BRITISH STANDARD

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1748-2-1:2004

Glass in building — Special basic products — Glass ceramics —

Part 2-1: Definitions and general physical and mechanical properties

The European Standard EN 1748-2-1:2004 has the status of a British Standard

ICS 01.040.81; 81.040.20

BSI
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National foreword

This British Standard is the official English language version of EN 1748-2-1:2004. It supersedes BS EN 1748-2:1998 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee B/520, Glass and glazing in building, to Subcommittee B/520/1, Glass and glazing in building — Basic and transformed glass products, which has the responsibility to:

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Foreword

This document (EN 1748-2-1:2004) has been prepared by Technical Committee CEN /TC 129 "Glass in Building", the secretariat of which is held by BIN.

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of an identical text or by endorsement, at the latest by March 2005, and conflicting national standards shall be withdrawn at the latest by March 2005.

This document supersedes EN 1748-2:1997.

This document consists of the following parts:

EN 1748-2-1 *Glass in building - Special basic products - Glass ceramics –Part 2 – 1: Definitions and general physical and mechanical properties*

EN 1748-2-2 *Glass in building - Special basic products - Glass ceramics – Part 2-2: Evaluation of conformity/Product standard*

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1 Scope

This document defines, specifies and classifies glass ceramics for use in building. It indicates their chemical composition, main physical and mechanical properties, dimensional and minimum quality requirements (in respect of optical and visual faults).

This document applies to glass ceramics supplied in stock sizes or in cut sizes for final end use.

This document does not apply to final cut sizes having a dimension less than 100 mm or a surface area less than 0,05 m².

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
glass ceramics
type of glass consisting of a crystalline and a residual glass phase. The glass is obtained by normal glass manufacturing methods, e.g. casting, floating, drawing, rolling and is subsequently subjected to a heat treatment which transforms, in a controlled manner, part of the glass into a fine grained crystalline phase. The glass ceramics has properties which deviate from those of the glass from which it was transformed.

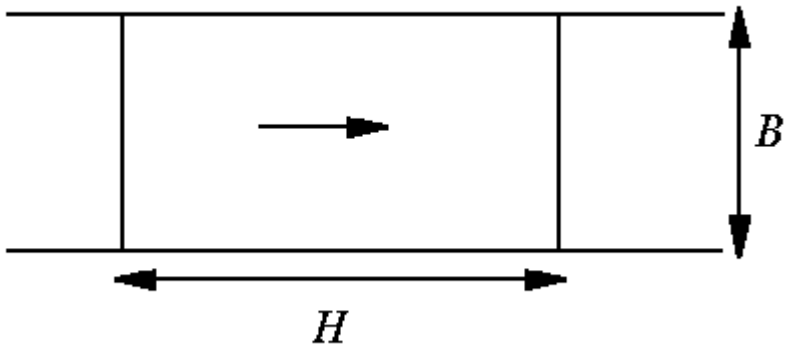
3.2
floated glass ceramics
flat, transparent or translucent, clear or tinted glass ceramics having parallel and polished faces obtained by continuous casting and flotation on a metal bath.

3.3
drawn sheet glass ceramics
flat, transparent or translucent, clear or tinted glass ceramics obtained by continuous drawing, initially vertically, of a regular thickness and with the two surfaces fire polished.

3.4
rolled glass ceramics
flat, transparent or translucent, clear or tinted glass ceramics obtained by rolling.

3.5
cast glass ceramics
flat, transparent or translucent, clear or tinted glass ceramics obtained by casting.

3.6
nominal length, *H and* nominal width, *B*
pane length or pane width defined with reference to the direction of draw of the glass ceramics ribbon as shown in Figure 1.



Key

⟶ Direction of draw

Figure 1 — Relationship of length, width and direction of draw

3.7
stock sizes
glass ceramics delivered in manufacturers standard stock sizes.

3.8
final cut size
pane of glass ceramics that has been cut down to the dimensions being required either for installation or processing into a final product e.g. insulating glass units.

3.9
optical faults
faults, which lead to distortions on the appearance of objects observed through the glass ceramics.

3.10
visual faults
faults, which alter the visual quality of the glass ceramics. They are spot faults and linear / extend faults.

3.11
spot faults
spot fault is a nucleus, which is sometimes accompanied by a halo of distorted glass ceramics. The dimension of a spot fault comprising a nucleus with a halo is obtained by multiplying the dimension of the nucleus by a factor of approximately 3.

3.12
linear / extended faults
these faults can be on or in the glass ceramics, in the form of deposits, marks or scratches that occupy an extended length or area.

3.13
edge defects
these defects can occur on the edge of a cut size piece in the form of entrant and emergent faults and / or bevels.

3.14
concentration, *c*
the sum of the lengths of gaseous inclusions greater than 1,0 mm in any circle of 400 mm diameter.

4 Chemical composition

4.1 Principal Constituents

The magnitude of the proportions by mass of the principal constituents of all the glass ceramics products covered by this standard is as follows:

—	Silicon dioxide	SiO_2	50 % to 80 %
—	Aluminium oxide	Al_2O_3	15 % to 27 %
—	Lithium oxide	Li_2O	0 % to 5 %
—	Zinc oxide	ZnO	0 % to 5 %
—	Titanium dioxide	TiO_2	0 % to 5 %
—	Zirconium dioxide	ZrO_2	0 % to 5 %
—	Magnesium oxide	MgO	0 % to 8 %
—	Calcium oxide	CaO	0 % to 8 %
—	Barium oxide	BaO	0 % to 8 %
—	Sodium oxide	Na_2O	0 % to 2 %
—	Potassium oxide	K_2O	0 % to 2 %
—	Others		0 % to 5 %

4.2 Tint

Body tinted glass ceramics is obtained by the addition of suitable materials.

5 Physical and mechanical characteristics

5.1 General characteristics

Conventional numerical values for the physical and mechanical characteristics of the glass ceramics used to manufacture basic product are given in Table 1. These values, for normal annealed glass ceramics (without any further toughening), are not precise requirements with which the glass ceramics shall strictly comply, but are the generally accepted figures for use in calculations where a high degree of accuracy is not required.

Table 1 — Physical and mechanical characteristics of glass ceramics

Characteristic	Symbol	Value and unit
Density (at 18 °C)	ρ	2500 kg/m^3 to 2600 kg/m^3
Hardness (Knoop)	$HK_{0,1/20}$	6 to 7,5 GPa
Young's modulus (modulus of elasticity)	E	9 x 10^{10} Pa
Poisson's ratio	μ	0,2
Characteristic bending strength	$f_{g,k}$	45 x 10^6 Pa [1]
Specific heat capacity	c_p	0,8 x 10^3 J/(kg*K) to 0,9 x 10^3 J/(kg*K)
Nominal value of average coefficient of linear expansion between 20 °C and 300 °C	α	zero
Resistance against temperature differential and sudden temperature change		650 K [2]
Thermal conductivity	λ	1,5 W/(m*K)
Mean refractive index to visible radiation (380 nm to 780 nm)	n	1,5
Emissivity (corrected)	ε	0,837
[1] A design method will be made available from TC 129 WG8 (prEN 13473) [2] Generally accepted value that is influenced by edge quality and glass type		

5.2 Definition of clear glass ceramics

A glass ceramics product is defined as clear glass ceramics when it is not tinted and when the light transmittance of the glass ceramics material, unmodified by the possible presence of a coating or surface roughness,

— after any necessary pre-treatment

— measured according to EN 410

— rounded to the nearest 0,01

is greater than or equal to the value given in Table 2 for the nominal thickness of the glass ceramics product.

In order to measure the light transmittance characteristics of glass ceramics, to determine whether it can be classified as clear, it is necessary, in some cases, to carry out a pre-treatment:

— coatings on smooth surfaces have to be eliminated, without modifying the thickness of the glass ceramics substrate.

— rough surfaces, with or without coatings, have to be eliminated by smoothing and polishing. The thickness of the glass ceramics will be modified by this process.

The light transmittance of a glass ceramics substrate has to be measured with its surfaces in a polished condition.

Table 2 — Minimum values for determining if a transparent or translucent glass ceramics product is clear

Nominal thickness in mm	Minimum value[1,2]
3	0,86
4	0,84
5	0,82
6	0,80
7	0,78
8	0,76

[1] The limiting values given are applicable provided that the measured thickness of the glass ceramics product is within the allowable tolerances for the nominal thickness of that product.

[2] The values given are not suitable for design. They are values used only for the definition of clear glass ceramics and exclude the effects of coatings and of surface patterns. The values of light transmittance used for design should be obtained from the glass manufacturer, measured according to EN 410.

5.3 Stability of physical and chemical characteristics

For glass ceramics products, the physical and chemical characteristics can be considered as remaining constant over time.

a) Since glass ceramics is insensitive to photochemical effects, the spectral properties (transmission of light and solar energy) of the glass ceramics products are not modified by direct or indirect solar radiation.

b) The surface of glass ceramics used in building is virtually insensitive to attack from the environment.

6 Dimensional requirements

6.1 Manufacturing dimensions

6.1.1 Stock sizes

Glass ceramics delivered in the following size range:

Nominal length H: 500 mm to 3300 mm
Nominal width B: 500 mm to 2300 mm

6.1.2 Final cut sizes

Glass ceramics delivered in any dimension less than those covered by the stock sizes.

The minimum cut size shall have dimensions H and B not less than 100 mm and a minimum surface area of not less 0,05 m².

6.2 Thickness

The actual thickness shall be the average of four measurements, taken to the nearest 0,01 mm, one taken at the centre of each side. Measurement shall be made by means of an instrument of the calliper micrometer type.

6.2.1 Tolerances

The actual thickness, rounded to the nearest 0,1 mm shall not vary from the nominal thickness by more than the tolerances shown in Table 3.

Table 3 — Nominal thicknesses and thickness tolerances

Nominal thickness in mm	thickness tolerances in mm
3	± 0,5
4	± 0,5
5	± 0,5
6	± 0,5
7	± 0,5
8	± 0,5

6.3 Length, width, squareness and tolerances

The nominal dimensions for the length, H, and width, B, being given the pane shall not be larger than a prescribed rectangle resulting from the nominal dimensions increased by the permissible plus tolerance, t, or smaller than a prescribed rectangle resulting from the nominal dimensions reduced by the permissible minus tolerance, t. The sides of the prescribed rectangles shall be parallel to one another and these rectangles shall have a common centre (see figure 2).

The limits of squareness shall also be prescribed by these rectangles.

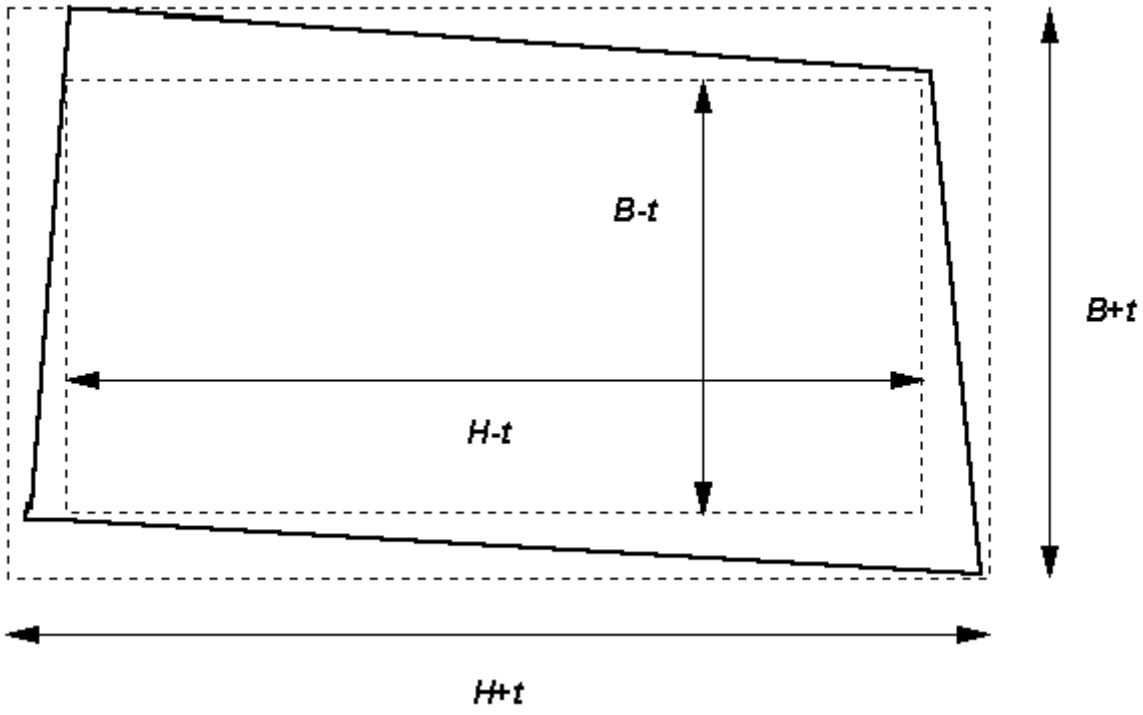


Figure 2 — Determination of length, width and squareness

The tolerance, *t*, on the nominal dimensions length H and width B is given in table 4.

Table 4 — Tolerance on the nominal dimensions length and width

Thickness in mm	Tolerance t in mm			
	stock	Final cut sizes in mm		
		(H, B) ≤ 1500	1500 < (H,B) ≤ 3000	(H, B) > 3000
3, 4, 5, 6	10	2	5	10
7, 8	10	3	5	10

7 Quality requirements

7.1 Methods of observation and measurement

7.1.1 Optical faults

7.1.1.1 Principle of test

A reticulated screen is observed through the pane of glass ceramics to be examined.

7.1.1.2 Screen

The screen should have approximately the same dimensions as the pane of glass ceramics to be examined. It consists of a matt grey background (reflection coefficient between 0,2 and 0,4) having a network of lines 10 mm thick of a colour contrasting clearly with the background.

The network of lines shall have appearance of a wall of bricks whose sizes are 200 mm x 70 mm, each vertical line offset by 100 mm from the vertical lines above and below.

The lighting of the screen shall correspond to natural day lighting.

7.1.1.3 Conditions of observation

The pane of glass to be examined shall be placed vertically 3 m from the screen. The point of observation shall be 1 m from the glass ceramics keeping the direction of observation perpendicular to the screen. The pane of glass ceramics shall form an angle of 45° with the pane of the screen.

7.1.1.4 Procedure

View the screen through the glass ceramics and note any disturbing distortions to the pattern.

7.1.2 Visual faults

7.1.2.1 Spot faults

Measure the largest dimension (diameter or length) of these faults with a micrometer with graduations in tenths of millimetre.

Note the number, dimensions and concentration of spot faults.

7.1.2.2 Linear/extended faults

7.1.2.2.1 Principle of test

The pane of glass ceramics to be examined is illuminated in conditions approximating to diffuse daylight and is observed in front of a matt black screen.

7.1.2.2.2 Conditions of observation

The pane of glass ceramics to be examined shall be placed vertically in front of the screen and parallel to it. The point of observation shall be 2 m from the glass ceramics, keeping the direction of observation normal to the glass ceramics surface.

7.1.2.2.3 Operating method

View the pane of glass ceramics and note the presence of visually disturbing faults.

7.2 Acceptance levels

7.2.1 Optical faults, spot faults, linear/extended faults

When viewed under the conditions of observation as described in 7.1, the allowable numbers of the categories of faults are shown in Table 5.

Table 5 — Summary of acceptance levels

Faults	Acceptance criteria
Optical	No disturbing distortions in observation conditions given under 7.1.1.3
Visual Spot Faults	
Gaseous inclusions $\leq$ 1 mm	acceptable
Gaseous inclusions > 1 mm acceptable if:	
- maximum length	$\leq$ 19 mm
- sum of lengths per m²	$\leq$ 500 mm
- maximum number per m²	100 for length 1 mm to 3 mm 30 for length 4 mm to 7 mm 4 for length 8 mm to 19 mm
Concentration (c)	$\leq$ 80 mm
Other spot faults	
- 0,5 mm to 1,5 mm	50 per m²
- > 1,5 mm to 2,5 mm	5 per m²
- > 2,5 mm to 5,0 mm	2 per m²
Remark concerning all spot faults	In the case of a single fault per m² the maximum dimension may be increased by 25 %
Linear/extended faults	The allowable number of faults is an average of 0,05 faults in 20m² of glass ceramics relating to at least 20 tonnes.

7.2.2 Edge defects for final cut sizes

7.2.2.1 Entrant and emergent faults

These faults are shown in figures 3 and 4. The dimensions h1, h2 and p and the glass ceramics thickness e are measured.

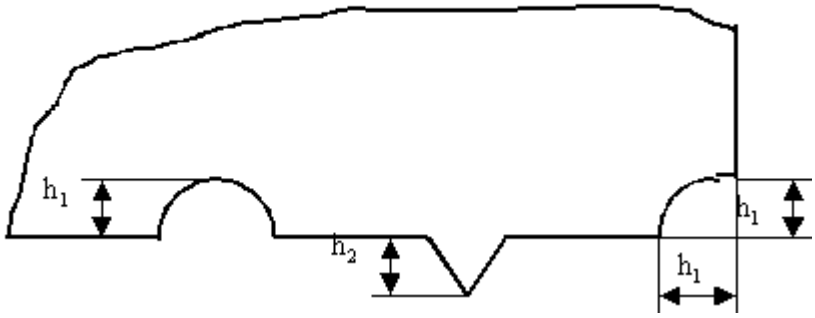


Figure 3 — Entrant and emergent faults – surface view

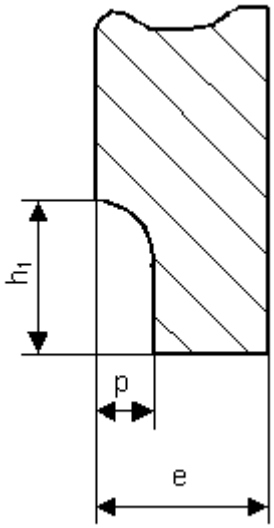


Figure 4 — Entrant faults – edge view

7.2.2.2 Bevel

This fault is shown in figure 5. The dimension d and the glass ceramics thickness e are measured.

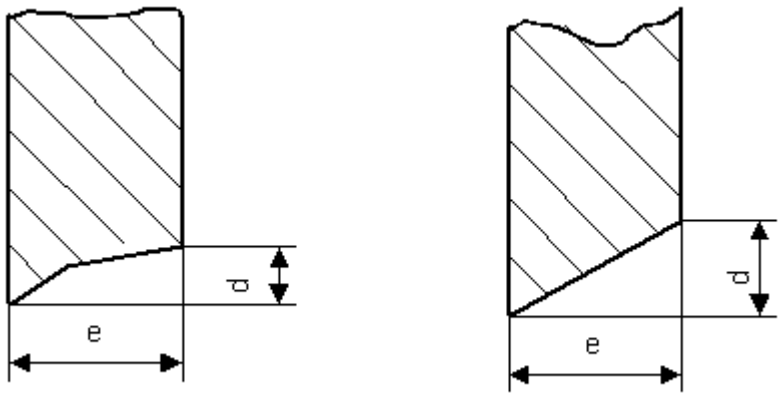


Figure 5 — Bevel – edge view

7.2.2.3 Limitations on edge defects

The limitations on entrant and emergent faults and bevel are given in table 6.

Table 6 — Limitations on edge defects

Edge defect	Limitations
Entrant fault	$h_1 < e - 1mm$ $p < (e/4)$
Emergent fault	h_2 shall not exceed the positive tolerance t as given in table 4 and the pane shall remain within the rectangles as shown in figure 2.
Bevel	The ratio (d/e) shall be less than 0,25

NOTE The limitations only apply when there is no risk of breakage resulting from thermal stress. In applications where thermal stress breakage may apply, the manufacturers' recommendations on edge quality should be followed.

8 Designation

Glass ceramics in compliance with this standard shall be designated respectively by:

— type

— reference to this document

— tint (manufacturers reference) or clear

— nominal thickness

— nominal length, *H*, and nominal width, *B*

EXAMPLE:

Designation of a glass ceramics, clear, thickness 5 mm, nominal width 1,2 m, nominal length 2,0 m, for use in buildings:

Floated glass ceramics,EN 1748-2-1, clear, 5 mm, 1200 mm x 2000 mm

Bibliography

[1] prEN 13474-3, *Glass in building – Design of glass panes – Part 3: Design for line and concentrated loads*

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