

Laminated tempered glass



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The laminated tempered glass (VSG) manufactured by Dubiel Vitrum is classified as safety glass. It is commonly used in construction and architecture, most often in structures comprising partitions, barriers, balustrades, canopy roofs, stairs, floors and ceilings, glass facades, etc. Due to the wide range of technical glass-enriching options available, in addition to its structural and architectural functions, we offer attractive glass designs, as we manufacture laminated tempered glass in many flavors – bent, flood-coated, decorated with graphics, with color foils and other extras.

VSG is made of two or more panes of glass joined with one or many PVB (polyvinyl butyral) foils. By differentiating the number and thickness of particular layers, we can produce laminated glass of various physical properties. Our glass is manufactured in conformity with the PN-EN 12543 standard.

Advantages of PVB-laminated glass:

- if laminated tempered glass breaks, the bonded PVB foil prevents glass pieces from falling out, which minimizes the risk of injury
- even when broken, laminated glass protects against the entry of objects and people, providing an effective anti-burglary and protective barrier
- laminated glass increases the noise insulation of a partition, compared to monolithic glass of the same thickness
- Laminated tempered glass limits the exposure to UV radiation, which is harmful to people and objects
- Properly configured laminated glass protects against a ballistic attack or detonation wave

Laminated glass - Composition and markings



Laminated safety glass (VSG) manufactured by Dubiel Vitrum includes the following families of soda-lime-silica glass:

- float glass – 3 to 19 mm thick
- body tinted glass
- etched glass
- flood-coated or screen-printed on the outside or inside
- with UV printed graphics on the inside of the laminate

Glass laminates consist of any combination of float glass:

- annealed (non-tempered)
- tempered (ESG)
- semi-tempered (TVG)

Additionally, Dubiel Vitrum manufactures laminates with foil prints, decorative elements placed inside the laminate – these types of projects have to be arranged individually with Sales.

Depending on the purpose of laminated glass (roofs, balustrades, floors and landings, interior architecture), glass and PVB of different thickness are used. There is a commonly accepted and used laminate marking system that describes the glass configuration, e.g. **AB.C**, where:

A – thickness of the first pane in millimeters

B – thickness of the second pane in millimeters

C – number of PVB foils (one foil with nominal thickness of 0.38 mm)

Example: VSG 44.2 means two #4 mm panes and two 0.38 mm foils or one 0.76 mm foil

Example: VSG 106.4 means one #10 mm pane, one #6 mm pane, and a 4 x 0.38 mm or 2 x 0.76 mm PVB interlayer

Example: VSG 10810.44 means one #10 mm external pane, one #8 middle pane, one #10 mm external pane, and 2 4 x 0.38 mm or 2 x 0.76 mm PVB interlayers

Laminated glass manufacturing

We use two basic technologies to produce laminated glass:



Suitably prepared glass (cut, ground, and/or tempered) is washed, and then layered with PVB in an air-conditioned clean room. Foil-layered pieces are then joined using a system of rollers and furnaces. In order to ensure suitable adhesion and inseparability of the glass and PVB foil combination, glass pieces are autoclaved at approx. 140°C and 12 atmospheres. Depending on the laminate composition, this process takes from approx. 1 hour up to 6 hours. After pieces leave the autoclave, surplus foil is cut off from the edges, and glass is cleaned.

2. Vacuum bag

A ready “sandwich” composed of float glass and PVB layers is placed in a specially prepared airtight bag, from which air is suctioned off to create vacuum. Vacuum-pressured glass is then placed in the autoclave to prepare it for the next stage (see above).

Manufacturing capabilities

Types of glass used for laminating:

- annealed float glass
- tempered glass (ESG)
- semi-tempered glass (TVG)
- bent glass
- body tinted glass
- etched (the etched side on the outside of the laminate)
- mirrors (the mirror substrate on the inside or outside of the laminate)
- sanded (the sanded side always on the outside of the laminate)
- coated:
 - painted with ceramic paint (the painted side on the inside or outside)
 - painted with water based paint (the painted side on the inside or outside)
 - UV printed (the printed side on the inside or outside)
 - special coats

Types of foil for laminating:



- colorless PVB, available in three thicknesses: 0.38mm, 0.76mm, 1.52mm
- mat PVB (popularly called frosted foil) or slightly mat PVB (more transparent), producing a steamy/foggy glass effect (*Cool White*)
- colored PVB (e.g. *Absolute Black*, *Polar White*, *Deep Red* and other colors)
- EVA – to order

At Dubiel Vitrum, we give our customer the unique opportunity to make laminated safety glass that meets highly individual needs: in addition to decorating glass using printing and painting techniques, we can place other components between the layers of laminated glass:

- structurally uniform fabrics, e.g. linen
- printed PCV foils
- paper
- other

ATTENTION: Tests are needed every time before completing the order proper.

TECHNICAL OPERATIONS

Laminating float glass with PVB (production of laminated tempered glass)

TECHNICAL TERMS OF REFERENCE for LAMINATING GLASS Vitrum

Line production – laminate size limits:

- min.: 250 x 550 mm
- max: 2,225 x 3,500 mm
- maximum laminate thickness: 60 mm
- maximum weight of one piece: 200 kg
- maximum weight of a laminated package: 800 kg

Manual production (vacuum bag)

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In manual production using vacuum bags, the laminate size is limited to the human physical capabilities (putting glass panes together) and the autoclave's internal dimensions.

- minimum piece size: none
- maximum piece size: 2,100 x 4,500 mm (taking into account weight) – to be consulted with Sales
- laminate thickness: no limits

Laminating bent glass

Bent laminate size at Dubiel Vitrum:

- minimum bent piece size: 200 x 350 mm (where 350 mm bending line)
- maximum bent piece size: 2,000 x 1,000 mm (where 1,000 mm bending line)

Bent glass is laminated by putting a “sandwich” into a vacuum bag and suctioning off the air with a vacuum pump.

We offer the option to laminate glass in different sizes than those listed above to order – in such cases, please contact Sales.

Laminating ornamented glass

Only the smooth side of ornamented glass is laminated.

Options and limitations – as in laminating float glass.

ATTENTION: The pattern of cracks pattern in laminated tempered glass (ESG VSG) and standard tempered glass (ESG).

Ice glass

At first glance, ice (crushed) glass differs from standard construction glass, because its structure is broken inside, while the external surface is kept intact and smooth.

Ice glass is a type of safety glass produced by laminating. It consists of three joined layers: the external layers are made of annealed glass, whereas the middle layer is made of tempered glass that contains a delicate pattern of cracks after being broken. Thus, the two external layers are smooth and intact, whereas the internal (middle) layer is a broken pane of glass to produce the impression of crushed glass (see photos below).

Ice glass is laminated in three configurations, e.g. 8/6/8 mm or 6/6/6 mm, or resin laminated glass. Ice glass comes in different colors; one of the layers is tinted (by using body tinted glass) or by tinting the adhesive (by adding dye to resin). Thanks to using body tinted glass (such as Antisol) as the layer that is tempered and broken, a uniform, subtle tint typical of ice glass is produced.

Applications of ice glass:



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- table tops
- bar counters
- interior decoration elements

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