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TNO report

TQS-RAP-08-3794/gge

EN ISO 12543-4 Glass in building - Laminated safety glass
Durability test on laminated safety glass
Sentry Glas® Plus, 2000 h + 4500 h UV Radiation

Lab. no. 1750

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Contents

1 Introduction

DuPont de Nemours (Belgium) BVBA, Mechelen, Belgium has commissioned TNO Quality Services BV, BU Glass to establish the durability of the laminated glass system Sentry Glas® Plus after 2000 h and 4500 h UV Radiation.
If any deviation of applied materials/process/machines is encountered (and a so-called major change), re-type testing or additional tests may be required. This decision and responsibility belongs to the manufacturer. The product description is the lead for determining the window of these rules.

The following paragraphs describe the tests, the results and the conclusions.

2 Product Testing

2.1 Producer of the samples

DuPont de Nemours (Belgium) BVBA
DuPont Glass Laminating Solutions
Antoon Spinoystraat 6
B – 2800 Mechelen
BELGIUM

2.2 Product description

3 samples of the following description were delivered for testing in September 2006:

- Sentry Glas® Plus.

Samples were coded: Sentry Glas® Plus BGSP 1, 2 and 3..
Dimensions of the sample: 3 samples of 300 mm x 300 mm (UV radiation)
Configuration of the test sample:

Flat glass	3 mm
Sentry Glas® Plus film	1.52 mm
Flat glass	3 mm
Thickness of the samples	7.1 mm.

Test specimens should be representative of standard production. Test specimens should either be specially manufactured to the test size or be cut from larger panes. Test specimen with cut edges should contain at least one edge from the original pane from which it was cut. If the final product has all its edges sealed/protected then the test specimen should also have all its edges sealed/protected. The method of supporting the test specimen shall not cover two edges of the test specimen. If the test specimen is cut from a larger pane at least one original edge was covered. The samples were identified and visually inspected prior to the test at a distance between 30 cm and 50 cm in front of a white diffuse background. Only samples free of faults (bubbles, delamination, cloudiness) are to be used for the test.
3 samples were tested prior to the 2000 h UV Radiation test on the initial Light Transmittance (EN 410). Then all three samples were tested on their durability behaviour under UV. Of all three samples after UV the Light Transmittance was measured after the 2000 h UV radiation. After these measurements the three samples were tested again on their UV durability behaviour, now for 2500 h.
After this second run again the Light Transmittance according to EN410 was measured.

2.3 Normative references

The EN ISO 12543-4 Standard specifies test methods in respect of resistance to high temperature, humidity and radiation for laminated glass and laminated safety glass for use in building.

EN 410	Glass in building - Determination of luminous and solar characteristics of glazing

2.4 Testing procedures

2.4.1 General

Testing the durability of laminated glass can divided into two main groups with each two subgroups.

Laminated safety glass (EN ISO 12543-2):
- Durability of laminated safety glass and laminated safety glass with fire resistant properties
  - High temperature test
  - Humidity test 5.3.1 (exposed direct to solar radiation)
  - Radiation test
- Durability of fire resistant laminated safety glass
  - Subgroup A:
    - Humidity test 5.3.2 (not exposed to direct solar radiation)
  - Subgroup B:
    - Humidity test 5.3.1 (exposed direct to solar radiation)
    - Radiation test

Laminated glass (EN ISO 12543-3):
- Durability of laminated glass and laminated glass with fire resistant properties
  - High temperature test
  - Humidity test 5.3.1 (exposed direct to solar radiation)
  - Radiation test
- Durability of fire resistant laminated glass
  - Subgroup A:
    - Humidity test 5.3.2 (not exposed to direct solar radiation)
  - Subgroup B:
    - Humidity test 5.3.1 (exposed direct to solar radiation)
    - Radiation test

2.4.2 Radiation test

2.4.2.1 Principle

The purpose of this test is to determine whether exposure of laminated glass or laminated safety glass to radiation over an extended period of time produces any appreciable change in its properties. The change in its properties is judged by a change in luminous transmittance and the occurrence of bubbles, delamination and cloudiness (not discolouration).

2.4.2.2 Exposure procedure to simulated solar radiation

A radiation source which emits a spectrum similar to solar radiation was used. Such a spectral distribution can be obtained by lamps which consist of a combination of a high pressure mercury vapour lamp with an incandescent tungsten filament. To obtain reproducible and comparable test results suitable lamps were used showing the following spectral characteristics by default:

UVB	(280 nm to 315 nm)	3% ± 1%
UVA	(315 nm to 380 nm)	8% ± 1%
Visible range	(380 nm to 780 nm)	18% ± 1%

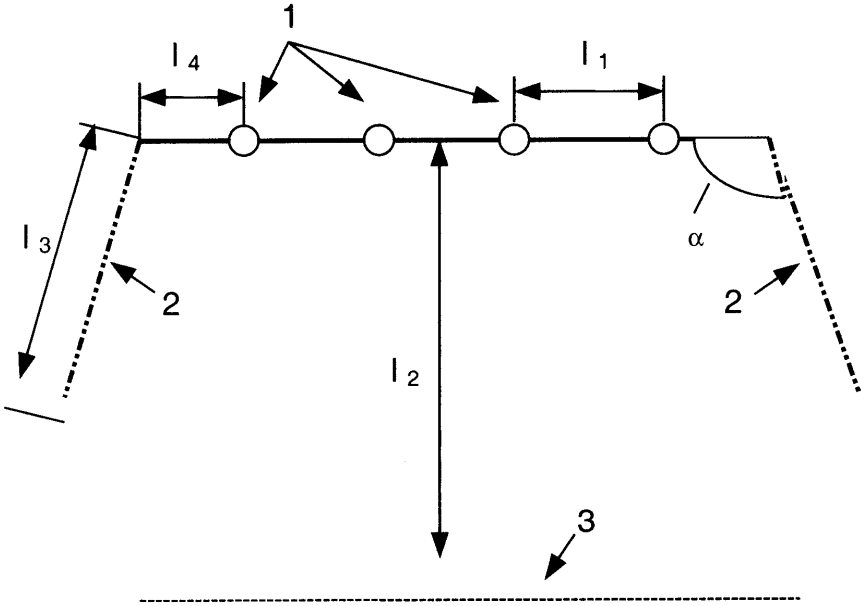
IRA	(780 nm to 1400 nm)	24% ± 2%
IRB	(1400 nm to 2600 nm)	27% ± 4%
IRC	(> 2600 nm)	20% ± 3%

2.4.2.3 Test conditions

The exposure time for the radiation test was 2000 h. The temperature of the test specimen was maintained at 45°C ± 5°C. The lamps were replaced when their irradiance level in the UVA decreases by more than 50%. The total irradiance level in the plane of the test samples was 900 W/m² ± 100 W/m².

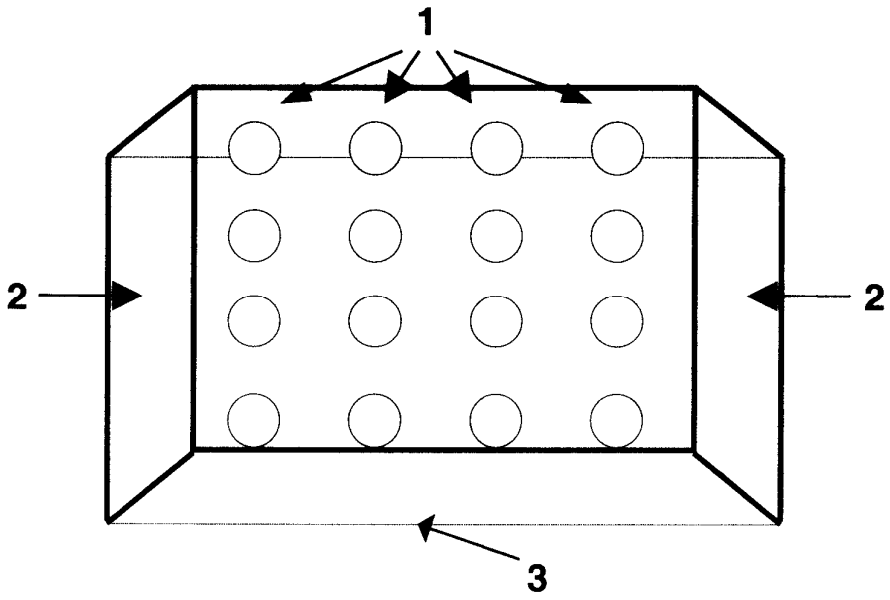
2.4.2.4 Arrangement of test apparatus

The test samples were mounted vertically in front of the radiation array. The radiation array consists of lamps uniformly separated to give the optimum radiation density in the plane of the test specimens. The minimum distance between the array of the test specimens and the bottom of the test room was 400 mm and the air space behind the array was at least 500 mm (to obtain undisturbed free natural convection upwards). In order to obtain a sufficiently uniform irradiance level the area covered by the test specimens did not exceed the area of the lamp array A given by the relation $A = n \times l_1^2$ where n = number of lamps and l_1 = distance between the axes of neighbouring lamps. As radiation sources OSRAM lamps type Ultra-Vitalux 300 W were used. 16 lamps were arranged in a square of 4 x 4 lamps with a distance of l_1 = 250 mm between the lamps forming a radiation field of 1 m x 1 m. The lamp array was framed by an stainless steel sides width l_3 = 1000 mm with a specular reflective surface. The distance between these sides and the outer row of lamps on each side is l_4 = 125 mm. The angle α between the plane of the radiation field and the aluminium foil is 100°. The test samples are placed in a parallel plane facing the lamp array at a distance of l_2 = 1100 mm forming an area of 1 m x 1 m (see figure 1).



1 lamps
2 aluminium foil
3 test specimens vertically mounted

Figure 1: Arrangement for the radiation test



1 lamps
2 aluminium foil
3 plane of test specimens

Figure 2: Arrangement for the radiation test (cross sectional view)

2.4.2.5 Size and number of test specimens

The size of the test specimens were 300 mm x 300 mm.

2.4.2.6 Procedure

When needed according to 6.5, the luminous transmittance was determined of the three test specimens before exposure according to EN 410.

The test specimens were orientated so that, if there is a designated outer surface, it faces the lamp array. Asymmetric laminated glass, which does not have a specific designated outer surface, should be tested both ways round. After exposure, the luminous transmittance of each test specimen was measured once again according to EN 410.

2.4.2.7 Expression of results

The samples were inspected at a distance between 30 cm and 50 cm in front of a white diffuse background. The number and extent of delamination occurring in the interlayer for each test specimen was reported (if any). All delamination within 15 mm from an original edge or 25 mm from a cut edge are not taken into account.

3 Results

3.1 Radiation test after 2000 h

Sentry Glas® Plus 3 mm / 0.38 mm / 3 mm

Sample Code	Type of test	Indoor / outdoor use?	Dimensions	Nominal thickness	asymmetrical y/n
Sentry Glas® Plus BGSP 1	Ultravitalux	outdoor	300 x 300	7.1 mm	N
Sentry Glas® Plus BGSP 2	Ultravitalux	outdoor	300 x 300	7.1 mm	N
Sentry Glas® Plus BGSP 3	Ultravitalux	outdoor	300 x 300	7.1 mm	N

Product description

Sample Code	Type of test	Cut or on size production	Edge type	Edge protection	Supported edge marked y/n	side facing radiation source
Sentry Glas® Plus BGSP 1	Ultravitalux	on size	arrissed	N	N	-
Sentry Glas® Plus BGSP 2	Ultravitalux	on size	arrissed	N	N	-
Sentry Glas® Plus BGSP 3	Ultravitalux	on size	arrissed	N	N	-

Results, after 2000 h UV radiation

Sample Code	Type of test	initial LT after 0 h	> 20%?y/n	LT after exposure	delamination y/n	Report value (%)
Sentry Glas® Plus BGSP 1	Ultravitalux	0.883	Y	0.883	N	0.0
Sentry Glas® Plus BGSP 2	Ultravitalux	0.883	Y	0.884	N	0.1
Sentry Glas® Plus BGSP 3	Ultravitalux	0.883	Y	0.884	N	0.1

3.2 Radiation test after 2000 h + 2500 h

Sentry Glas® Plus 3 mm / 0.38 mm / 3 mm

Sample Code	Type of test	Indoor / outdoor use?	Dimensions	Nominal thickness	asymmetrical y/n
Sentry Glas® Plus BGSP 1	Ultravitalux	outdoor	300 x 300	7.1 mm	N
Sentry Glas® Plus BGSP 2	Ultravitalux	outdoor	300 x 300	7.1 mm	N
Sentry Glas® Plus BGSP 3	Ultravitalux	outdoor	300 x 300	7.1 mm	N

Product description

Sample Code	Type of test	Cut or on size production	Edge type	Edge protection	Supported edge marked y/n	side facing radiation source
Sentry Glas® Plus BGSP 1	Ultravitalux	on size	arrissed	N	N	-
Sentry Glas® Plus BGSP 2	Ultravitalux	on size	arrissed	N	N	-
Sentry Glas® Plus BGSP 3	Ultravitalux	on size	arrissed	N	N	-

Results, after 2000 h + 2500 h UV radiation

Sample Code	Type of test	initial LT after 0 h	> 20%?y/n	LT after exposure	delamination y/n	Report value (%)
Sentry Glas® Plus BGSP 1	Ultravitalux	0.883	Y	0.884	N	0.1
Sentry Glas® Plus BGSP 2	Ultravitalux	0.883	Y	0.884	N	0.1
Sentry Glas® Plus BGSP 3	Ultravitalux	0.883	Y	0.884	N	0.1

3.3 Summary of results

Sample	Light Transmittance EN 410 / EN ISO 12543			Light Transmittance EN 410 / EN ISO 12543		
	initial LT before 2000 h UV	LT after 2000 h UV	report value in %	LT after 4500 h (= 2000 + 2500 h)	difference in % compared with 0 h UV	difference in % compared with 2000 h UV
Sentry Glas® Plus BGSP 1	0.883	0.883	0	0.884	0.1	0.1
Sentry Glas® Plus BGSP 2	0.883	0.884	0.1	0.884	0.1	0
Sentry Glas® Plus BGSP 3	0.883	0.884	0.1	0.884	0.1	0

4 Signature

Eindhoven, February 2008

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