Test report no.: **203241/19**

Customer:

Teknos Feyco AG
Industriestr. 3
9487 Gamprin-Bendern
LIECHTENSTEIN

Order:

Testing of Fastness to weathering (colour fastness) and Resistance to weathering (cross-cut test) after artificial weathering according to Technical appendix, section A, CAT.5 to RAL-GZ 716 (issue July 2018) on colour-coated window profiles made of PVC-U.

Artificial weathering according to DIN EN 513: 2019-03, procedure 1 (simulation of a moderate climate zone M) up to a total irradiation dose equivalent of 8 GJ/m^2 in the wave length range of 300 nm to 800 nm.

E-Mail dated: 2019-11-13 **from:** Mr. Karl Bechtold

Test samples received on: 2019-11-26

Test period: 2019-12-02 to 2020-06-16

This test report consists of 22 pages.

Würzburg, 7 July 2020
Rs/km

i. V.

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

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SKZform 1020 - 8/18

1. Order

The company Teknos Feyco AG, Industriestr. 3, 9487 Gamprin-Bendern, LIECHTENSTEIN ordered the following test to be carried out at SKZ - Testing GmbH in their email dated 13 November 2019: Testing of Fastness to weathering (colour fastness) and Resistance to weathering (cross-cut test) after artificial weathering according to Technical appendix, section A, CAT.5 to RAL-GZ 716 (issue July 2018) on colour-coated window profiles made of PVC-U.

Artificial weathering according to DIN EN 513: 2019-03, procedure 1 (simulation of a moderate climate zone M) up to a total irradiation dose equivalent of 8 GJ/m^2 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 26 November 2019:

Each 1 x 0.25 m coated window profile section

Base profile: Quality assured profile made of PVC-U

Sample no.:	Structure / Colour	Cleaning / Application quantity / Marking
1	**Alpocryl LE / RAL 6009**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
2	**Hydropur 2K 7515 / RAL 6009**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
3	**Alpocryl LE / RAL 5011**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
4	**Hydropur 2K 7515 / RAL 5011**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
5	**Hydropur 2K 7515 / RAL 9006 + Hydropur Decklack 2K 7590**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
6	**Alpocryl LE / RAL 9006 + Alpocryl Klarlack 5454**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
7	**Hydropur 2K 7515 / RAL 9001**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
8	**Alpocryl LE / RAL 9001**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
9	**Alpocryl LE / RAL 7016**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV
10	**Hydropur 2K 7515 / RAL 7016**	V1530.98 / 80 g/m^2 / 20.11.2019 ANDV

Further information on the sample material was not available from the client.

3. Execution of test

Below listed tests were carried out according to Technical Appendix, Section A, CAT.5 to RAL-GZ 716 (issue July 2018) on colour-coated window profiles made of PVC-U with a total irradiation dose equivalent (300 - 800) nm of 8 GJ/m^2.

Unless indicated otherwise, 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. In case of non-accredited procedures they are marked with *.

Artificial weathering was carried out according to DIN EN 513: 2019-03, procedure 1, simulation of a moderate climate zone (M). The colour-coated visible outer surface was irradiated.

Parameter of the weathering device:

Type of exposure device:	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/m²
Irradiation dose equivalent in the wave length range (300 - 800) nm:	8 GJ/m²
Exposure period:	4074 h
Start (Weathering up to 8 GJ/m²):	2019-12-10
End (Weathering up to 8 GJ/m²):	2020-06-02

3.1 Fastness to weathering

Fastness to weathering was determined according to A.2.2.14.1, the test was performed according to P.3.16 D.

3.1.1 Visible 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, issue July 2018 after 8 GJ/m^2:

Changes must not result in specking, blistering, striation or cracking, or any other notable adverse effects on appearance.

3.1.2 Colorimetric evaluation

The colorimetric 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.

Requirement according to RAL-GZ 716, issue July 2018 after 8 GJ/m^2:

After artificial weathering the colour change ΔE^*_{00} must be ≤ 4.

3.2 Resistance to weathering

Evaluation of Resistance to weathering took place according to item A.2.2.14.2, testing was carried out according to P.3.16 G.

3.2.1 Adhesion of coating (coss-cut test)

Cross-cut test was carried out according to Technical Appendix to RAL-GZ 716, Quality and Test Requirements for Components and Procedures, Section A, category 5: Painted (coated) profiles, item A.2.2.20 and P.3.19 according to DIN EN ISO 2409: 2013-06. The adhesion of the coating was tested both in the delivery condition (before weathering), after half of the weathering period (4 GJ/m^2, single cross-cut test), and after artificial exposure of 8 GJ/m^2 (3-fold evaluation).

Requirement according to RAL-GZ 716, issue July 2018 after 8 GJ/m^2:

Unweathered coated profiles must achieve class 0 when tested according to DIN EN ISO 2409. The coating must not detach from the carrier profile.

Weathered coated profiles must achieve class 0 when tested according to DIN EN ISO 2409. The coating must not detach from the carrier profile.

4. Test results

4.1 Fastness to weathering

4.1.1 Visible evaluation

Irradiation dose **4 GJ/m²**:

Sample no.:	Structure / Colour	Cleaning / Application quantity / Marking	Grey scale value	
			A02	A03
1	**Alpocryl LE / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4**	---
2	**Hydropur 2K 7515 / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
3	**Alpocryl LE / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
4	**Hydropur 2K 7515 / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
5	**Hydropur 2K 7515 / RAL 9006 + Hydropur Decklack 2K 7590**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
6	**Alpocryl LE / RAL 9006 + Alpocryl Klarlack 5454**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
7	**Hydropur 2K 7515 / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
8	**Alpocryl LE / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
9	**Alpocryl LE / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
10	**Hydropur 2K 7515 / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---

No spots, bubbles, streaks, cracks or notable adverse effects were observed on the sample surfaces.

Irradiation dose **8 GJ/m²**:

Sample no.:	Structure / Colour	Cleaning / Application quantity / Marking	Grey scale value	
			A02	A03
1	**Alpocryl LE / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**3 - 4**	---
2	**Hydropur 2K 7515 / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4**	---
3	**Alpocryl LE / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4**	---
4	**Hydropur 2K 7515 / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4**	---
5	**Hydropur 2K 7515 / RAL 9006 + Hydropur Decklack 2K 7590**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
6	**Alpocryl LE / RAL 9006 + Alpocryl Klarlack 5454**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
7	**Hydropur 2K 7515 / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
8	**Alpocryl LE / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---
9	**Alpocryl LE / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**3 - 4**	---
10	**Hydropur 2K 7515 / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	**4 - 5**	---

No spots, bubbles, streaks, cracks or notable adverse effects were observed on the sample surfaces.

4.1.2 Colorimetric evaluation

Irradiation dose **4 GJ/m²**:

Sample no.:	Structure / Colour	Cleaning / Application quantity / Marking	Colour distance			
			Δ L*	Δ a*	Δ b*	Δ E^*_{00}
1	**Alpocryl LE / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.1	-0.2	-0.2	**0.3**
2	**Hydropur 2K 7515 / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	-0.2	0.4	-0.5	**0.6**
3	**Alpocryl LE / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.0	0.0	-0.2	**0.2**
4	**Hydropur 2K 7515 / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.2	0.0	-0.6	**0.4**
5	**Hydropur 2K 7515 / RAL 9006 + Hydropur Decklack 2K 7590**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.3	0.0	0.3	**0.2**
6	**Alpocryl LE / RAL 9006 + Alpocryl Klarlack 5454**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.6	0.0	0.1	**0.4**
7	**Hydropur 2K 7515 / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.2	0.0	0.0	**0.1**
8	**Alpocryl LE / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	-0.2	0.0	0.0	**0.1**
9	**Alpocryl LE / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.1	0.0	-0.2	**0.2**
10	**Hydropur 2K 7515 / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.4	0.1	-0.3	**0.4**

Irradiation dose **8 GJ/m²**:

Sample no.:	Structure / Colour	Cleaning / Application quantity / Marking	Colour distance			
			Δ L*	Δ a*	Δ b*	Δ E^*_{00}
1	**Alpocryl LE / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	-0.1	-0.3	-0.4	**0.5**
2	**Hydropur 2K 7515 / RAL 6009**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	-0.6	1.0	-0.6	**1.3**
3	**Alpocryl LE / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.0	0.3	-0.1	**0.4**
4	**Hydropur 2K 7515 / RAL 5011**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.7	0.0	-0.9	**0.8**
5	**Hydropur 2K 7515 / RAL 9006 + Hydropur Decklack 2K 7590**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.3	0.0	0.0	**0.2**
6	**Alpocryl LE / RAL 9006 + Alpocryl Klarlack 5454**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.7	0.0	0.1	**0.5**
7	**Hydropur 2K 7515 / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.1	0.0	0.0	**0.1**
8	**Alpocryl LE / RAL 9001**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.0	-0.1	-0.3	**0.2**
9	**Alpocryl LE / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	1.2	-0.5	-0.8	**1.4**
10	**Hydropur 2K 7515 / RAL 7016**	V1530.98 / 80 g/m² / 20.11.2019 ANDV	0.5	0.2	-0.3	**0.6**

Evaluation of gloss:

Sample no. 1: **Alpocryl LE / RAL 6009**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	39	26
2000 h	4 GJ/m²		19
3000 h	6 GJ/m²		16
4074 h	8 GJ/m²		11

Sample no. 2: **Hydropur 2K 7515 / RAL 6009**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	28	32
2000 h	4 GJ/m²		29
3000 h	6 GJ/m²		28
4074 h	8 GJ/m²		24

Sample no. 3: **Alpocryl LE / RAL 5011**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	38	28
2000 h	4 GJ/m²		25
3000 h	6 GJ/m²		24
4074 h	8 GJ/m²		22

Sample no. 4: **Hydropur 2K 7515 / RAL 5011**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	28	28
2000 h	4 GJ/m²		25
3000 h	6 GJ/m²		24
4074 h	8 GJ/m²		22

Sample no. 5: **Hydropur 2K 7515 / RAL 9006 + Hydropur Decklack 2K 7590**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	9	11
2000 h	4 GJ/m²		11
3000 h	6 GJ/m²		12
4074 h	8 GJ/m²		12

Sample no. 6: **Alpocryl LE / RAL 9006 + Alpocryl Klarlack 5454**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	21	21
2000 h	4 GJ/m²		20
3000 h	6 GJ/m²		20
4074 h	8 GJ/m²		20

Sample no. 7: **Hydropur 2K 7515 / RAL 9001**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	38	39
2000 h	4 GJ/m²		37
3000 h	6 GJ/m²		39
4074 h	8 GJ/m²		38

Sample no. 8: **Alpocryl LE / RAL 9001**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	40	35
2000 h	4 GJ/m²		32
3000 h	6 GJ/m²		20
4074 h	8 GJ/m²		5

Sample no. 9: **Alpocryl LE / RAL 7016**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	37	24
2000 h	4 GJ/m²		19
3000 h	6 GJ/m²		12
4074 h	8 GJ/m²		1

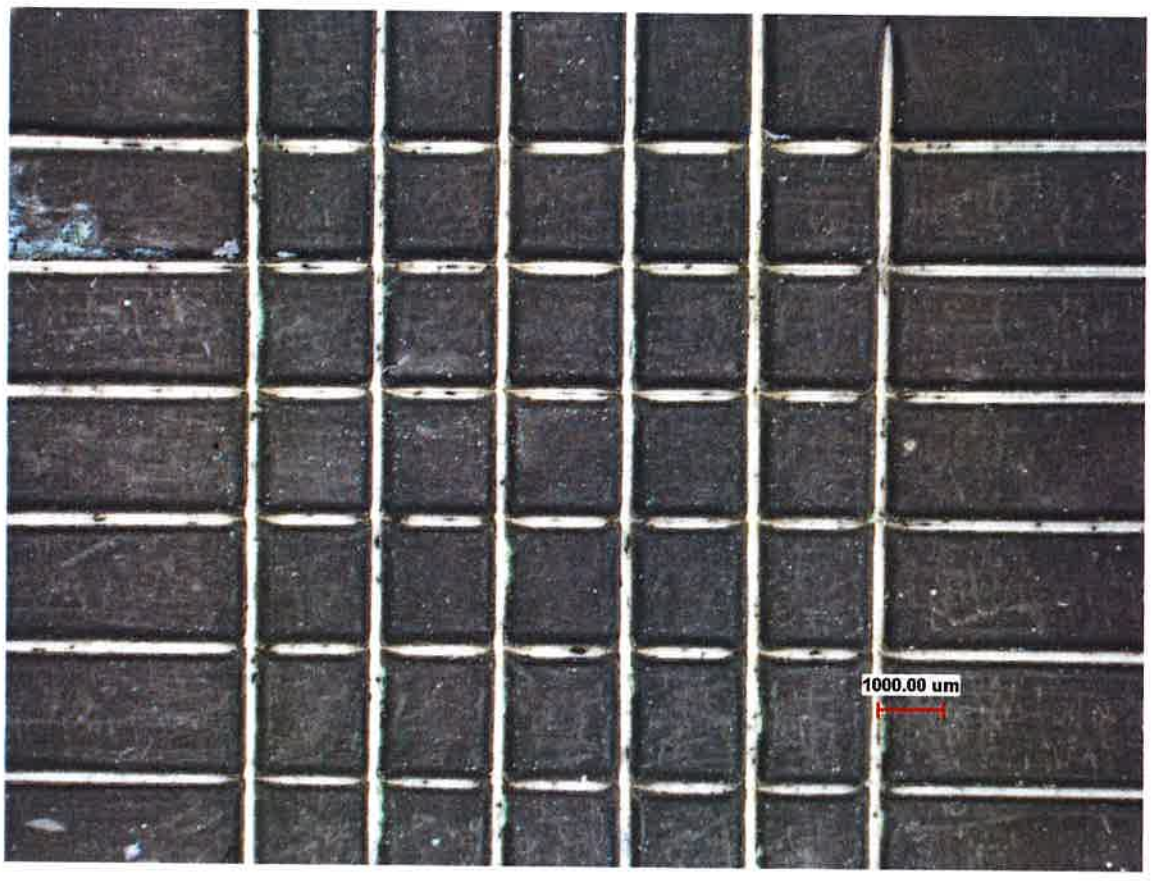
Sample no. 10: **Hydropur 2K 7515 / RAL 7016**

Weathering duration	Irradiation dose	Gloss (60°), Condition as delivery	Gloss (60°), After weathering
1000 h	2 GJ/m²	31	32
2000 h	4 GJ/m²		30
3000 h	6 GJ/m²		30
4074 h	8 GJ/m²		29

4.2 Resistance to weathering

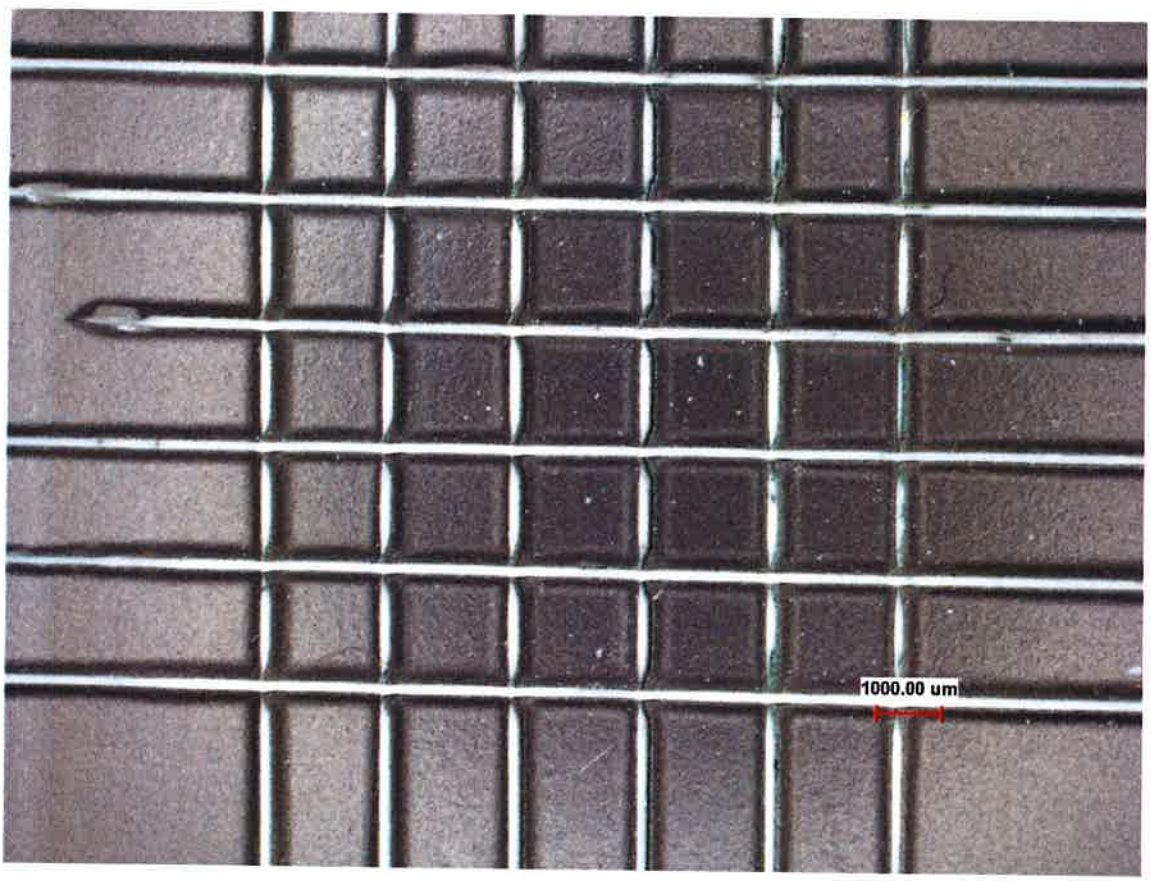
4.2.1 Adhesion of coating (coss-cut test)

Cross-cut Grade **Sample no. 1: Alpocryl LE / RAL 6009**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		



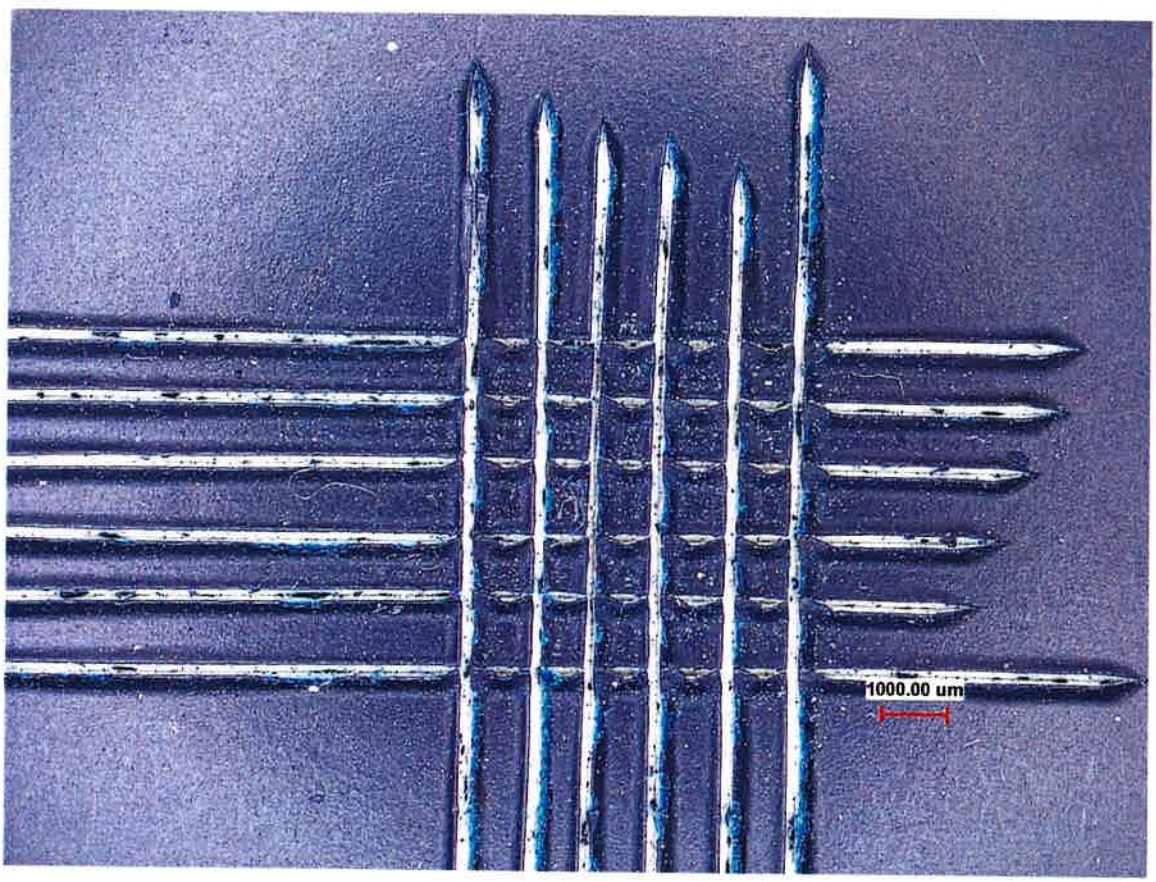
Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 2: Hydropur 2K 7515 / RAL 6009**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		



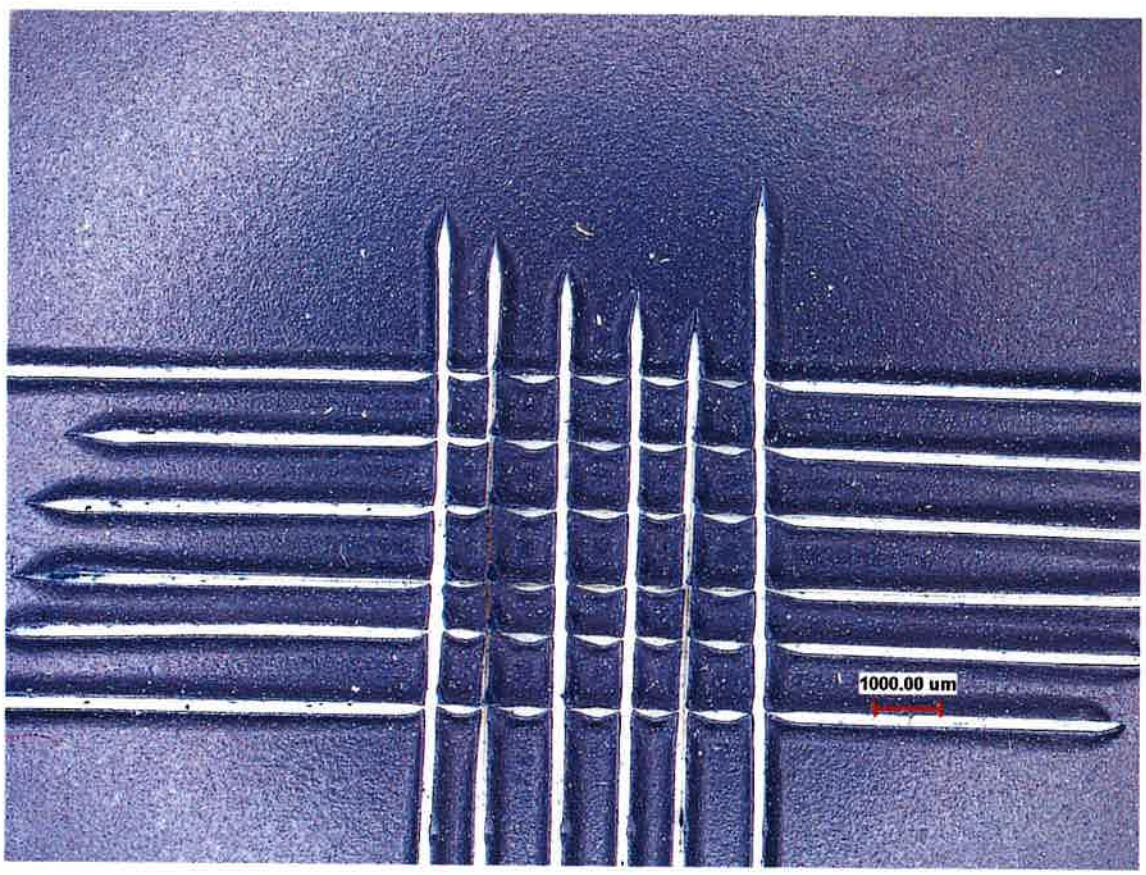
Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 3: Alpocryl LE / RAL 5011**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		



Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 4: Hydropur 2K 7515 / RAL 5011**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		



Detailed view 20x magnification after **8 GJ/m²**

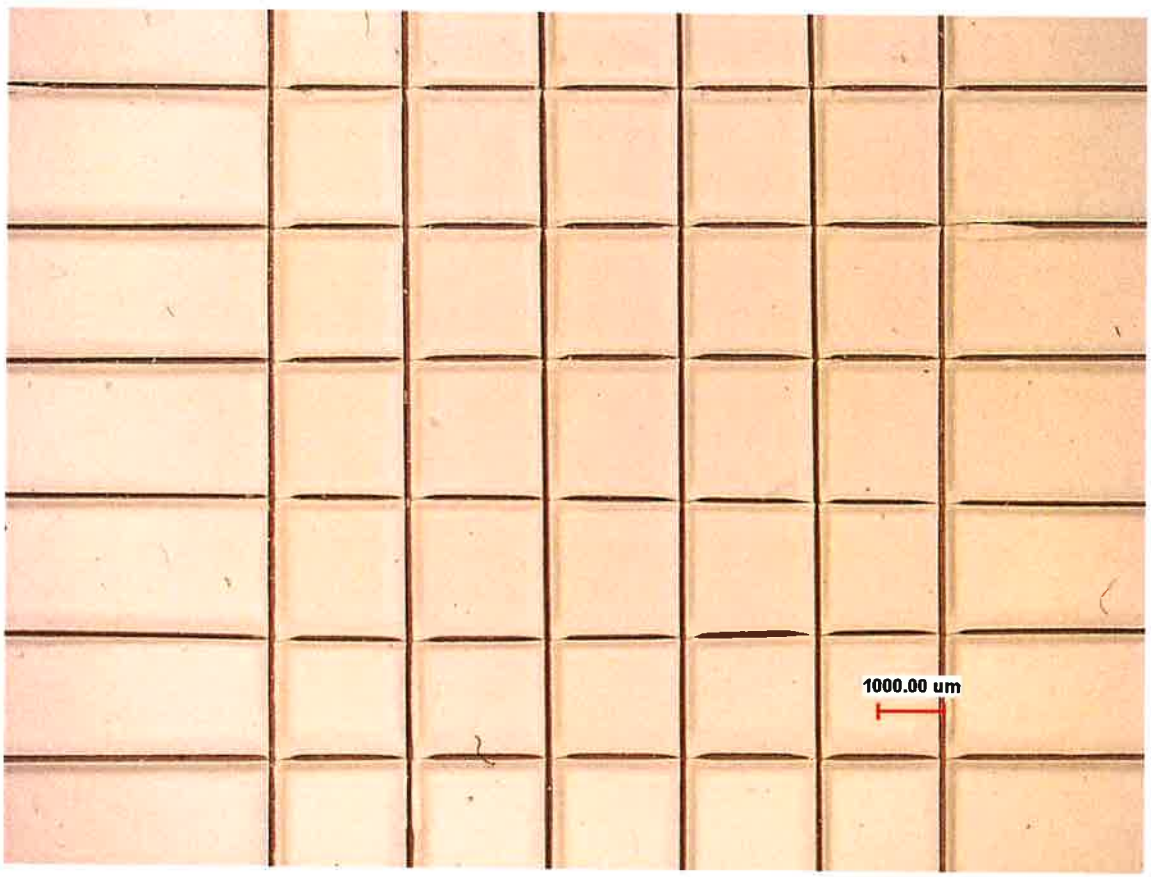
Cross-cut Grade **Sample no. 5: Hydropur 2K 7515 / RAL 9006 + Hydropur Decklack 2K 7590**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		

Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 6: Alpocryl LE / RAL 9006 + Alpocryl Klarlack 5454**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 1** (ISO 2409: 2013 – 1c – **1**)
On zero sample (delivery condition) as well as on the sample artificially weathered with 4 GJ/m² cross-cut grade 0 was determined. The cut edges were completely smooth, none of the squares of the grid had chipped off. On the test specimen artificially weathered with 8 GJ/m2, a cross-cut grade of 1 was determined on the coating. At the intersections of the grid lines, small splinters of the coating have flaked off.		

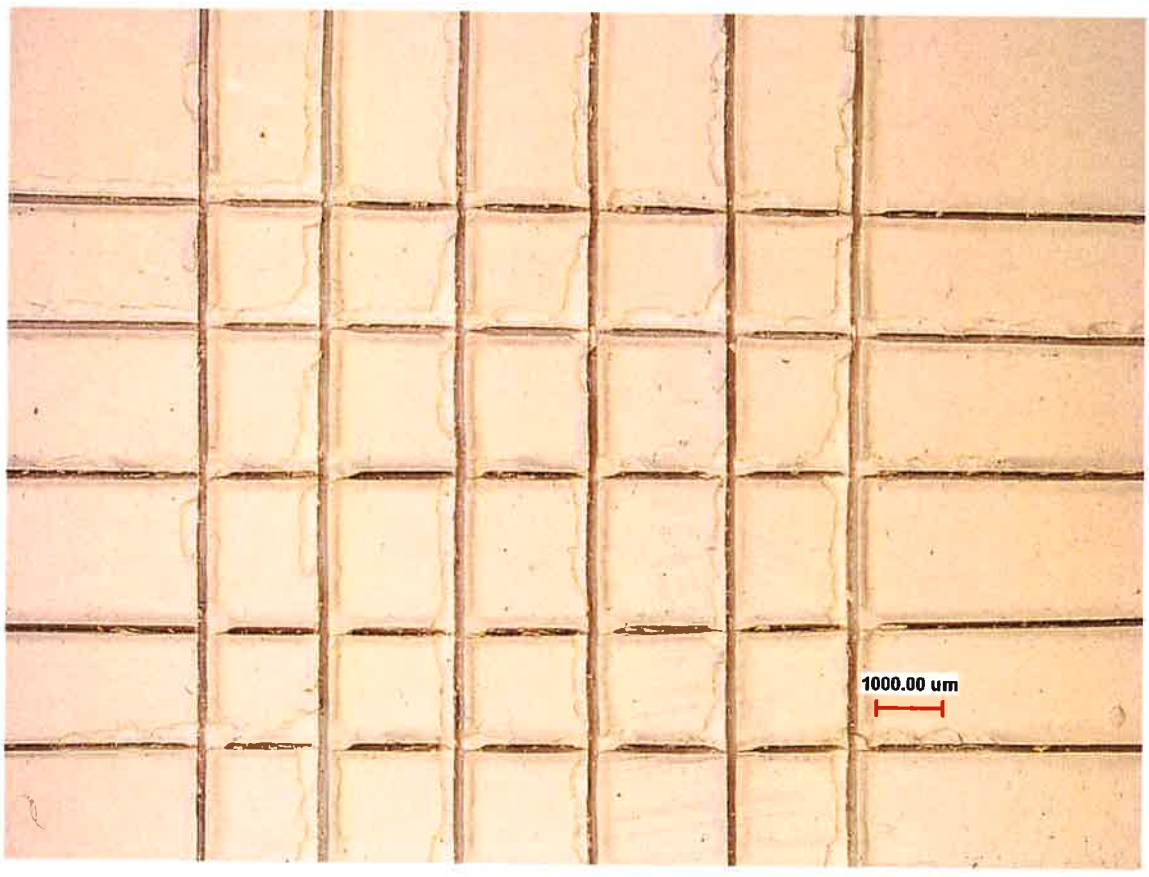
Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 7: Hydropur 2K 7515 / RAL 9001**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		



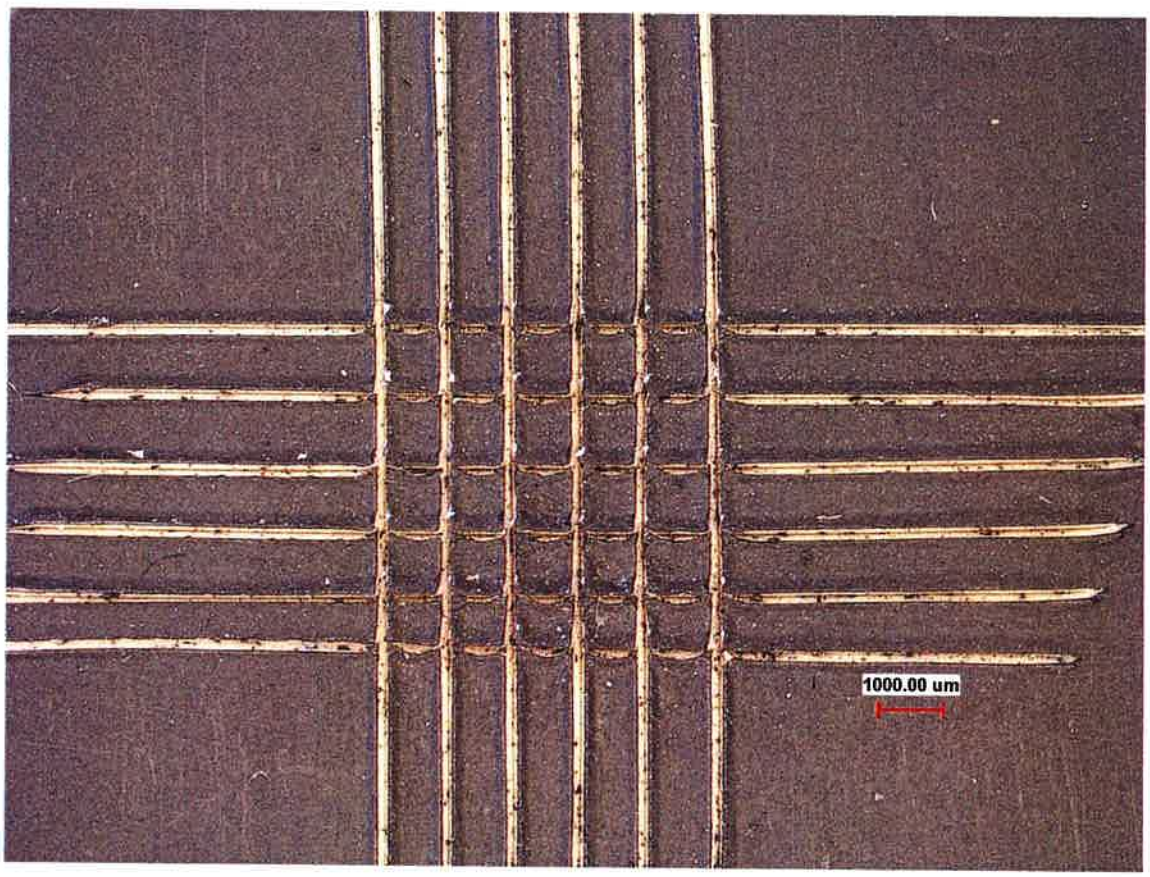
Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 8: Alpocryl LE / RAL 9001**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 1** (ISO 2409: 2013 – 1c – 1)
On zero sample (delivery condition) as well as on the sample artificially weathered with 4 GJ/m² cross-cut grade 0 was determined. The cut edges were completely smooth, none of the squares of the grid had chipped off. On the test specimen artificially weathered with 8 GJ/m², a cross-cut grade of 1 was determined on the coating. At the intersections of the grid lines, small splinters of the coating have flaked off.		



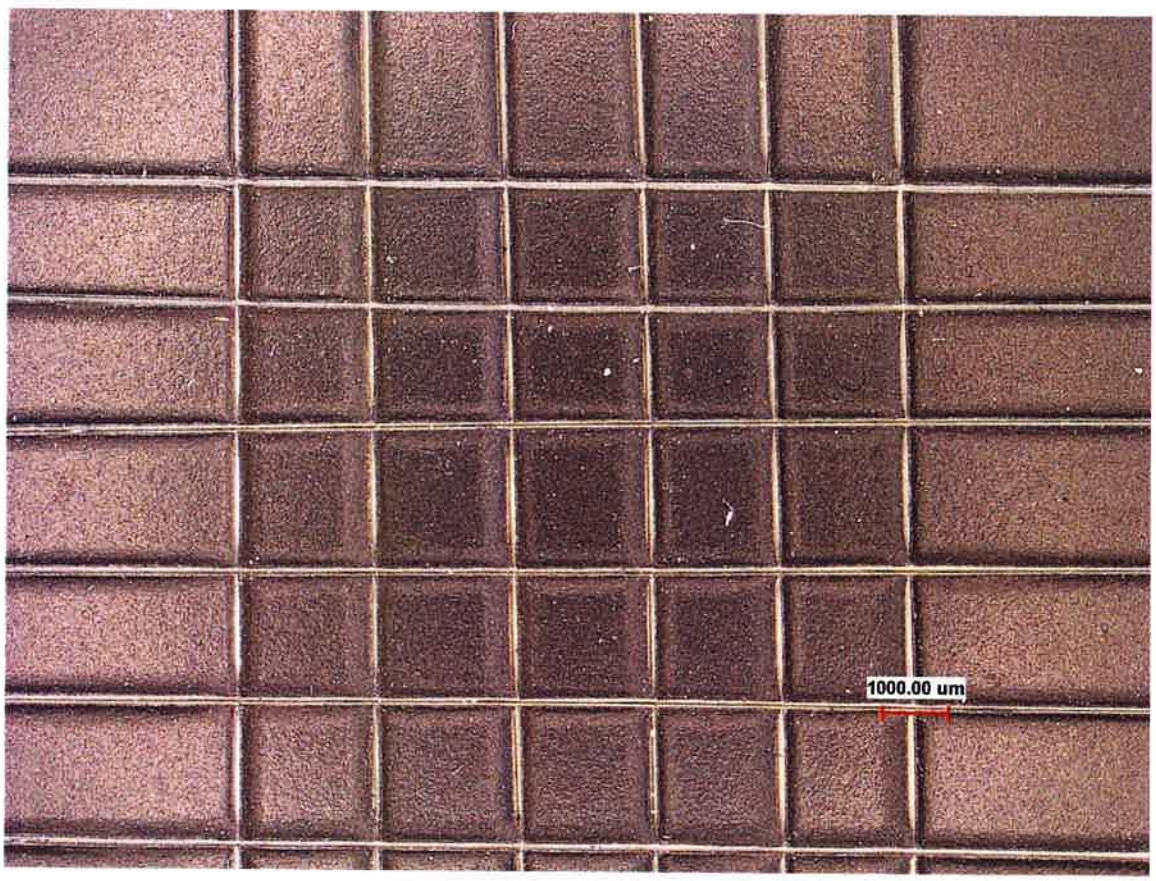
Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 9: Alpocryl LE / RAL 7016**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		



Detailed view 20x magnification after **8 GJ/m²**

Cross-cut Grade **Sample no. 10: Hydropur 2K 7515 / RAL 7016**		
before artificial weathering	after artificial weathering	
	4 GJ/m²	**8 GJ/m²**
Gt 0 (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)	**Gt 0** (ISO 2409: 2013 – 1c – 0)
Cross-cut grade 0 was determined on zero sample (delivery condition) as well as on artificially weathered test specimen. The cut edges were completely smooth, none of the squares of the grid had chipped off.		



Detailed view 20x magnification after **8 GJ/m²**