

Test Report

ISO 22975-3 Part 3: *Absorber Surface Durability*

-

Part B

The test allows the qualification of solar absorber coatings to be used in ventilated flat plate collectors with a maximum loss in system performance of 5% during 25 years of operation. A full test according to ISO 22975-3 Part 3 consists of 3 parts:

Part A: Stability with regards to high temperature

Part B: Stability with regards to high humidity and condensation

Part C: Stability with regards to atmospheric corrosion (SO₂)

Test material

Commissioner:	ALANOD Aluminium-Veredelung GmbH & Co. KG Egerstrasse 12 DE-58256 Ennepetal
Trade name:	eta plus® Al
Description:	Tin dioxide on chromium oxynitride on passivated aluminum
Start of test:	September 2014
Completion of test:	December 2014
Expiration date:	January 2018 (The test result is no longer valid after substantial changes of the coating or substrate)

Test results

The test material has passed **part B (stability with regards to high humidity and condensation)** of the test according to ISO 22975-3 and is qualified to be used in single glazed flat plate collectors.

Preliminary Testing

Sample conditioning

According to clause 5.2 of the standard, the optical properties of three virginal samples have been measured in order to determine the temperature for pre-conditioning by the use of table B.1 of ISO 22975-3.

Table 1: Optical properties of three virginal samples and pre-conditioning temperature

	Sample V1	Sample V2	Sample V3	Mean value
Solar absorptance, α_s	0.944	0.942	0.943	0.943
Emittance, ϵ_{100}	0.047	0.051	0.058	0.052
Temperature to be applied for pre-conditioning of the samples				210°C

Qualification for testing

In total 18 samples have been pre-conditioned by tempering for 5 hours at the pre-conditioning temperature given in table 1 above. After pre-conditioning an adhesion test according ISO 2409 (for soft samples) has been applied to three of the samples.

Table 2: Mean values of the optical properties of 18 samples after pre-conditioning

	Solar Absorptance, α_s	Emittance, ϵ_{100}
Mean value	0.943	0.046
Standard deviation	0.001	0.003
Minimum value	0.942	0.040
Maximum value	0.944	0.053

Table 3: Result of the adhesion test on three samples after pre-conditioning

	Sample 1	Sample 2	Sample 3
Adhesion test result grade	0	0	0

The test specimens are qualified for testing, since the standard deviation for solar absorptance and thermal emittance are less than 0.01 and 0.04, respectively, and as the adhesion test of the three samples was leading to a result grade ≤ 1 .

Qualification Testing

According to clause 7.4.1 of the standard three samples have been exposed to the first testing temperature level $T_1 = 40^\circ\text{C}$ for a testing time up to 600 h or until $PC \geq 0.05$. Time t_1 is defined to be the latest testing time with $PC \leq 0.05$.

Table 3: PC mean value of three samples after testing at $T_1 = 40^\circ\text{C}$ and identification of t_1

Time of exposure	18 h	36 h	75 h	150 h	300 h	600 h
PC	0.001	-0.001	-0.004	0.000	-0.002	-0.005
$t_1 =$						600 h

Table 6: Results of the adhesion tests performed on three samples after 600 h of testing at temperature T_1 .

	Sample 1	Sample 2	Sample 3
Adhesion test result grade	0	0	0

The absorber coating has qualified with regards to its stability against high humidity and condensation, as after testing at temperature level T_1 for a testing time $t_1 = 600\text{h}$ $PC(t_1) \leq 0.015$ and as the adhesion test of the three tempered samples at T_1 was leading to a result grade ≤ 1 .

SPF-Solartechnik
Rapperswil, September 2014

Lukas Omlin
SPF Projektmitarbeiter

Stefan Brunold
SPF Institutsleiter Stv.

Annex

Deviations from the testing method

None

Solar absorptance, α_s

Solar absorptance, α_s , was measured with a BRUKER IFS 66 UV-VIS-MIR Fourier-transform spectrophotometer equipped with an integrating sphere. 'Spectralon' diffuse reflectance standard was used as a reflectance reference. α_s was calculated for airmass 1.5 using hemispherical solar spectral irradiance data as described in ISO 9050:2003.

Thermal emittance, ε_{100}

The thermal emittance, ε_{100} , was measured using the same instrument as for solar absorptance measurements. However, an 'Infragold' reflectance standard was used as a reference. The black body radiation spectrum for a temperature of 100°C (373 K) was used for the calculation of ε_{100} . It was generated according to Planck's law of black body radiation.

Testing chambers

A Horstmann humidity cabinet, type HS 220 K 45 (volume 0.22m³) was used for the condensation tests. The samples were mounted on a water cooled metal sample holder, which was tilted 45°. The temperature of the samples was measured with a calibrated ($\pm 1^\circ\text{C}$) Pt-100 sensor. The temperature of the cabinet was 5°C higher than the sample temperature. The humidity inside the cabinet was 95% RH. The samples were electrically insulated from the sample holder by Teflon films.

Detailed Results

75h @ 45/95/40		36h @ 45/95/40		18h @ 45/95/40		5h @ 210°C tempered		reference		samples
epsilon	alpha	epsilon	alpha	epsilon	alpha	epsilon	alpha	epsilon	alpha	
						0.047	0.944	0.047	0.944	ALAM140900xZ
						0.046	0.943	0.051	0.942	ALAM140901xZ
						0.040	0.943	0.058	0.943	ALAM140902xZ
0.043	0.946	0.049	0.946	0.045	0.944	0.047	0.943			ALAM140903xZ
0.043	0.944	0.046	0.945	0.057	0.944	0.049	0.944			ALAM140904xZ
0.037	0.943	0.048	0.944	0.047	0.944	0.042	0.943			ALAM140905xZ
						0.044	0.943			ALAM140906xZ
						0.045	0.942			ALAM140907xZ
						0.045	0.942			ALAM140908xZ
						0.047	0.944			ALAM140909xZ
						0.047	0.944			ALAM140910xZ
						0.053	0.943			ALAM140911xZ
						0.045	0.943			ALAM140912xZ
						0.048	0.942			ALAM140913xZ
						0.044	0.944			ALAM140914xZ
						0.042	0.944			ALAM140915xZ
						0.048	0.943			ALAM140916xZ
						0.046	0.943			ALAM140917xZ

600h @ 45/95/40		300h @ 45/95/40		150h @ 45/95/40		samples
epsilon	alpha	epsilon	alpha	epsilon	alpha	
						ALAM140900xZ
						ALAM140901xZ
						ALAM140902xZ
0.055	0.951	0.050	0.949	0.051	0.948	ALAM140903xZ
0.054	0.950	0.048	0.946	0.045	0.944	ALAM140904xZ
0.048	0.952	0.048	0.946	0.054	0.944	ALAM140905xZ
						ALAM140906xZ
						ALAM140907xZ
						ALAM140908xZ
						ALAM140909xZ
						ALAM140910xZ
						ALAM140911xZ
						ALAM140912xZ
						ALAM140913xZ
						ALAM140914xZ
						ALAM140915xZ
						ALAM140916xZ
						ALAM140917xZ