

General information

Overview

Laminated glass consists of a laminar system of layers of glass interleaved by flexible polymeric material. This assembly has the advantage that if the glass cracks due to impact or exposure to high temperatures, it will not shatter since the broken glass will remain bonded to the polymer layer. In addition, the assembly displays improved thermal resistance and acoustic properties compared to a single glass window layer. There are two types of laminated glass - poly vinyl butyral (PVB) laminated glass (with typically a 0.38mm thick layer of poly vinyl butyral sandwiched between two glass layers by the application of pressure and heat), and Cast in Place (CIP) laminate glass (where the 1.0 to 1.5mm layer of resin is poured into the cavity between two sheets of glass). Within these two major types further variation in the performance of the laminated glass is available through the use of multilayer (e.g. 5 ply) laminated glass, varying the thickness of the polymer and glass, and using different types of glass (e.g. annealed, heat-strengthened, toughened, low-e glass, tinted, reflective). For architectural purposes there are four main grades: Safety, Security, Bullet Resistant and Solar Control. This record contains data for two 1/4" sheets of normal clear float glass sandwiching 0.3mm of PVB.

Tradenames

Optilam; Pilkington Frontline; Saflex; SentryGlas; Keepsafe

Typical uses

Safety windows (will not shatter on impact or exposure to high temperatures); floors, staircases.

Composition overview

Composition (summary)

Glass layers: 73% SiO₂/1% Al₂O₃/17% Na₂O/4% MgO/5% CaO

Polymer layer: poly vinyl butyral

Base	Oxide
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Composition detail (metals, ceramics and glasses)

Al ₂ O ₃ (alumina)	0,95	%
CaO (calcia)	4,75	%
MgO (magnesia)	3,8	%
Na ₂ O (sodium oxide)	16,2	%
SiO ₂ (silica)	69,4	%

Composition detail (polymers and natural materials)

Polymer	5	%
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Price

Price	* 4,31	- 6,95	EUR/kg
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Physical properties

Density	2,35e3	- 2,45e3	kg/m ³
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Mechanical properties

Young's modulus	* 66	- 68	GPa
Yield strength (elastic limit)	* 33	- 38	MPa
Tensile strength	* 33	- 38	MPa
Elongation	* 0,05	- 0,06	% strain
Compressive modulus	* 63,8	- 70,4	GPa
Compressive strength	* 370	- 410	MPa
Flexural modulus	70	- 74	GPa
Flexural strength (modulus of rupture)	* 40	- 45	MPa
Shear modulus	* 27	- 29	GPa
Bulk modulus	* 37	- 40	GPa
Poisson's ratio	* 0,22	- 0,24	
Shape factor	15		
Hardness - Vickers	* 438	- 483	HV

Fatigue strength at 10 ⁷ cycles	* 26,5	- 31,8	MPa
Mechanical loss coefficient (tan delta)	* 0,01	- 0,05	

Impact & fracture properties

Fracture toughness	* 1	- 1,3	MPa.m ^{0.5}
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Thermal properties

Glass temperature	100	- 592	°C
Maximum service temperature	* 63,2	- 76,9	°C
Thermal conductivity	* 0,625	- 1,11	W/m.°C
Specific heat capacity	850	- 950	J/kg.°C
Thermal expansion coefficient	9,1	- 9,5	µstrain/°C

Electrical properties

Electrical resistivity	8e17	- 8e18	µohm.cm
Dielectric constant (relative permittivity)	5,6	- 6,2	
Dissipation factor (dielectric loss tangent)	0,027	- 0,037	
Dielectric strength (dielectric breakdown)	* 12	- 14	MV/m

Optical properties

Refractive index	1,5	- 1,52	
Transparency	Optical quality		

Durability

Water (fresh)	Excellent
Water (salt)	Excellent
Weak acids	Excellent
Strong acids	Acceptable
Weak alkalis	Excellent
Strong alkalis	Unacceptable
Organic solvents	Excellent
Oxidation at 500C	Excellent
UV radiation (sunlight)	Excellent
Flammability	Non-flammable

Primary production energy, CO2 and water

Embodied energy, primary production	* 27,7	- 30,6	MJ/kg
CO2 footprint, primary production	* 1,67	- 1,84	kg/kg
Water usage	* 28,7	- 31,8	l/kg

Processing energy & CO2 footprint

Glass molding energy	* 6,18	- 6,83	MJ/kg
Glass molding CO2	* 0,494	- 0,546	kg/kg
Grinding energy (per unit wt removed)	* 31,3	- 34,6	MJ/kg
Grinding CO2 (per unit wt removed)	* 2,35	- 2,6	kg/kg

Recycling and end of life

Recycle	✓		
Embodied energy, recycling	* 22,7	- 25,1	MJ/kg
CO2 footprint, recycling	* 1,17	- 1,29	kg/kg
Recycle fraction in current supply	0,1		%
Downcycle	✓		
Combust for energy recovery	✗		
Landfill	✓		
Biodegrade	✗		

Liens

ProcessUniverse

Producers

Shape