

**Test Report**  
**ISO 22975-3 Part 3: Absorber Surface Durability**  
-  
**Part A**

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 (SO<sub>2</sub>)*

**Test material**

<b>Commissioner:</b>	ALANOD Aluminium-Veredelung GmbH & Co. KG Egerstrasse 12 DE-58256 Ennepetal
<b>Trade name:</b>	eta plus® Al
<b>Description:</b>	Tin dioxide on chromium oxynitride on passivated aluminum
<b>Start of test:</b>	September 2014
<b>Completion of test:</b>	December 2014
<b>Expiration date:</b>	January 2018 (The test result is no longer valid after substantial changes of the coating or substrate)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 A (stability with regards to high temperature)** 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 virgin 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 virgin samples and pre-conditioning temperature**

	Sample V1	Sample V2	Sample V3	Mean value
<b>Solar absorptance, <math>\alpha_s</math></b>	0.944	0.942	0.943	<b>0.943</b>
<b>Emittance, <math>\epsilon_{100}</math></b>	0.047	0.051	0.058	<b>0.052</b>
<b>Temperature to be applied for pre-conditioning of the samples</b>				<b>210°C</b>

### 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.

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

	Solar Absorptance, $\alpha_s$	Emittance, $\epsilon_{100}$
<b>Mean value</b>	0.943	0.046
<b>Standard deviation</b>	0.001	0.003
<b>Minimum value</b>	0.942	0.040
<b>Maximum value</b>	0.944	0.053

After pre-conditioning an adhesion test according ISO 2409 (for soft samples) has been applied to three of the samples.

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

	Sample 1	Sample 2	Sample 3
<b>Adhesion test result grade</b>	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  $\leq 1$ .

From the mean values of the optical properties from table 2 above the maximum solar absorber temperature  $T_{max}$  according table B.1 of ISO 22975-3 has been determined which is

needed to evaluate the testing temperature levels for qualification testing by the use of table B.2 of ISO 22975-3.

**Table 4:  $T_{\max}$  and testing temperature levels to be used for qualification testing**

	Temperature [°C]
maximum absorber surface temperature $T_{\max}$	210
first testing temperature $T_1$	285
second testing temperature $T_2$	255
second testing temperature $T_3$	315

## Qualification Testing

According to clause 6.4.3 of the standard three samples have been exposed to the first testing temperature level  $T_1$  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 5: PC mean value of three samples after testing at  $T_1$  and identification of  $t_1$**

Time of exposure	18 h	36 h	75 h	150 h	300 h	600 h
PC	-0.008	-0.007	-0.007	-0.001	-0.002	0.000
$t_1 =$						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 thermal stability 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  $\leq 1$ .

SPF-Solartechnik  
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## Annex

### Deviations from the testing method

None.

### Solar absorptance, $\alpha_s$

Solar absorptance,  $\alpha_s$ , 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.  $\alpha_s$  was calculated for airmass 1.5 using hemispherical solar spectral irradiance data as described in ISO 9050:2003.

### Thermal emittance, $\varepsilon_{100}$

The thermal emittance,  $\varepsilon_{100}$ , 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  $\varepsilon_{100}$ . It was generated according to Planck's law of black body radiation.

### Testing chambers

A Snijstaal, type S 30 I (volume 30 litre) or a Fresenberger circulating air oven, type HT80.600, was used for high temperature exposure. The temperatures were measured with a calibrated ( $\pm 1$  K) Pt-100 sensor.

Detailed Results

75h @ 285°C		36h @ 285°C		18h @ 285°C		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
						0.047	0.943			ALAM140903xZ
						0.049	0.944			ALAM140904xZ
						0.042	0.943			ALAM140905xZ
0.033	0.942	0.032	0.945	0.033	0.945	0.044	0.943			ALAM140906xZ
0.024	0.940	0.033	0.943	0.033	0.944	0.045	0.942			ALAM140907xZ
0.028	0.940	0.035	0.943	0.034	0.944	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 @ 285°C		300h @ 285°C		150h @ 285°C		samples
epsilon	alpha	epsilon	alpha	epsilon	alpha	
						ALAM140900xZ
						ALAM140901xZ
						ALAM140902xZ
						ALAM140903xZ
						ALAM140904xZ
						ALAM140905xZ
0.037	0.940	0.033	0.941	0.037	0.942	ALAM140906xZ
0.036	0.936	0.040	0.939	0.037	0.939	ALAM140907xZ
0.032	0.936	0.034	0.939	0.040	0.939	ALAM140908xZ
						ALAM140909xZ
						ALAM140910xZ
						ALAM140911xZ
						ALAM140912xZ
						ALAM140913xZ
						ALAM140914xZ
						ALAM140915xZ
						ALAM140916xZ
						ALAM140917xZ