

Test report: 115346/15

Customer: HANWHA L&C
Hanwha Building 1
Janggyo-Dong Chung-Gu
100-797 SEOUL
KOREA

Order: Testing of weathering fastness after artificial weathering according to RAL-GZ 716/1 section I, part 7, issue March 2008 or Technical appendix "section II" to RAL-GZ 716, part II-a-3 (issue December 2013) respectively on window profiles made of PVC-U laminated with film.

Artificial weathering according to DIN EN 513: 1999-10, procedure 1 (simulation of a moderate climate zone M) up to an irradiation dose equivalent first of 12 GJ/m², continuation following up to a total irradiation dose equivalent of altogether 30 GJ/m² in the wave length range of 300 nm to 800 nm.

Letter of: 2013-11-05 **from:** Mr. Park
E-mail dated: 2014-09-19
2015-03-23

Test samples received on: 2013-10-31

Test period: 2013-11-05 to 2015-10-20

The test report comprises 6 pages.

Würzburg, 2015-10-28
Wk/ste

i. V.


Dr. Anton Zahn



i. A.


Wolfgang Ries

The original language of the report is German. In case of doubt, the German version is obligatory.

Die ungekürzte oder auszugsweise Wiedergabe, Vervielfältigung und Übersetzung dieses Berichtes zu Werbezwecken bedarf der schriftlichen Genehmigung der SKZ - Testing GmbH. Die Ergebnisse beziehen sich auf die geprüften Produkte. Die Akkreditierungen gelten nur für die in den Urkunden aufgeführten Normen und Verfahren, die im Internet unter www.skz.de eingesehen werden können.

1. Order

The company HANWHA L&C, Hanwha Building 1, Janggyo-Dong Chung-Gu, 100-797 SEOUL, KOREA ordered the following test to be carried out at SKZ - TeConA GmbH (effective 29 July 2015, the company name has been changed to "SKZ - Testing GmbH") in their letter dated 05 November 2013 and by E-mail of 19 September 2014 and 23 March 2015: Testing of weathering fastness after artificial weathering on window profiles made of PVC-U laminated with film according to RAL-GZ 716/1 section I, part 7, issue March 2008 or Technical appendix "section II" to RAL-GZ 716, part II-a-3 (issue December 2013) respectively

Artificial weathering was carried out according to DIN EN 513: 1999-10, procedure 1 (simulation of a moderate climate zone M) up to an irradiation dose equivalent first of 12 GJ/m², continuation following up to an total irradiation dose equivalent of altogether 30 GJ/m² in the wave length range of 300 nm to 800 nm.

2. Test material

SKZ - Testing GmbH had the following test material at their disposal on 31 October 2013:

1 x 0.5 m window profile section, foil-laminated.

Base profile: Quality assured profile made of PVC-U

Sample no.:	Colour/Design of foil
1	Dark Walnut

3. Execution of test

Following tests were carried out according to the quality and test specifications "Plastic window profile systems, quality assurance, RAL-GZ 716/1 section I: plastic window profiles parts 1 - 3, 5, 7", test methods and requirements, part 7, window profiles made of PVC-U, laminated with film, issue March 2008. Divergent the tests were performed up to an total irradiation dose equivalent (300 - 800 nm) of altogether 30 GJ/m² or according to Technical appendix "section II" to RAL-GZ 716, part II-a-3: Films for laminating PVC-U-window profiles (issue December 2013) respectively.

Unless indicated otherwise, the tests were carried out at standard conditioning atmosphere 23/50, class 1 according to DIN EN ISO 291: 2008-08.

Usually we carry out tests according to standards for which we have an accreditation. The list of all standards for which we are accredited is shown on the homepage at www.skz.de.

3.1 Fastness to weathering

Procedure of artificial weathering is based on the requirements according to DIN EN 513: 1999-10, procedure 1, simulation of a moderate climate zone (M). Laminated outside surface was irradiated.

Parameter of the weathering device:

Type of exposure device:	Xenontestgerät 1200 CPS / XENOTEST® BETA LM
Light source:	Xenon arc source
Filter system:	Terrestrial daylight simulation
Operation:	non-alternating mode
Black standard temperature:	60 ± 3 °C
White standard temperature:	40 - 45 °C
Relative humidity:	65 ± 5 %
Spray cycle:	18 min water spray, 102 min dry cycle
Irradiance E_{UV} (300 - 400) nm:	60 ± 2 W/m ²
Total irradiation dose equivalent in the wave length range (300 - 800) nm:	30 GJ/m²
Exposure period:	15278 h
Start (Exposure up to 12 GJ/m ²):	2013-11-07
End (Exposure up to 12 GJ/m ²):	2014-09-03
Start (Exposure up to 20 GJ/m ²):	2014-09-03
End (Exposure up to 20 GJ/m ²):	2015-03-09
Start (Exposure up to 30 GJ/m ²):	2015-03-09
End (Exposure up to 30 GJ/m ²):	2015-10-20

3.1.1 Visual evaluation

Visual evaluation was carried out according to DIN EN 20105-A02: 1994-10 by using the grey scale for assessing change in colour.

Requirement according to RAL-GZ 716/1, issue March 2008 after 12 GJ/m²:

Upon termination of artificial weathering after 12 GJ/m², the colour change must not be greater than allowed by grade 3 of the grey scale according to DIN EN 20105-A02.

Changes must not bring about stains, bubbles, streaks or cracks. A peel-off between the polyacrylate protective layer and the base foil as well as between the base foil and the PVC-U-profile must not occur.

Requirement according to RAL-GZ 716, issue December 2013 after 30 GJ/m²:

Upon termination of artificial weathering after 30 GJ/m², the colour change must not be greater than allowed by grade 3 of the grey scale according to DIN EN 20105-A02.

Changes must not bring about stains, bubbles or cracks in surface.

3.1.2 Colourimetric evaluation

The colourimetric evaluation was carried out via a spectrophotometer in the wavelength range from 360 to 750 nm, standard light type D65, gloss inclusion, 10° standard observation. The colour distance ΔE^*_{ab} according to DIN EN ISO 11664-4: 2012-06 was determined.

Each sample was measured before and after artificial weathering at the same measuring position on the sample, upon identical sample placement. Due to that, also in case of the not single-coloured foils with surface texture, a guide value for colour change can be determined in terms of colourimetry.

Requirements: none

4. Test results

4.1 Fastness to weathering

4.1.1 Visual evaluation

Sample 1: "Dark Walnut"

Time of exposure	Dose of irradiation	Grey scale value		Remark
		A02	A03	
1000 h	2 GJ/m ²	4 - 5	4 - 5	more yellow
2000 h	4 GJ/m ²	4 - 5	4 - 5	more yellow
3000 h	6 GJ/m ²	4 - 5	4 - 5	more yellow
4000 h	8 GJ/m ²	4 - 5	4 - 5	more yellow
5000 h	10 GJ/m ²	4 - 5	4 - 5	more yellow
6129 h	12 GJ/m ²	4 - 5	4 - 5	more yellow
7000 h	14 GJ/m ²	4 - 5	4 - 5	more yellow
8000 h	16 GJ/m ²	4 - 5	4 - 5	more yellow
9000 h	18 GJ/m ²	4 - 5	4 - 5	more yellow
10187 h	20 GJ/m ²	4 - 5	4 - 5	more yellow
11000 h	22 GJ/m ²	4 - 5	4 - 5	more yellow
12000 h	24 GJ/m ²	4 - 5	4 - 5	more yellow
13000 h	26 GJ/m ²	4 - 5	4 - 5	more yellow
14000 h	28 GJ/m ²	4 - 5	4 - 5	more yellow
15278 h	30 GJ/m ²	4 - 5	4 - 5	more yellow

No stains, bubbles, streaks or cracks were found on the samples surfaces.

A peel-off between the polyacrylate protective layer and the base foil as well as between the base foil and the PVC-U-profile did not occur.

4.1.2 Colourimetric evaluation

Sample 1: "Dark Walnut"

Time of exposure	Dose of irradiation	Colour coordinates			Total colour distance Delta E
		Delta L*	Delta a*	Delta b*	
1000 h	2 GJ/m ²	-0.5	0.1	0.6	0.8
2000 h	4 GJ/m ²	-0.6	0.2	1.0	1.2
3000 h	6 GJ/m ²	-0.3	0.0	0.5	0.6
4000 h	8 GJ/m ²	-0.2	0.0	0.5	0.5
5000 h	10 GJ/m ²	-0.2	-0.1	0.6	0.6
6129 h	12 GJ/m ²	-0.1	-0.1	0.6	0.6
7000 h	14 GJ/m ²	-0.1	-0.2	0.6	0.6
8000 h	16 GJ/m ²	0.0	-0.2	0.7	0.7
9000 h	18 GJ/m ²	0.0	-0.3	0.7	0.8
10187 h	20 GJ/m ²	0.0	-0.3	0.9	0.9
11000 h	22 GJ/m ²	0.0	-0.3	1.0	1.0
12000 h	24 GJ/m ²	0.0	-0.3	1.1	1.1
13000 h	26 GJ/m ²	-0.1	-0.3	1.2	1.2
14000 h	28 GJ/m ²	-0.4	-0.1	1.6	1.7
15278 h	30 GJ/m ²	-0.3	-0.1	1.5	1.5

5. Assessment of test results on the basis of RAL-GZ 716/1, issue March 2008

The requirements of item 2.13.1 (Fastness to weathering after artificial weathering) according to RAL-GZ 716/1, section I, part 7, issue March 2008 for climate zone M and an total irradiation dose equivalent of 12 GJ/m² are met from the tested foil.

Assessment of test results on the basis of RAL-GZ 716, issue December 2013

The requirements according to Technical annex „section II“ of RAL-GZ 716 Quality and Test Requirements for components and procedures, part II-a-3: Films for the lamination of window profiles made of PVC-U, for climate zone M and an total irradiation dose equivalent of altogether 30 GJ/m² are met from the tested foil. According to item 5.2-2.1.2, table 2 minimum requirement class M20, as well as the higher classification M30 was achieved.