN SPEC (PAS) consortium cannot give any explicit or implicit assurance or warranty in respect of the accuracy of the document. Users of this document are hereby made aware that the consortium cannot be held liable for any damage or loss. The application of this DIN SPEC (PAS) does not release users from the responsibility for their own actions and is applied at their own risk.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. DIN shall not be held responsible for identifying any or all such patent rights.

Provision of this document free of charge as a PDF via the Beuth WebShop has been financed in advance.

For current information on this document, please go to DIN's website (www.din.de) and search for the document number in question.

Introduction

The accumulation of dust and other contaminants on the surfaces (“soiling”) of photovoltaic modules, solar thermal mirrors and glass sheets for the collection of solar energy in general can lead to significant loss of radiation energy and thus energy yield. Therefore, the glass surfaces are usually cleaned, in locations with particularly high soiling rates even on a daily basis. Anti-reflective coatings (ARCs) on top of the glass sheets are usually applied to reduce optical losses. Regular cleaning with high mechanical loads on the glass surfaces may damage the ARC. The damage of these layers by cleaning may lead to significant, irreversible losses in energy yield, which imply severe financial risks for system operators, investors and system manufacturers.

Currently, there are no standards for tests of coated solar energy collecting original format glass panes with regards to resistance to routine cleaning. Therefore, this DIN SPEC aims to specify testing conditions for coated surfaces of solar energy systems with regards to their resistance to standardized, realistic cleaning loads such as those applied in Europe and desert regions. In addition, a variant of the test method evaluates the damage potential of user-specific cleaning materials, methods and parameters.

1 Scope

This document specifies requirements and a method for testing the abrasion resistance of anti-reflective coatings (ARC) on original format full-size, planar glass sheets for solar energy applications against wet rotating brush cleaning. This document covers ARC abrasion on photovoltaic modules, planar glass sheets for concentrating solar power installations and green houses.

Firstly, this document provides a classification of ARC-glass abrasion sensitivity (working mode 1) based on a standardized laboratory cleaning test apparatus, procedure and materials (brush, washing suspension, test dust).

Secondly, this document defines mandatory test conditions in a working mode 2, aiming at qualitatively testing the impact of specific brushes, brushing parameters and test dusts on ARC-glass.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

DIN 5033-7, *Colorimetry — Part 7: Measuring conditions for object colours*

DIN EN 62805-2 (VDE 0126-4-21), *Method for measuring photovoltaic (PV) glass — Part 2: Measurement of transmittance and reflectance*

DIN EN IEC 60904-3 (VDE 0126-4-3):2020-01, *Photovoltaic devices — Part 3: Measurement principles for terrestrial photovoltaic (PV) solar devices with reference spectral irradiance data (IEC 60904-3:2019); German version EN IEC 60904-3:2019*

3 Terms and definitions

No terms and definitions are listed in this document.

DIN and DKE maintain terminological databases for use in standardization at the following addresses:

- DIN-TERMinologieportal: available at <https://www.din.de/go/din-term>
- DKE-IEV: available at <http://www.dke.de/DKE-IEV>

4 Symbols and abbreviations

4.1 Symbols

Symbols used throughout this document are listed in Table 1.

Table 1 — Symbols

Symbol	Explanation	Unit
a	average immersion depth of the rotating brush	mm
d	brush diameter	mm
w	horizontal distance of the nozzle output to the brush rotation axis	mm
h	height of the nozzle output above the sample surface	mm
α	spray direction angle	°
i	index of measurement position	—
N	brush stroke number, one stroke consists of one passage over the sample, i.e. one forward passage or one backward passage	—
$N_{50\%}$ ($N_{90\%}$)	brush stroke number, where 50 % (90 %) of the maximal reflectance change is reached	—
x, y	sample dimensions (length, width)	m
$\rho(\lambda)$	spectral reflectance, being the ratio of the reflected to the incident radiant flux density measured with an integrating sphere between 360 nm and 740 nm in 10 nm steps	—
$R_{N,i}$	effective reflectance value of measurement position in dependence of brush stroke number N	%
$\Delta R_{N,i}$	effective reflectance change value of measurement position after N strokes compared to the initial (before the first brushing stroke) reflectance $R_{0,i}$	%
$\Delta R_{N,median}$	median effective reflectance change value of all measurement positions i after N strokes	%

4.2 Abbreviations

AR	anti-reflective
ARC	anti-reflective coating
PV	photovoltaics, photovoltaic