

English Version

Glass in building - Folio interlayers for the manufacturing of laminated glass

Verre dans la construction - Films intercalaires pour la fabrication du verre feuilleté

Glas im Bauwesen - Folien-Zwischenlagen für die Herstellung von Verbundglas

This European Standard was approved by CEN on 20 January 2025.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

This document (EN 17940:2025) has been prepared by Technical Committee CEN/TC 129 “Glass in building”, the secretariat of which is held by NBN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by September 2025, and conflicting national standards shall be withdrawn at the latest by September 2025.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

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ISO 527-3:2018, *Plastics — Determination of tensile properties — Part 3: Test conditions for films and sheets*

ISO 11359-2:2021, *Plastics — Thermomechanical analysis (TMA) — Part 2: Determination of coefficient of linear thermal expansion and glass transition temperature*

ASTM D1003:2021, *Standard Test Method for Haze and Luminous Transmittance of Transparent Plastics*

ASTM E313:2020, *Standard Practice for Calculating Yellowness and Whiteness Indices from Instrumentally Measured Color Coordinates*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12543-1:2021 and EN ISO 12543-6:2021 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

4 General

The folio manufacturer is responsible for the preparation and maintenance of a product description. The folios may be described either in full, i.e. chemical composition, or by a manufacturer's code. Further guidance on documentation is given in Annex A.

Clause 5 covers the properties which are measured on the folio supplied, Clause 6 covers the folio properties which are determined on laminated glass incorporating the folio to be assessed.

Some folios reach their final properties only after the lamination process. This shall be considered in the evaluation of the interlayer properties to this document.

NOTE Mixing of different types of interlayers on top of each other can lead to e.g. chemical incompatibility, optical defects and changes in mechanical properties.

5 Properties of folios before processing

5.1 Dimensions

5.1.1 Length and width

The nominal length and width of the folio shall be provided by the folio manufacturer. The actual length and width of the folio product supplied shall not be less than the nominal length and width.

The oversize in width should be agreed upon by the laminated glass producer and folio manufacturer and can vary with the nature of the lamination process.

5.1.2 Thickness

The actual thickness d shall be the average of three measurements, taken to 0,01 mm at the edges and the centre of the folio interlayer. The measurement shall be performed by means of an instrument of the calliper micrometre type at a temperature of $(23 \pm 3) ^\circ\text{C}$. The measurement shall be taken having applied a pressure to the interlayer of not more than 60 N/m² for 5 s to 10 s.

NOTE The relative ambient humidity does not have a significant influence on the result of the thickness measurement.

The nominal thickness of the folio shall be provided by the folio manufacturer. The actual thickness of the folio supplied, rounded to the nearest 0,01 mm, shall not vary from the nominal thickness by more than the tolerances shown in Table 1.

Table 1 — Tolerances on nominal thickness

Nominal thickness mm	Tolerances mm
$d \leq 1$	$\pm 0,05$
$1 < d \leq 2$	$\pm 0,07$
$d > 2$	$\pm 0,1$

Narrower product specific thickness tolerances should be available from the folio interlayer manufacturer.

For the final laminated glass, Clause 4.1.2.1 of EN ISO 12543-5:2021 also applies.

5.2 Appearance

5.2.1 General

The folio manufacturer shall have a process in place to control foreign particles and/or contaminations that can lead to defects in the laminated glass.

5.2.2 Methods of observation and measurement

5.2.2.1 General

In order to check the appearance of the interlayer supplied, a representative folio sample of at least 1 m² size is inspected with the naked eye and under normal diffused lighting conditions, (natural daylight or simulated daylight, between 300 lx and 600 lx at the folio) from a distance of 1 m. The direction of observation is normal, i.e. at right angles, to the folio. When inspected to this observation method, holes, creases and streaks are not allowed.

5.2.2.2 Spot imperfections

The largest dimension (diameter or length) of these imperfections is measured with a micrometer with graduations in tenths of a millimetre. The number and dimensions of the spot imperfections are noted. Table 2 gives the allowable number of imperfections.

Table 2 — Acceptance levels of spot imperfections

Dimension of spot imperfections mm	Average per 20 m ²
$\leq 0,5$	No cluster allowed
$> 0,5$ and $\leq 1,0$	3
$> 1,0$ and $\leq 3,0$	0,6
$> 3,0$	0,05

NOTE The word average indicates a cumulative average over at least 2 000 m² of foil.

5.2.2.3 Linear/extended imperfections

The sample is inspected to the observation method described in 5.2.2 and the presence of visually disturbing imperfections is noted.

The allowable number of imperfections is an average 0,05 imperfections in 20 m² of foil, related to at least 2 000 m².

5.3 Interlayer stiffness properties

The viscoelastic properties of the folio or folio product family shall be determined according to EN 16613:2019 for use in calculations of laminated glass load resistance.

If no determination to EN 16613:2019 is available from the folio manufacturer, the level of interlayer modelling 1, from CEN/TS 19100-1:2021 Table 7.1 should be used.

In absence of further information of the folio manufacturer, the Poisson's ratio of the folio can be taken as 0,49 for isotropic folios.

5.4 Safety in the case of fire (cf. Reaction to fire EN 13501-1)

The calorific value of a single composition per folio or folio product family shall be determined according to EN ISO 1716.

This can be used by the laminated glass producer, as part of the determination of the class of reaction to fire of the laminated glass to EN 13501-1.

NOTE The availability of such test report does not imply the necessity for classification of the laminated glass, nor an opinion on the suitability or relevance of EN 13501-1 for such classification.

5.5 Thermal and other physical properties

The density, coefficient of thermal expansion, thermal conductivity and specific heat of the folio shall be assessed using the standards given in Table 3.

Table 3 — Test methods to determine the material properties before lamination

Material property	Test method
Density	EN ISO 1183-1:2019, procedure A
Thermal expansion coefficient	ISO 11359-2:2021
Thermal conductivity	EN ISO 22007-4:2024
Specific heat capacity	EN ISO 11357-4:2021
Calorific value (gross heat of combustion)	EN ISO 1716:2018
Tensile strength at 23 °C	ISO 527-3:2018

In absence of further information from the folio producer, the values given in Table 4 can be used to calculate the properties of laminated glass:

Table 4 — Conventional values of material properties

Property	Unit	Material	Value
Density	g/cm ³	PVB	1,07
		EVA	0,95
		Ionomer	0,97
Thermal expansion coefficient	1/K	PVB	$1,7 \cdot 10^{-4}$
		EVA	$1,6 \cdot 10^{-4}$
		Ionomer	$1,3 \cdot 10^{-4}$
Thermal conductivity	W/(m·K)	PVB	0,2
		EVA	0,3
		Ionomer	0,25
Specific heat capacity	J/kg·K	PVB	2 000
		EVA	2 300
		Ionomer	1 800 (at 20 °C) 2 400 (at 60 °C)
Calorific value	MJ/kg	PVB	31
		EVA	40
		Ionomer	40

6 Properties of folios after lamination

6.1 General

Some folio properties can only be assessed after lamination.

For some folios, e.g. EVA, the degree of crosslinking can have an influence on the properties of the processed folio. It can be determined according to ISO 10147:2011 or EN 62788-1-6:2017¹. The necessary degree of crosslinking should be considered when defining the processing conditions.

6.2 Adhesion

The mechanical behaviour of a laminated glass assembly is a result of the inherent mechanical or viscoelastic properties of the folio, and the adhesion of the folio to the other components of the assembly.

The inherent mechanical properties are set by the composition of the folio and are further specified in 5.3.

The folio manufacturer shall have a procedure in place to control the adhesion of the folio.

The folio manufacturer can base this procedure on any of the methods applicable on laminated glass in EN 14449:2005, Annex C or use an appropriate method that is executed on the folio product, e.g. a peel test according to EN 28510-1:2014 (90°) or EN ISO 8510-2:2010 (180°).

The folio manufacturer shall specify the adhesion level of the folio to glass including the tolerance and link this information to the test method used to determine the adhesion.

¹ As impacted by EN 62788-1-6:2017/A1:2020

6.3 Resistance to radiation

The resistance to radiation of a single composition per folio or folio product family shall be tested according to EN ISO 12543-4:2021, 7.3.1 and assessed according to EN ISO 12543-2:2021, 5.3 or EN ISO 12543-3:2021, 5.3.

The test specimens for the radiation test shall conform to the minimum specification of the product family related to folio type and shall be manufactured using the recommended processing conditions.

Although coloured folios can be grouped into the same product family, they should be tested individually or by subfamily for the purposes of this test.

6.4 Spectral properties and other optical properties

The luminous and solar properties of an interlayer in laminated glass shall be determined in accordance with EN 410:2011, B.3.2.

The light transmittance and light reflectance spectra of one sample of laminated glass, made of one specific folio and two identical glass components of known thicknesses, shall be measured.

The light transmittance and light reflectance spectra of one sample of the same glass as the glass components referred to above shall be measured.

The spectra of the folio shall be derived by calculation in accordance with EN 410.

Tolerances shall be given by the folio manufacturer.

The folio colour and colour tolerances should be agreed between the folio manufacturer and glass producer using an appropriate code, e.g. L^* , a^* , b^* coordinates (ISO/CIE 11664-4).

In addition to the spectral properties, the folio manufacturer shall declare the refractive index, yellowness index and haze of the folio for the nominal folio thickness. They shall be assessed using the standards given in Table 5.

Table 5 — Test methods to determine the material properties after lamination

Material property	Test method
Refractive index	EN ISO 489:2022
Haze value	ASTM D1003:2021
Yellowness index	ASTM E313:2020

The haze value shall be declared for each folio thickness.

The yellowness index shall be declared for each folio thickness excluding the contribution of the glass by calculation according to EN 410:2011, Annex B.

Guidance for optimizing accuracy in the determination of the luminous and solar properties of an interlayer is provided in Annex B.

6.5 Acoustic properties

The folio capability to dampen sound waves can be determined on laminated glass specimen in accordance with ISO 16940.

A folio can be described as having a specific acoustic performance if the measured loss factor of the 1st mode of the beam of the folio is equal to or greater than 0,20, when measured in accordance with ISO 16940.

For acoustic calculation purposes (software simulation), the following values need to be provided:

— Poisson's ratio;

— shear modulus determined according to EN 16613:2019, Annex D.

The modulus values shall be determined at a temperature of (20 ± 1) °C for the following nominal third octave band frequencies:

50,63,80,100,125,160,200,250,315,400,500,630,800,1 000,1 250,1 600,2 000,2 500,3 150,4 000, 5 000 Hz.

Annex A **(informative)**

Documentation

A.1 General

A product description either for a single product or a product family should be prepared and maintained by the manufacturer.

The folios may be described either in full, i.e. chemical composition, or by a manufacturer's code.

A product family can be related e.g. to the performance of the folios, to the composition of the folios, or to a combination of these. It is considered that the results for one or more characteristics from any one folio within the family are representative for those same characteristics for all products within the same family. If possible, it is recommended that the folio with the lowest performance for a certain characteristic is used to represent the product family. Products may be grouped in different families for different characteristics.

A.2 Documentation

For every folio or folio product family supplied, a technical document detailing at least the characteristics required in this document should be provided by the manufacturer.

The folio manufacturer's documentation and procedures should be relevant to the production and process control of the laminated glass and laminated safety glass, and should be adequately described in a manual which should include:

- a) a general description of the product;
- b) a description of the product form and packaging, including a description of the information available on the packaging such as dimensions of the product supplied and information relevant for quality control purposes of the laminated glass supplier (traceability);
- c) a description of handling and storage conditions, including a specification of moisture control if relevant;
- d) guidance for the lamination process to produce laminated glass and laminated safety glass. This can include, but it is not limited to, a description of suitable lamination process type and process conditions recommended during the lamination process.

A.3 Complementary information related to REACH

According to EU REACH Regulation (EC) No 1907/2006, an SDS (safety data sheet) is required for substances and mixtures that meet the criteria for classification as hazardous. That same regulation does not require an SDS for articles.

The folio is 1) an article and 2) is not classified with hazardous properties. So legally, it is not entitled to provide an SDS for articles.

However, according to Article 33 of the REACH Regulation (EC) No 1907/2006, any supplier of an article containing a substance meeting the criteria of Article 57 and identified in accordance with Article 59(1) (Substance of Very High Concern), in a concentration above 0,1 % weight by weight (w/w) should

provide the recipient of the article with sufficient information, available to the supplier, to allow safe use of the article including, as a minimum, the name of that substance.

Annex B

(informative)

Considerations for optimizing accuracy in determination of luminous and solar properties of folio interlayers

The following should be taken into account when determining the luminous and solar spectra of an interlayer in laminated glass:

- a) The glass components should have as high a transmittance as possible and be transmissive in the same wavelength region as the interlayer material when laminated. It is suggested that the direct solar transmittance of each float glass component determined in accordance with EN 410 should be a minimum of 0,83.

NOTE 1 This is to avoid the case of an interlayer with a high transmittance in the UV region and the glass components with a low transmittance in the same region.

- b) The use of a spectrophotometer equipped with an integrating sphere is highly recommended.

NOTE 2 The procedure in EN 410:2011, Annex B is not appropriate for calculation of the properties of light scattering interlayer materials.

- c) In the case of an interlayer that polarizes the light, then the spectrophotometer should be equipped with a depolarizer.
- d) Should the thickness of the interlayer be recalculated in accordance with EN 410:2011, B.3.2, then it is advisable for the source interlayer data to be for the minimum and maximum thickness of the range of intended use. For example, for an interlayer thickness range of 0,38 mm to 1,52 mm, it would be preferable for an interlayer thickness of 0,38 mm and 1,52 mm to be used for the source data.

Bibliography

- EN 13501-1, *Fire classification of construction products and building elements — Part 1: Classification using data from reaction to fire tests*
- EN 14449:2005, *Glass in building — Laminated glass and laminated safety glass — Evaluation of conformity/Product standard*
- EN 28510-1:2014, *Adhesives — Peel test for a flexible-bonded-to-rigid test specimen assembly — Part 1: 90° peel*
- EN ISO 8510-2:2010, *Adhesives — Peel test for a flexible-bonded-to-rigid test specimen assembly — Part 2: 180 degree peel (ISO 8510-2:2006)*
- ISO 10147:2011, *Pipes and fittings made of crosslinked polyethylene (PE-X) — Estimation of the degree of crosslinking by determination of the gel content*
- ISO 16940:2008, *Glass in building — Glazing and airborne sound insulation — Measurement of the mechanical impedance of laminated glass*
- ISO/CIE 11664-4, *Colorimetry — Part 4: CIE 1976 L*a*b* colour space*
- EN 62788-1-6:2017², *Measurement procedures for materials used in photovoltaic modules — Part 1-6: Encapsulants — Test methods for determining the degree of cure in Ethylene-Vinyl Acetate*
- CEN/TS 19100-1:2021, *Design of glass structures — Part 1: Basis of design and materials*
- Regulation (EC) No 1907/2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH)
- Regulation (EC) 305/2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC

² As impacted by EN 62788-1-6:2017/A1:2020