REPORT

issued by an Accredited Testing Laboratory

Contact person RISE
Johan Nordberg
Chemistry and Materials
+46 10 516 55 58
johan.nordberg@ri.se

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Hexatronic Fiberoptic AB
Daniel Blomér
Maskingatan 16
702 86 ÖREBRO

Weathering of polymeric material according to ISO 4892-2

(1 appendix)

RISE is accredited by Swedac for testing according to SS-EN ISO 4892-2:2013, ISO 7724, SS-EN ISO 178:2010 and SS-EN ISO 179-1:2010.

Commission

The commission was to perform weathering test according to ISO 4892-2 on a piece of polymer from a box for fibreoptic. Colour measurements (L, a , b and ΔE*) with a spectrophotometer after every week (168 hours) of weathering. Due to the significant change in colour Hexatronic desired to make strength measurements (ISO 178 and ISO 179-1) on the exposed sample.

Test specimens

The first test object arrived at RISE the May 5 2018. It contained a box for fibreoptic.

It was delivered in a cardboard package that was labelled:

P/N: HX-13431-02
E-no: E5060461
Skarv/Överföringsbox
4-fiber, 16mm
Batch: 21756

The object will henceforth be called **21756**

The second shipment of test objects arrived June 1 2018. It contained two boxes for fibreoptic.

It was delivered in a cardboard package that was labelled:

P/N: HX-13431-03
E-no: E5060783
Skarv/överl.box
4-fiber, IP55
Batch: 23140

The object will henceforth be called **23140**

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Testing
ISO/IEC 17025

The third shipment of objects arrived June 12 2018. It contained two lids to box for fibreoptic.

The object will henceforth be called **20180612**

Equipment

ISO 4892-2, Weathering

The test specimens were exposed in an Atlas Weather-Ometer Ci4000 (402671) and an Atlas Weather-Ometer Ci4400 (BX816879) , where the light source was a 6.5 kW water cooled Xenon arc lamp. The lamp in Ci4000 was equipped with an inner and an outer filter, both of borosilicate glass. The inner filter is replaced every 400 hours and the outer filter is replaced every 2000 hours. The lamp in the Ci4400 was equipped with an Right Light inner filter and quartz outer filter. Both the filters are replaced after 2000 hours.

ISO 7724, Colour

The colour measurements were performed with an UltraScan VIS spectrophotometer (BX60328). It measures in a wavelength range from 360 to 780 nanometers and with a wavelength interval of 10 nm. The sensor uses a integrating sphere (152.4 mm in diameter) which diffuses the light from a xenon flash lamp. The light illuminates the sample through a reflectance port (diameter 25.4 mm) and is reflected from it. A lens is located at an angle of 8° from the perpendicular to the sample surface. The selected illuminant/observer combination was D65/10°.

ISO 178, Flexural properties

A Zwick Z1 universal testing machine (BX32358) with 1kN load cell (BX32804)

ISO 179-1/1fU, Charpy impact strength

A CEAST Resil Impactor (901512).

Test procedure

ISO 4892-2, Weathering tests

One piece was sawed from each object and attached to test specimens holders, see Figures 1-4 in appendix 1.

The test was performed according to ISO 4892-2:2013 Method A Cycle 1.

The light intensity was 0.51 W/m^2 at 340 nm or 60±2 W/m^2 at 300-400 nm, see table 1. A spray cycle of 102/18 minutes with deionised water was used (102 min dry interval, 18 min of spraying). The temperature on a black standard thermometer was 65 ± 3 °C, the relative humidity 50 ± 5 % and the chamber temperature 38±3°C.

Table 1.Weathering tests

Sample name	21756	20180612
Equipment	Atlas Ci4000	Atlas Ci4400
Test start	May 7 2018	June 13 2018
Test stop	May 21 2018	June 27 2018
Test time, hours	334	332
Irradiance, W/m^2	0.51 at 340nm	60 at 300-400nm

ISO 7724, Colour measurements

The colour measurements were performed approximately every 168 hours in accordance with ISO 7724. The instrument made measurements with Reflectance-specular included mode, which measured total reflectance, including diffuse reflectance and specular reflectance. Three readings on different positions of the test specimen were averaged into the final result, which is shown in the report.

The total colour difference ΔE* is calculated from the differences of the individual colour coordinates ΔL*, Δa* and Δb* according to the formula:

$$\Delta E^* = \sqrt{(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2}$$

”L*” is a measure of brightness, ”a*” is a measure of reddish-greenish and ”b*” is a measure of yellowish-bluish. The symbol in front of ΔL*, Δa* and Δb* has the following meaning:

ΔL*	+	brighter than standard
	-	darker than standard
Δa*	+	more reddish than standard
	-	more greenish than standard
Δb*	+	more yellowish than standard
	-	more bluish than standard

ISO 178 Flexural properties

4 reference samples (23140) and 3 weathered samples (21756) were tested.

The impact testing was performed at 23 °C and 50% relative humidity.

Test date 7 June 2018

ISO 179-1/1fU, Charpy impact strength

1 reference sample (23140) and 1 weathered sample (21756) was tested.

The pendulum energy was 15 J.

The impact testing was performed at 23 °C and 50% relative humidity.

Test date 7 June 2018

Results

ISO 7724, Colour measurements

The results from the colour measurements are presented in table 3.

Table 3. Colour measurements with spectrophotometer

Object ID	Date of measurement	Weathering Time (hours)	L*	a*	b*	ΔL*	Δa*	Δb*	ΔE*
21756	04-May-18	0	87.53	-0.36	-2.07				
21756	14-May-18	168	86.23	-2.2	10.25	-1.3	-1.84	12.32	12.53
21756	23-May-18	334	85.32	-2.17	16.38	-2.21	-1.81	18.46	18.68
20180612	13-June-18	0	86.07	-0.37	0.57				
20180612	20-June-18	171	86.26	-0.36	0.05	0.19	0.01	-0.52	0.55
20180612	03-July-18	332	86.21	-0.74	1.41	0.14	-0.37	0.83	0.92

Sample 21756 became clearly yellowish already after 168 hours of weathering and it increased even more after 334 hours. It is clearly visible in table 1 and appendix 1 figure 2 and figure 3. Sample 20180612 became slightly yellowish after 332 hours of weathering, see table 1 (Δb* and ΔE*) and appendix 1 figure 4.

ISO 178, Flexural properties

Table 4. ISO 178 Flexural properties of 4 refence test specimens

	Modulus of flexural elasticity, MPa	Flexural strength, MPa	Deformation at flexural strength, %	Sample height, mm	Sample width, mm	Cross section area
Arithmetic mean	2350	92.5	6.0	2.523	10	25.23
Std.dev	542	8.33	0.8	0.03403	0.08221	0.52
Coefficient of variance, %	23	9.0	14.2	1.35	0.82	2.06

Table 5. ISO 178 Flexural properties of 3 weathered test specimens

	Modulus of flexural elasticity, MPa	Flexural strength, MPa	Deformation at flexural strength, %	Sample height, mm	Sample width, mm	Cross section area
Arithmetic mean	2200	88.1	6.2	2.517	10.07	25.35
Std.dev	456	7.30	0.8	0.03055	0.01155	0.28
Coefficient of variance, %	21	8.3	13.4	1.21	0.11	1.11

The difference between the refence and the weathered test specimens is considered to be small when it is compared to the spread in the results.

ISO 179-1/1fU, Charpy impact strength

The reference sample did not break but the weathered sample did break. With a non-break the impact strength could not be calculated. Therefore it was only possible to make a qualitive comparison, non-break or complete. The testing was carried on with ISO 178.

RISE Research Institutes of Sweden AB
Chemistry and Materials - Corrosion and Surface Protection

Performed by

Signed by: Johan Nordberg
Reason: I am the author of this document
Date & Time: 2018-07-12 09:25:14 +02:00

Johan Nordberg

Examined by

Signed by: Konrad Tarka
Reason: I have reviewed this document
Date & Time: 2018-07-13 11:18:24 +02:00

Konrad Tarka

Appendix

Appendix 1

Figure 1. Front of polymeric box for fibreoptic (21756) photographed in D65 light

Figure 2. Test specimen (21756) before weathering photographed in D65 light

Appendix 1

Figure 3. Test specimen (21756) after 168 hours of weathering photographed in D65 light

Figure 4. Test specimen (21756) after 334 hours of weathering photographed in D65 light

Appendix 1

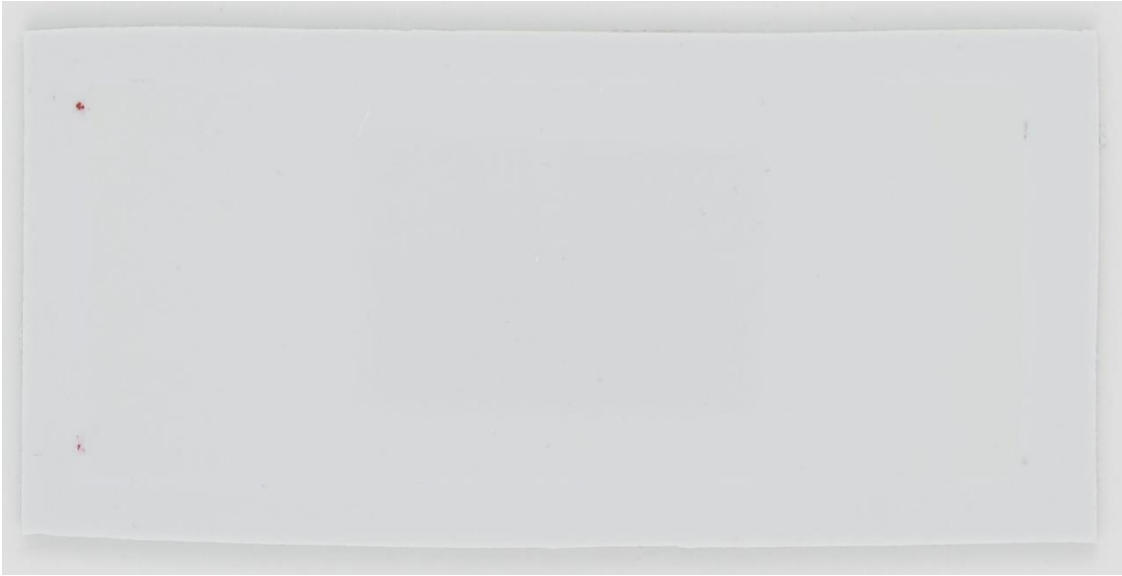

Figure 4. Test specimen (20180612) after 334 hours of weathering photographed in D65 light.

Remark: The red dots were present in areas that were covered by the sample holder.