Special Glasses from SCHOTT AT for Use in Architecture

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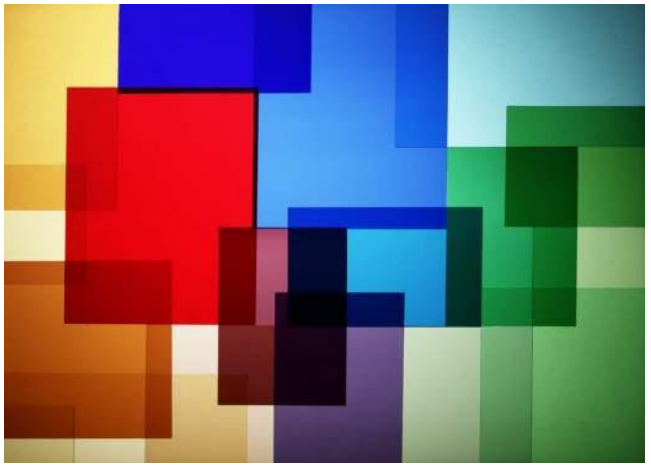
Function and Design

- **Glass and reflection**

- **Glass and color and Texture**



Glass and Reflection

Reflections on glass

Sometimes desirable...

Solar Control Glass

...sometimes just annoying!

Ordinary glass

The Problem

Reflection from the surface of glass is inevitable

You can reduce reflections with numerous solutions:

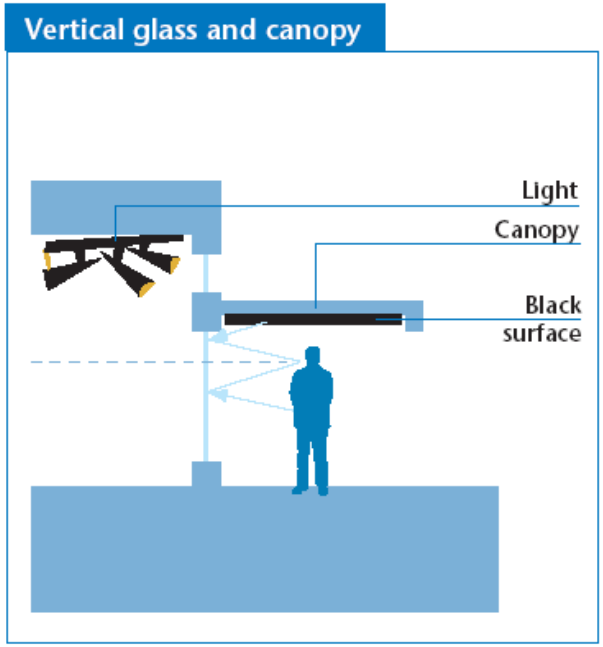
Internal options:

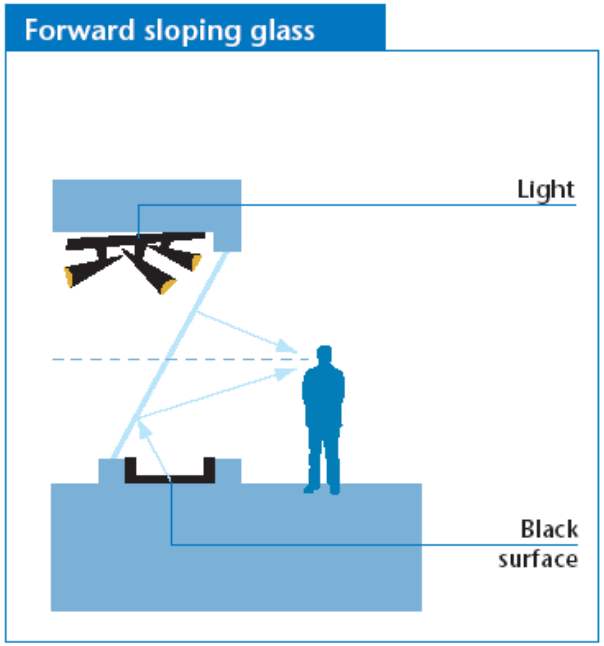
- Increase of internal lighting
  - reduce aesthetics
  - decrease comfort
  - increase fading
  - lead to higher costs

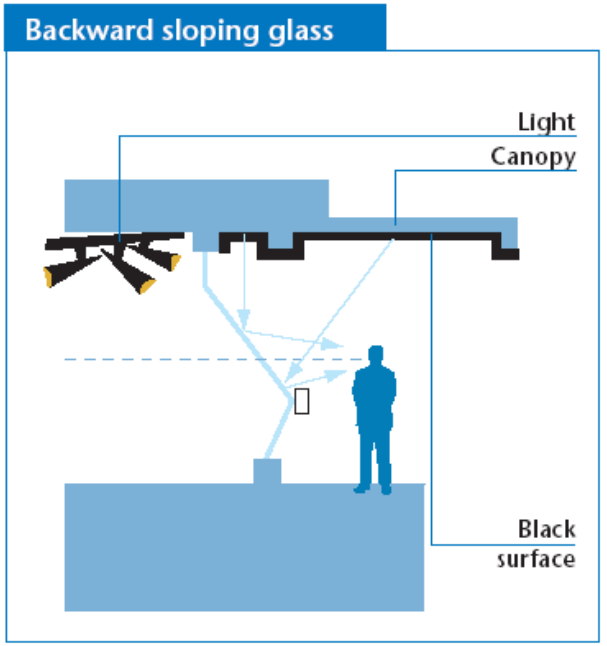
External Options:

- Installation of e.g. canopies, sloped glazing
  - reduce aesthetics
  - lead to higher costs

External options



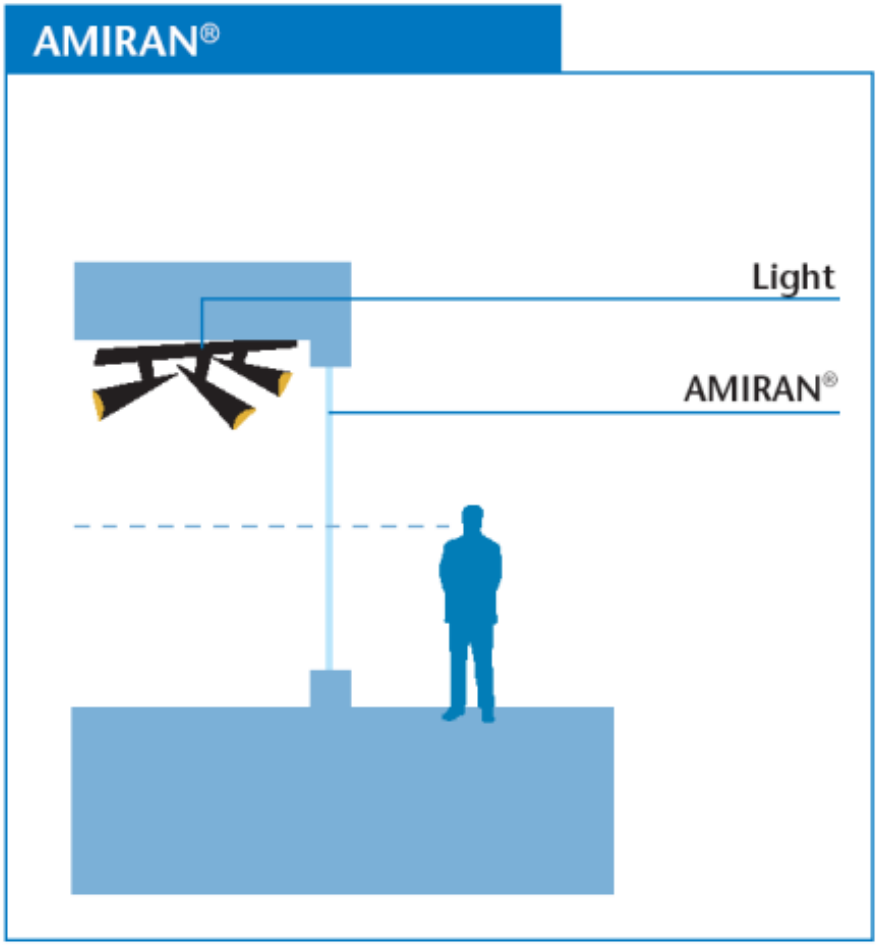




Not only an option – a solution

Anti-reflective glass

- ✓ nearly free of glare
- ✓ highly transparent
- ✓ conserves energy



Anti-reflective Glass AMIRAN®

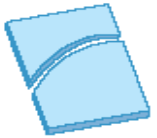
Conventional float glass

Residual reflection: 8%

Glazing performed with AMIRAN®

Residual reflection: <1%

- ✓ anti-reflection through dip-coating
- ✓ nearly free of glare
- ✓ highly transparent



- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass and DGU

- ✓ very resistant hard coating
- ✓ easier to clean than sputtered coatings
- ✓ conserves energy

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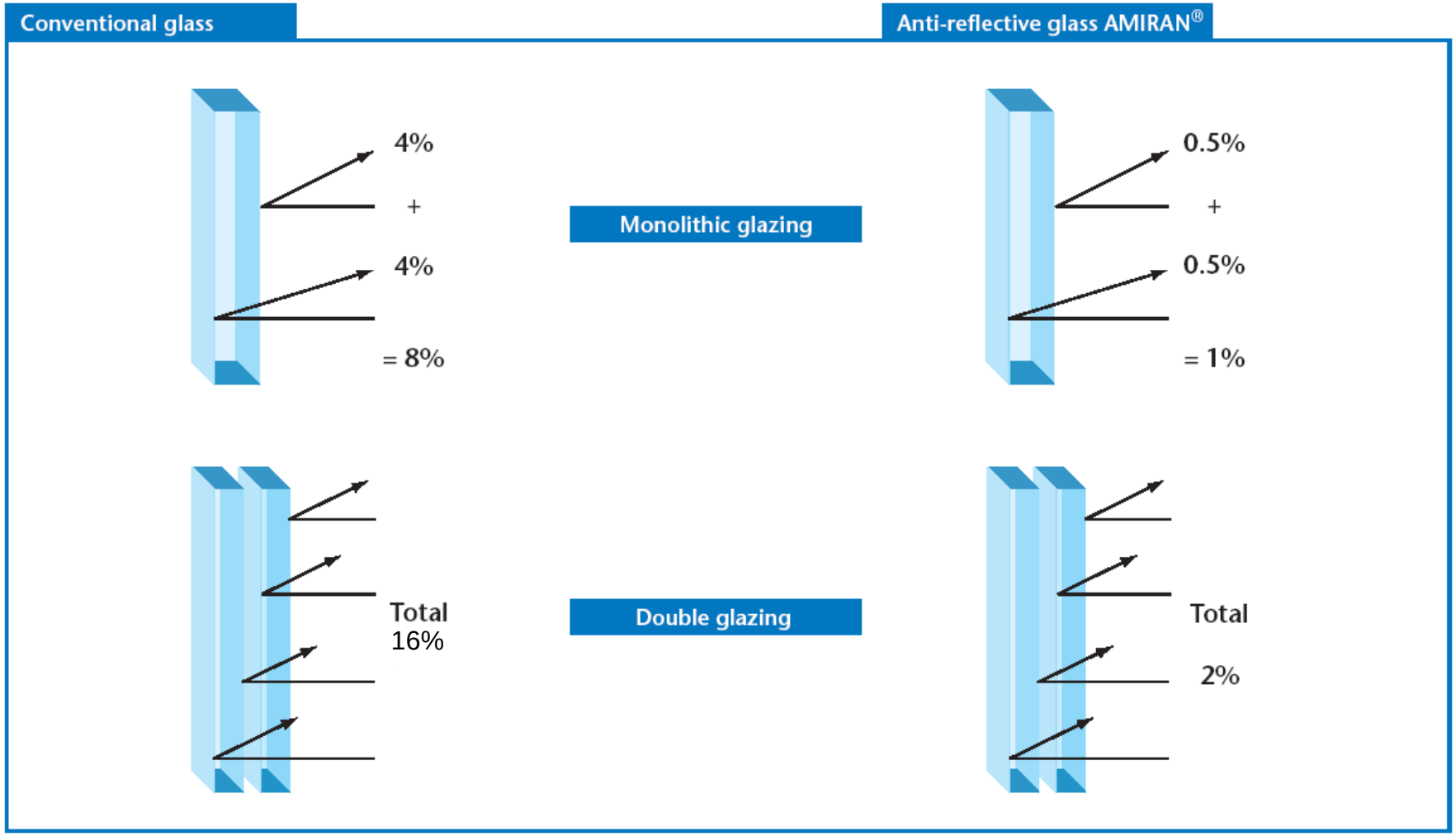
Anti-reflective glass AMIRAN® vs. conventional float glass



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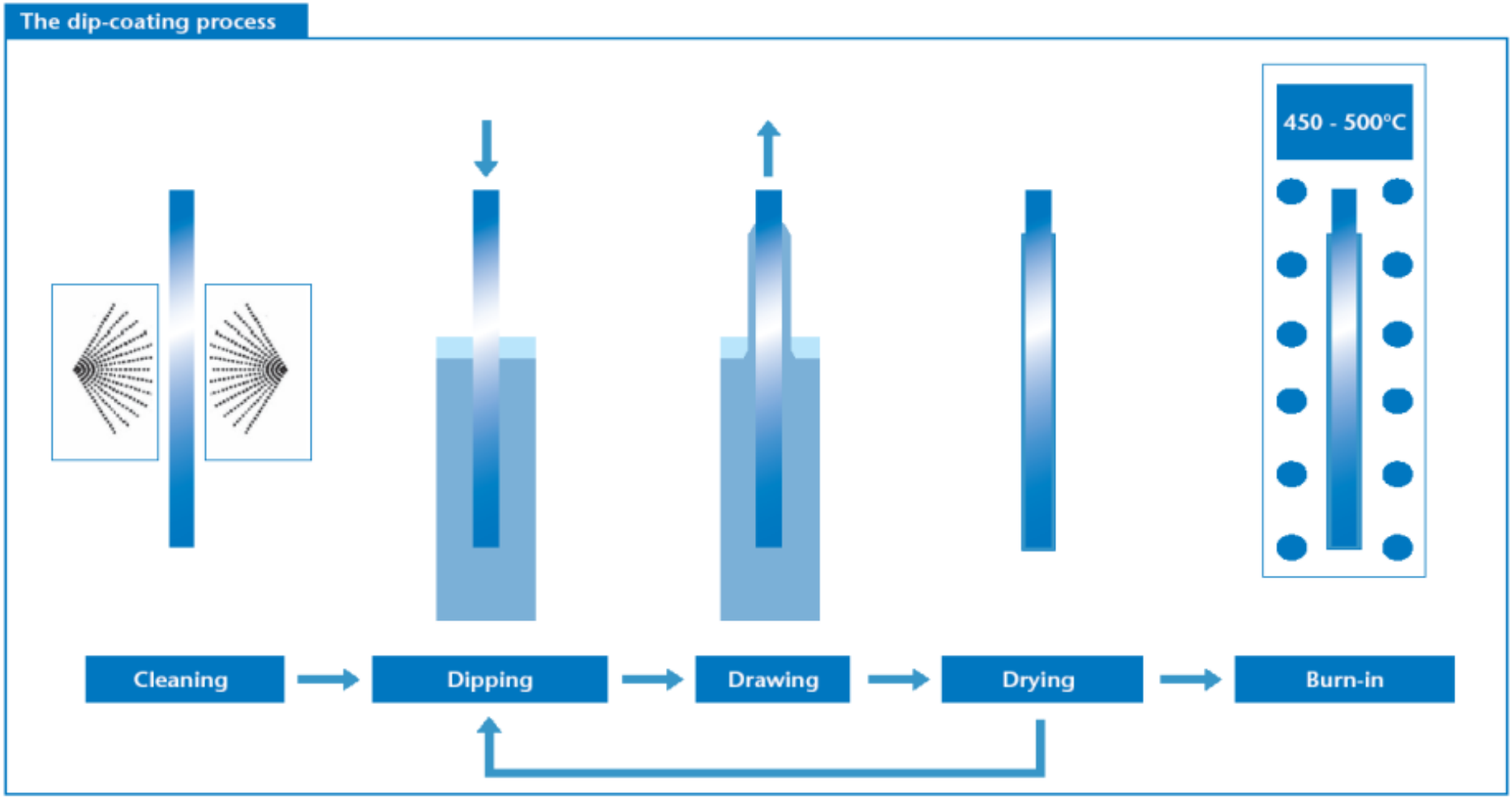
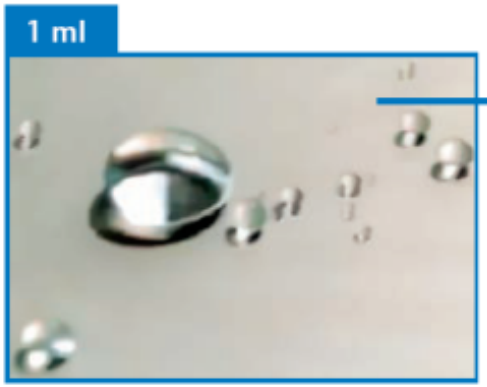
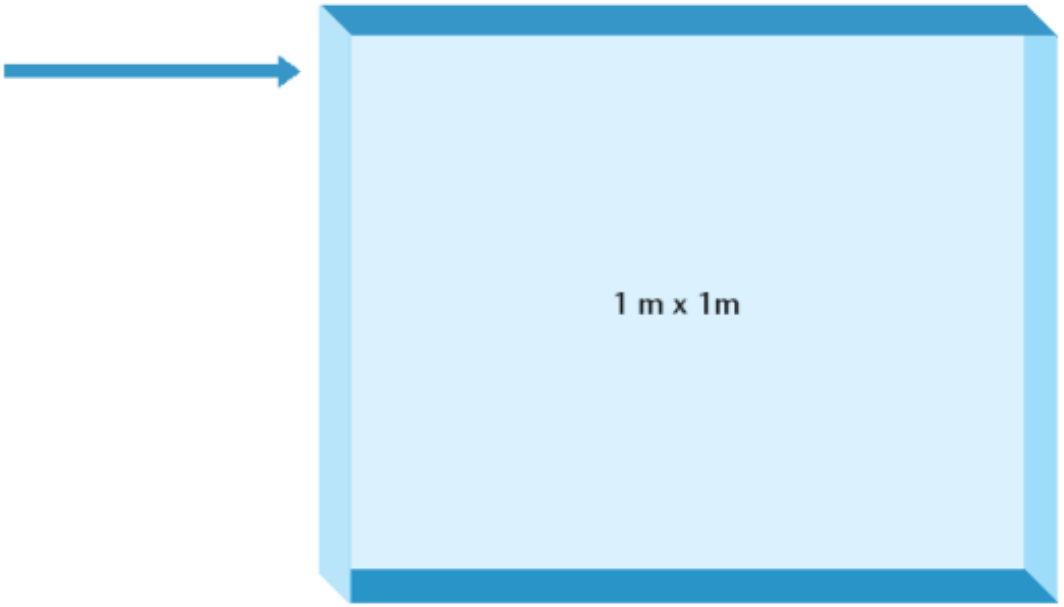
The dip-Coating process



Nano-coating spread

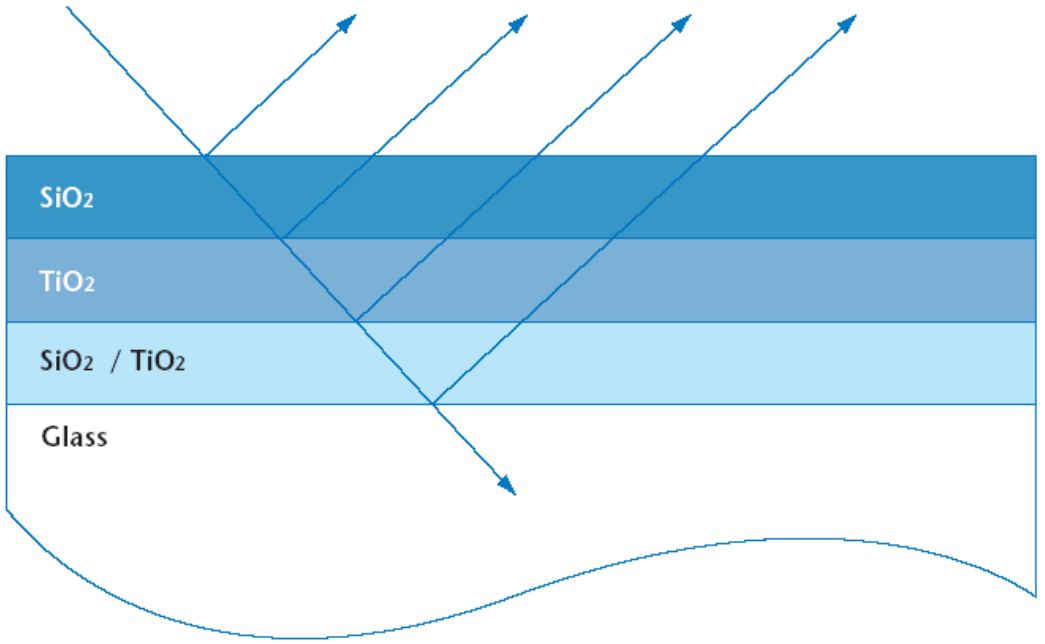


With dip coating, only 1 ml of the coating solution is needed to coat a 1 m x 1 m surface evenly, without leaving any areas uncoated.



Principles of optical interference coatings

Optical interference coating



AMIRAN® is a glass product with optical interference coating on both sides.
The layers are applied using a dip-coating process.

The layer thickness is exact to the nanometre, with available thicknesses ranging from 50 to 100 nm.

The layer thickness must not deviate by more than +/- 1 nm on any part of the glass.

Coating durability

The burned-in surface coating results in the following products benefits:

- easy to clean
- weather resistant
- highly resistant to its environment
- highly resistant to abrasion

All product benefits are tested and approved by the following tests:

- Salt spray test
- Copper chloride acetic acid spray test
- Condensed water constant climate test
- Sliding abrasion with taber abraser process
- Adhesive tape test
- Alcohol rubbing test
- Stylus test

Benefits of anti-reflective glass

- Dramatic reduction in glass reflections
- Superb clarity of display
- More visually appealing buildings
- Significant reductions in lighting costs due to decrease of expenditure on e.g. canopies, extra lighting
- Significantly improved night time viewing
- Ability to photograph through glass
- Improved UV protection
  - 99% when laminated

UBS Tower, Chicago

UBS Tower, Chicago

Location	Chicago
Type of construction	Pre-stressed cable system
Architect	Steve Nilles (Lohan Caprile Goettsch Architects)
Cables	d = 20 mm in 1.53 x 1.53 m, Pre-stressing: 7,000 kg
AMIRAN® glass panes	12 mm thick using white glass (ISO with LSG)
allowed pressure	800 kg/m² (472 km/h wind temperature)

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Restaurant with view of Bosporus Bridge, Istanbul

Double glazing with AMIRAN® as toughened safety glass

BMW Showroom, Istanbul

Conventional glass

AMIRAN®

Double glazing with AMIRAN®

Gucci, Vienna

Display window glazing with AMIRAN®

Showcases at British Museum, London

Double glazing with AMIRAN®

Control Tower Aberdeen Harbour

Double glazing with AMIRAN®

Media Center at Admiral´s Cup, Valencia

Double glazing with AMIRAN®

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The Forbidden City, Beijing

Conventional glass

AMIRAN®

Single glazing with AMIRAN®

Gottlieb-Daimler-Stadion, Stuttgart

Double glazed unit with AMIRAN® as laminated safety glass

Residential house, Istanbul

Double glazed unit with AMIRAN®

Zoo, San Francisco/USA

Double glazed unit with AMIRAN®

Nando´s Restaurant Guilford/UK

Double glazed unit with AMIRAN®

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... not only anti-reflective, but also

Reflective glasses NARIMA® and MIRONA™

Color Effect Glass NARIMA®

- ✓ dichroic effects
- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass
- ✓ very resistant hard coating
- ✓ large dimensions

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NARIMA® – Color Effect Glass

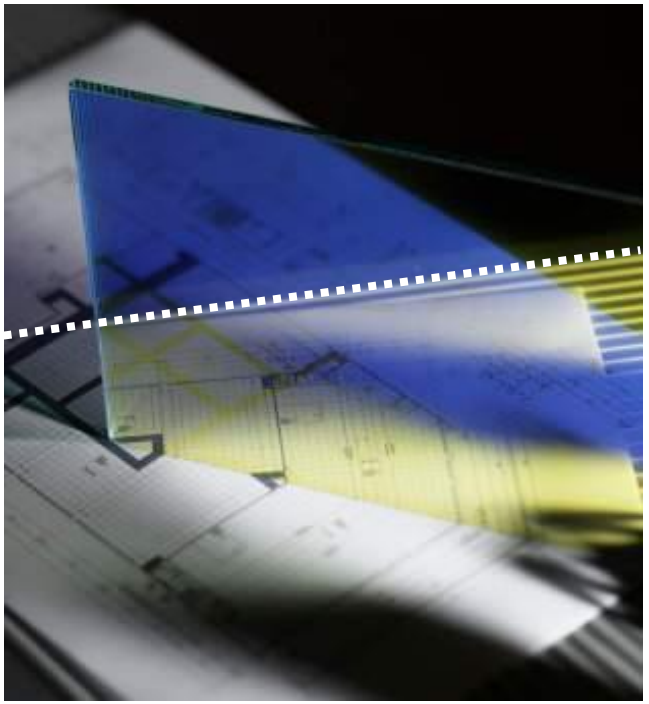
Is NARIMA® a dichroic glass?

Dichroic = two colored

Due to interference optical effects and depending on the coating system (refractive index, number and thickness of the layers) a certain range of the light is transmitted, and the rest is reflected.

Result: we receive two complementary colors

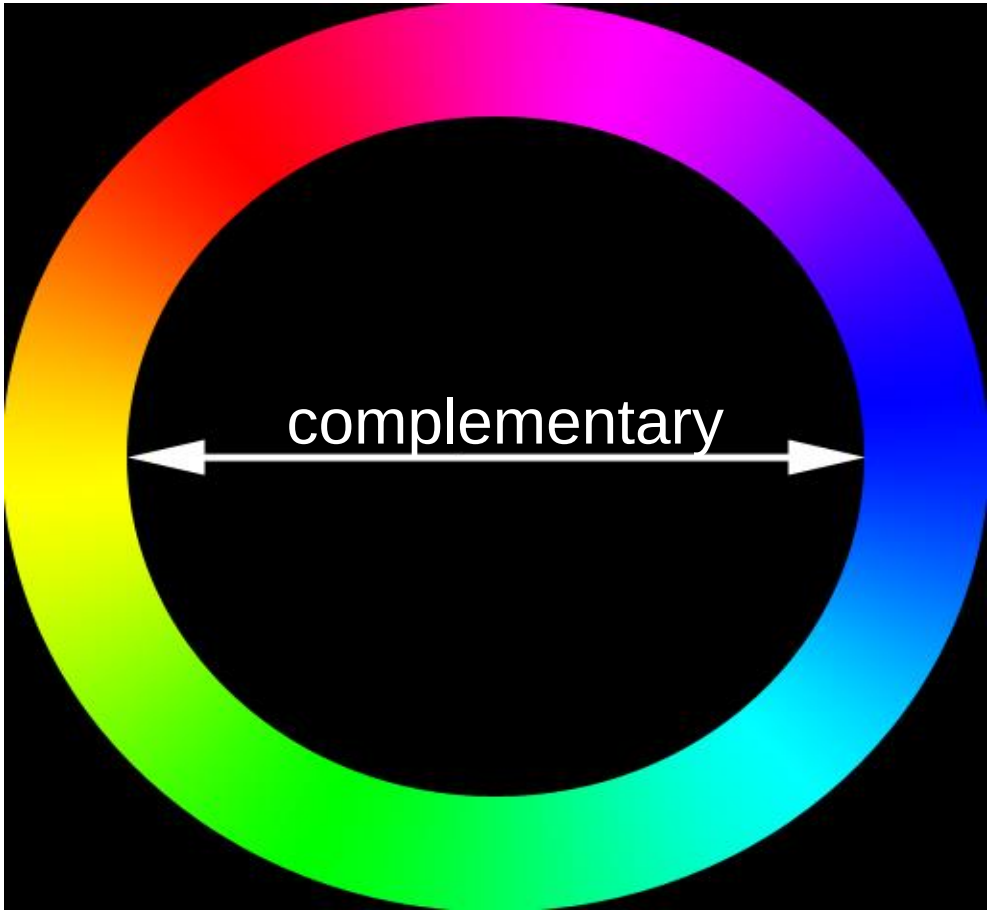
light is transmitted



light is reflected

Is NARIMA® a dichroic glass?

Definition
color in
reflection <-> transmission

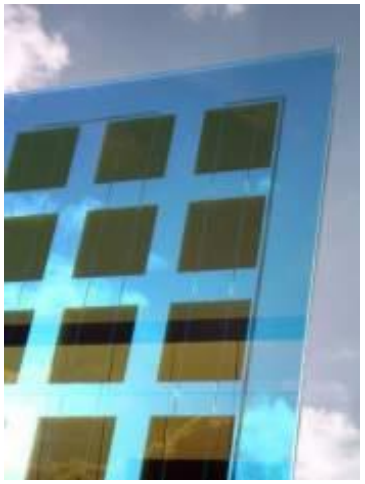


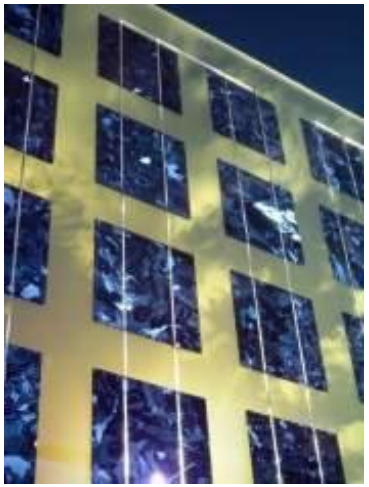
Is NARIMA® a dichroic glass?

AND THE CLOU ...

These two colors vary depending on the angle at which the light meets the glass surface.

Depending on the time of day and year, the color and light effects are slightly different.



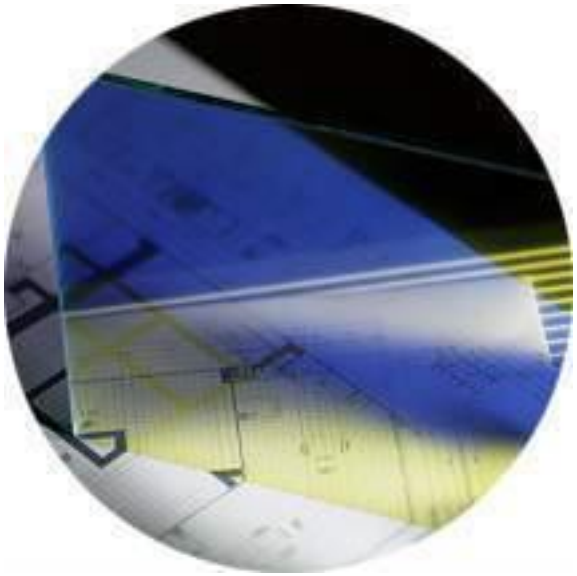


NARIMA® with integrated PV moduls

... by day

... at night

The color range of NARIMA®



Color code 4160 0

Color code 4160 2

Color code 4160 5

Customizing NARIMA®

No problem, if the quantity is okay

We can

- Customize degree of reflection ⟺ degree of transmission
- Develop special colors in the greenish, yellowish and bluish area; red or magenta colors are not possible in transmission.

Nord/LB, Hanover

Nord/LB, Hanover

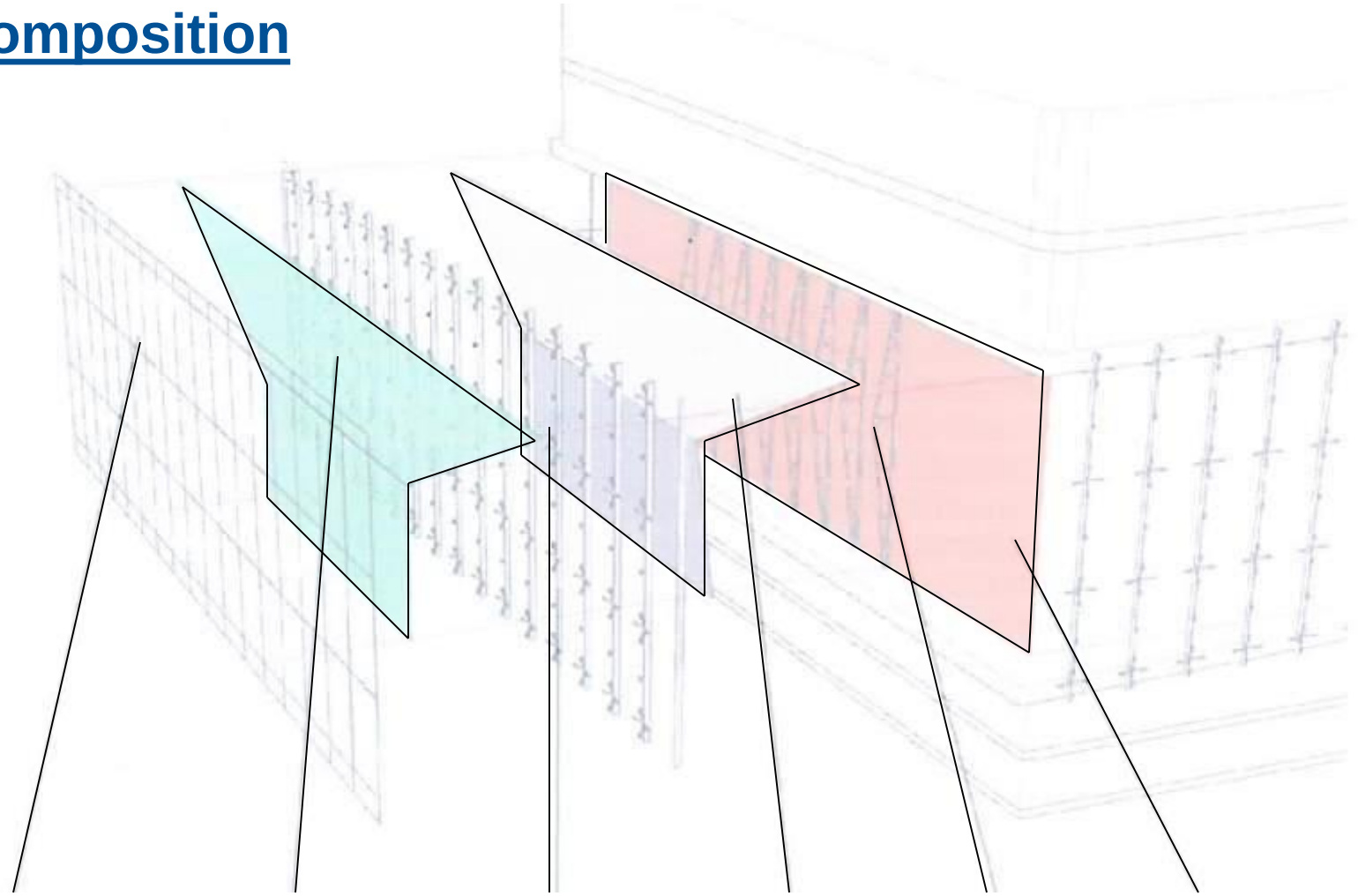
Location	Hanover
Architects	Behnisch, Behnisch & Partner
Construction	Color Effect Glass (dichroic glass) as LSG using white glass made of toughened safety glass

Rehearsal of the Bavarian Opera, Munich

Designer: Olafur Eliasson

Rehearsal of the Bavarian Opera, Munich

Composition



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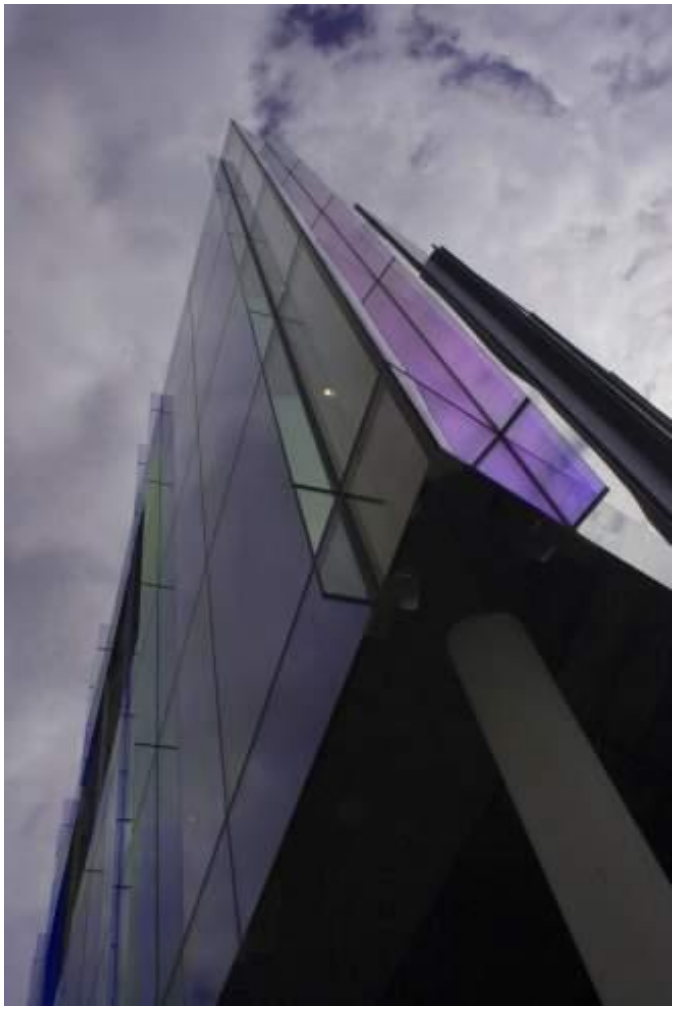
Grand Canal Square, Dublin/Ireland



Real Estate Company, Hildesheim

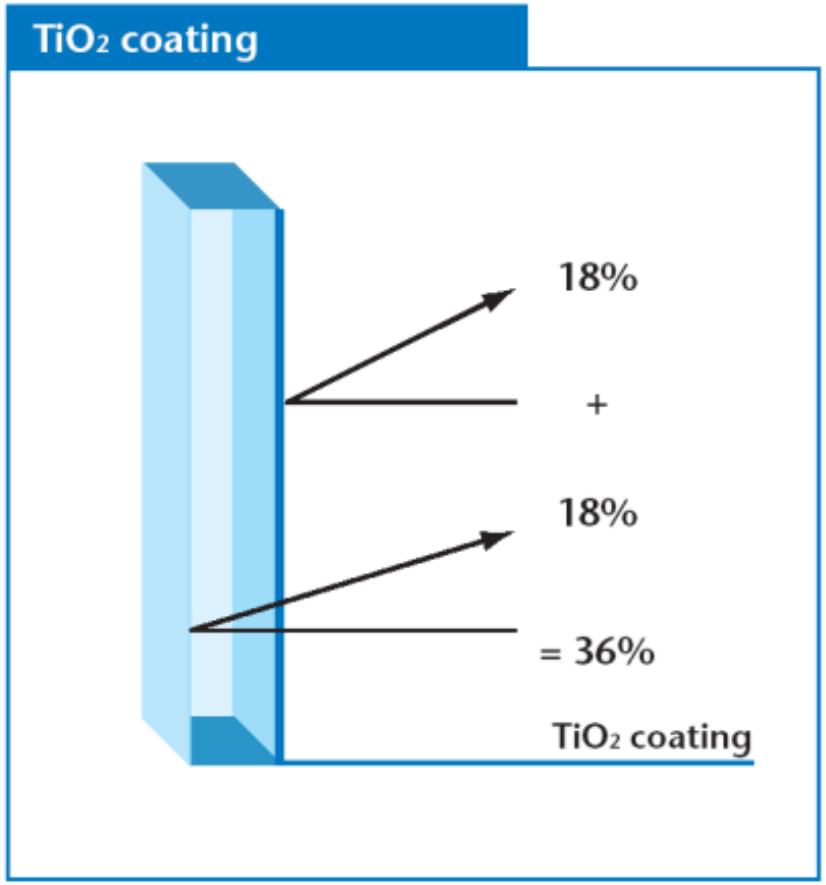
Ann Fontaine Store, Lausanne

Designer Lamps from Kazu Blumfeld Hanada

MIRONA™ – the transparent mirror

- ✓ with dark background it acts as a mirror, with illumination from behind, it has a transmission
- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass
- ✓ very resistant hard coating

Operating principle of MIRONA™



Index of refraction:

TiO^2 coating:	2.1
Base glass:	1.52

Light is reflected at every interface between two materials with different indexes of refraction.

Because the TiO^2 layer exhibits a higher refraction index than base glass, the reflection is also higher.

=> this gives MIRONA™ its silvery, precious looking surface appearance

With a dark surface behind MIRONA™, the mirror layer that is usually outshined when light penetrates steps into the foreground.

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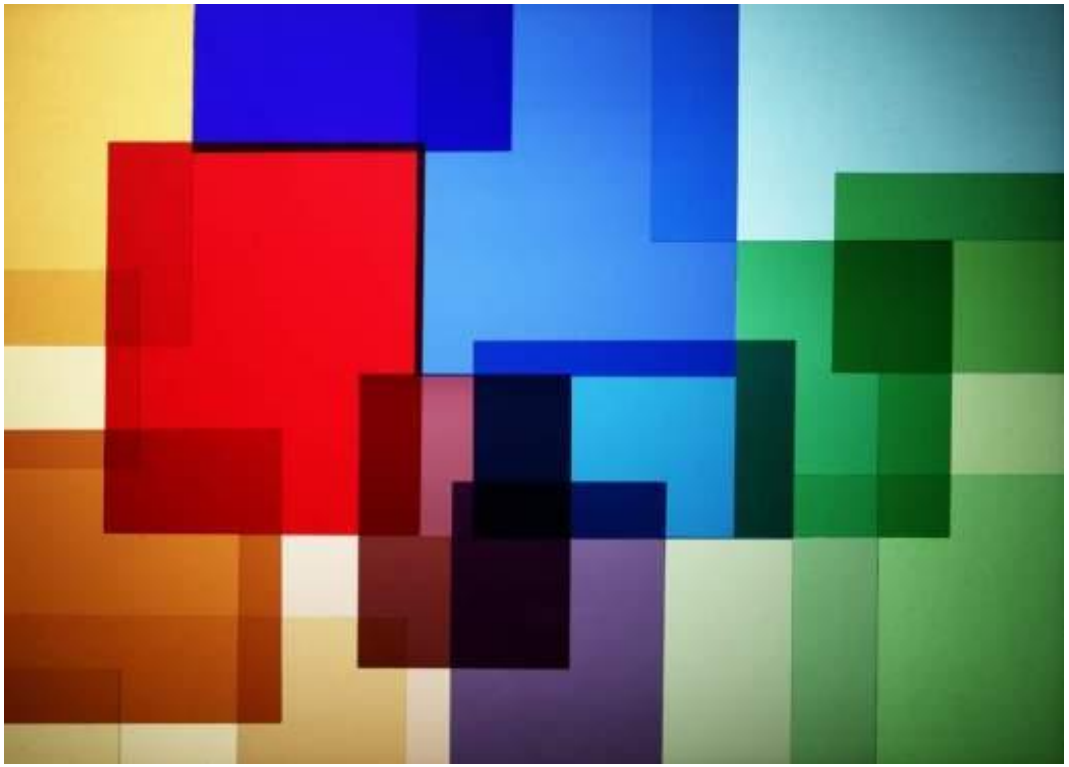
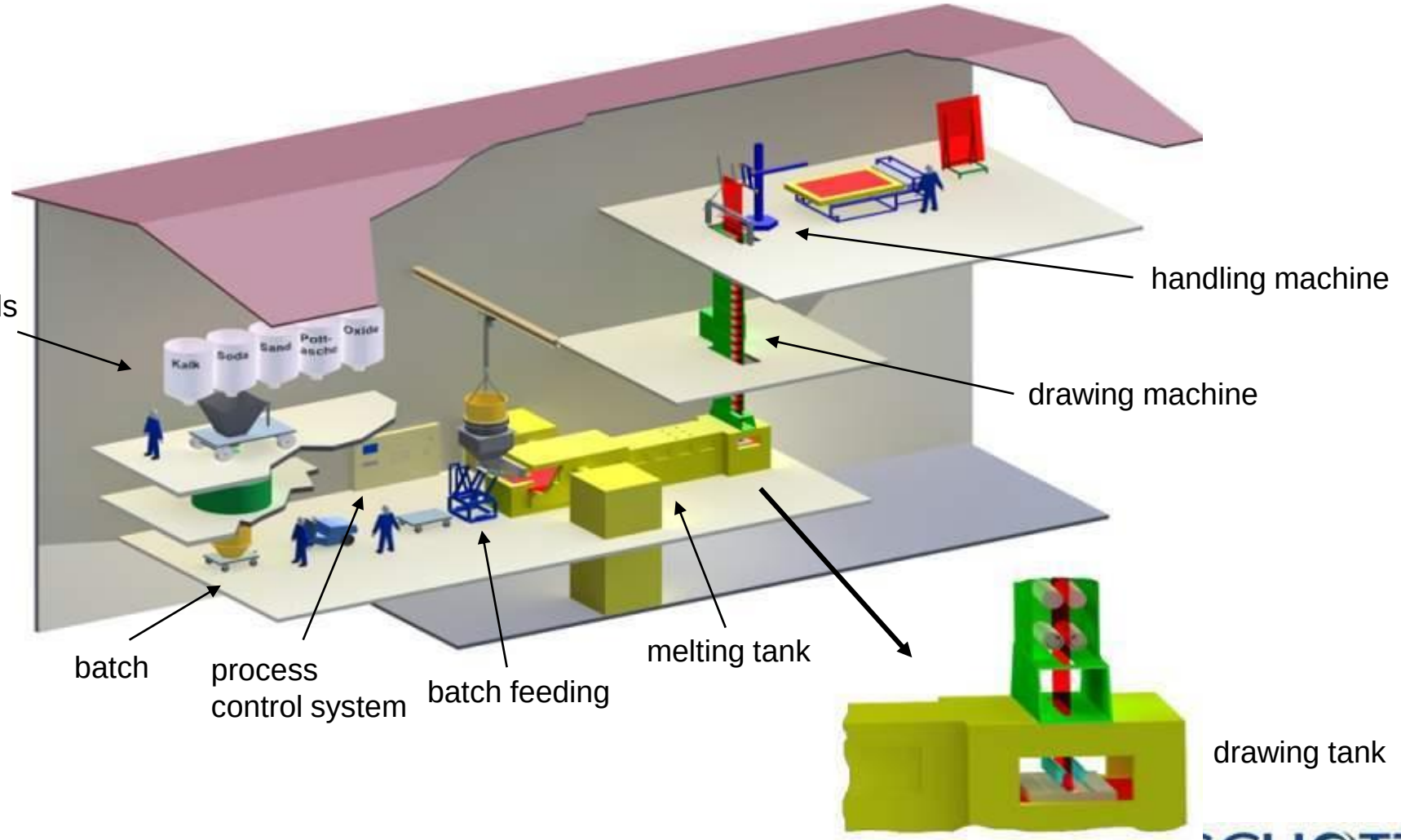
Horstmann & Sander, Hanover

Meeting room of the BMW supervisory board, Munich

Glass and Color and Texture



Machine-drawn body-tinted colored glass



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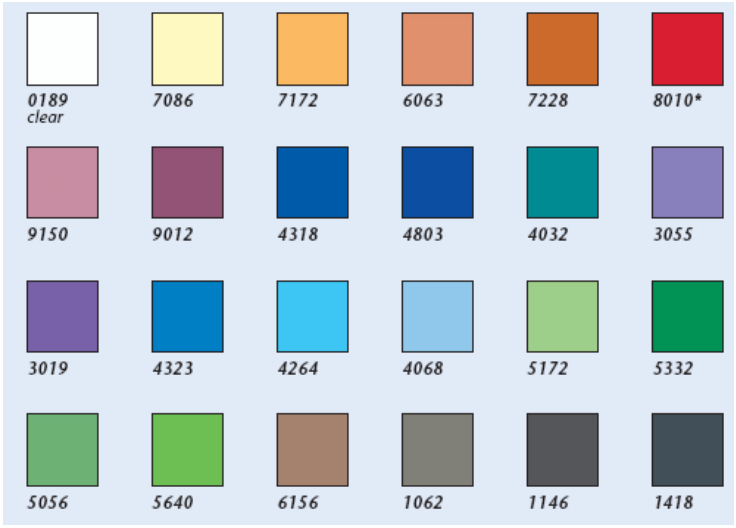
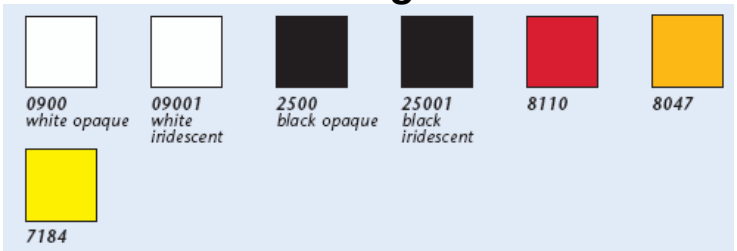
Colored Glass ARTISTA®

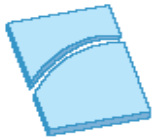
Machine-drawn colored flat glass



Rolled colored flat glasses



- ✓ Solid body-tinted flat glass
- ✓ fire-polished surface



- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass

- ✓ color shades exactly as specified
- ✓ stability with devitrification, to the highest possible extent

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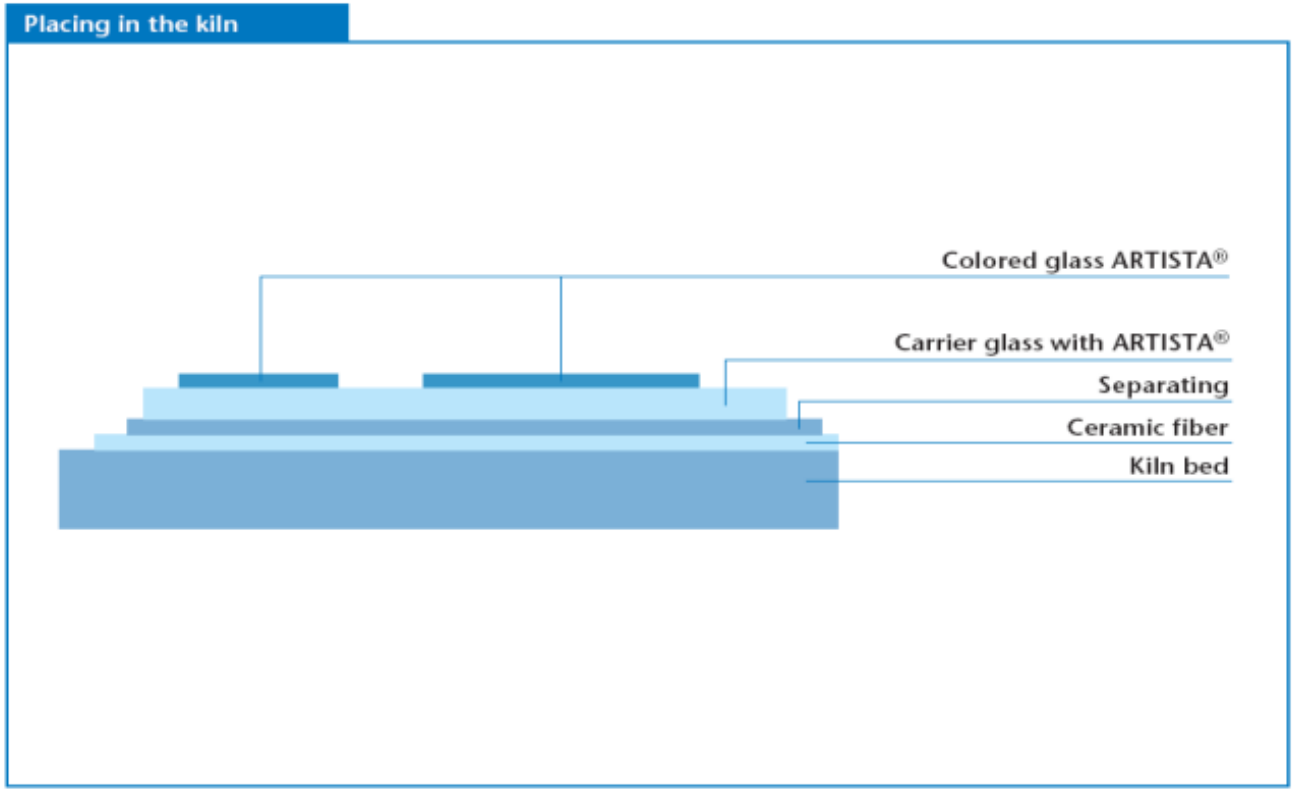
Fusing compatibility of ARTISTA®

All listed ARTISTA® colors (except color code: 8010) can be used for the fusing technique.

The coefficient of thermal expansion (COE) of ARTISTA® is 94!



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Tempering of ARTISTA® in fused state

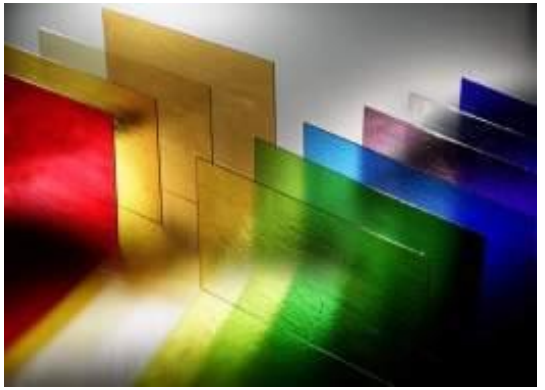
Thanks to the expansion of the ARTISTA® flat glass program to include ARTISTA® Frits and ARTISTA® Thin Glasses, the topics safety and design no longer rule each other out.

Through the use of glass frits and thin glasses, a breakthrough was achieved for the first time with respect to thermal toughening of melted glasses.

As a result, design can move into areas in which safety aspects have traditionally required special attention.

Typical breakage pattern with a toughened fusing pane

ARTISTA® Frits



ARTISTA® Thin glasses

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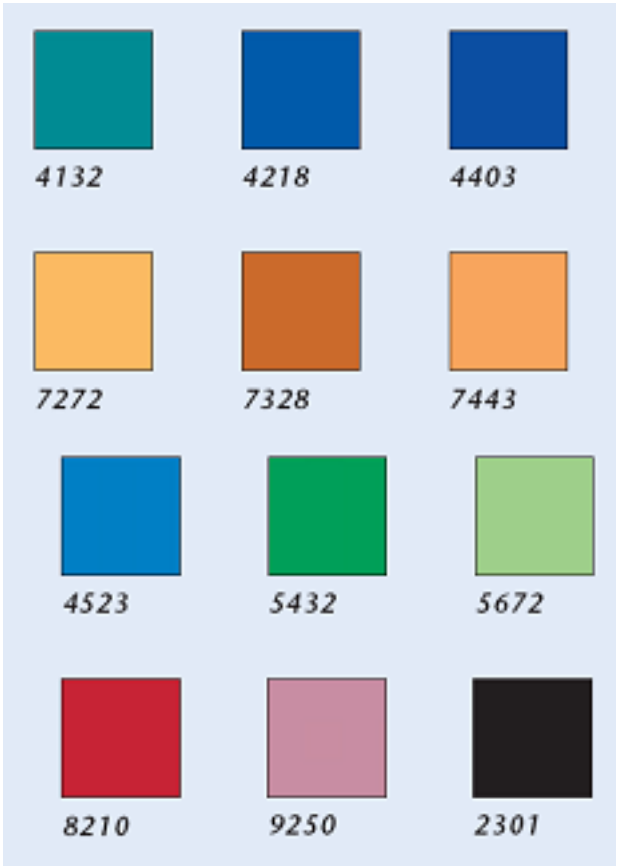
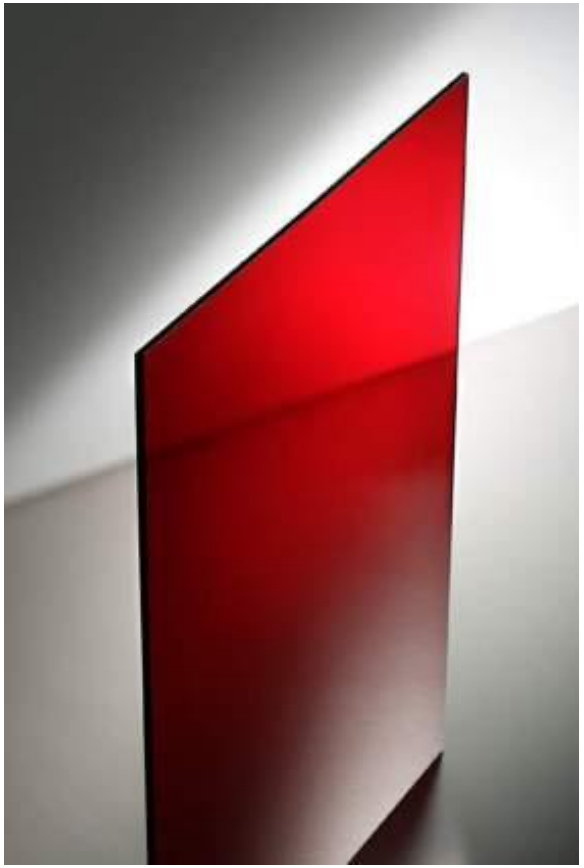
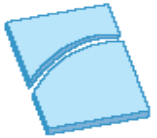
Colored Glass IMERA®

Machine-drawn colored flat glass





- ✓ Solid body-tinted flat glass
- ✓ highly transparent
- ✓ conserves energy



- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass

- ✓ color shades exactly as specified
- ✓ intense colors and some dark color shades (in comparison with float glasses)

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Advantages of body-tinted colored glass

- solid body-tinted flat glass
- consistent exactly specified color shades
- intense colors and some dark color shades (in comparison with float glasses)
- fire-polished surface (only IMERA®)
- no bleaching of color (compared with float glasses with color dyes i.e. films or printing)
- scratch-proof color (compared with float glasses with color dyes i.e. films or printing)
- fusing compatible (only ARTISTA®)
- using ARTISTA® Frits and Thin Glasses, fused glasses can also be thermally toughened (into safety glass).
- stability with devitrification, to the highest possible extent

Novartis Headquarters, Basel

Novartis Headquarters, Basel

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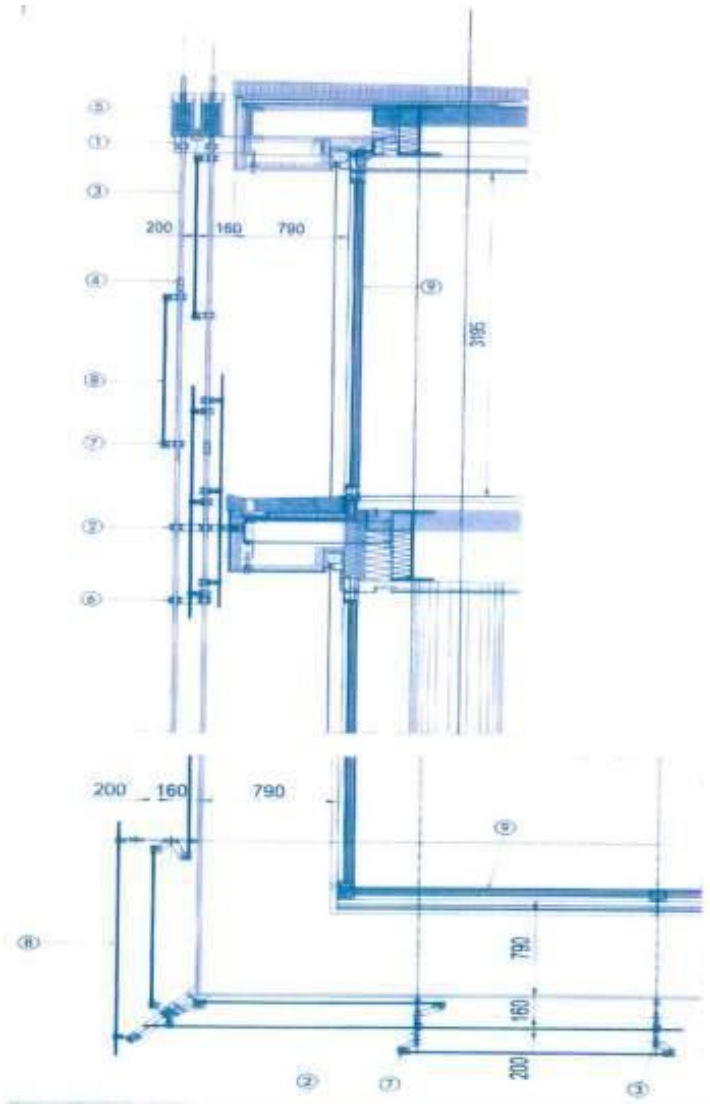
Novartis Headquarters, Basel

Novartis Headquarters, Basel

Novartis Headquarters, Basel

Location	Basel
Processing	Butt glazing, point-mounted
Architects	Diener & Diener
Artist	Prof. Helmut Federle
Construction	Color glass panes laminated onto a larger pane of white glass or between two larger panes of white glass

Novartis Headquarters, Basel



1. Mounting substructure for the rods
2. Rod clamp (always at ceiling height)
3. Rod
4. Connection piece between rods
5. Pretensioning spring
6. Coupling intermediate link for the rods
7. Glass retainer
8. Colored laminated safety glass
9. Threefold insulation glazed indoor facade

Novartis Headquarters, Basel

The Science Museum, London

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The Science Museum, London

Location	London
Construction	Post-Bar Construction
Architects	Mac Cormac, Jamieson and Prichard
Task:	large glass surface (approx: 300 m^2) so that daylight does not endanger the exhibits
Solution and Composition	Insulation glass OKASOLAR: - Float glass - 8 mm IMERA® - silvered fin system inside

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SCHOTT Iberica, Barcelona

SCHOTT Iberica, Barcelona

Location Barcelona

Construction Post-Bar Construction

Architect Torsten Masseck

SCHOTT Iberica, Barcelona

Task

Reduce energy consumption and increase the energy efficiency of the building, while providing an innovative and decorative solution

Solution and Composition

Insulation glass composition ASITHRU color:
- LSG using TLG white glass with Asithru photovoltaic module

- LSG using IMERA® with float glass

North Greenwich Station, London

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North Greenwich Station, London

Location:
London

Construction:
Point-mounted

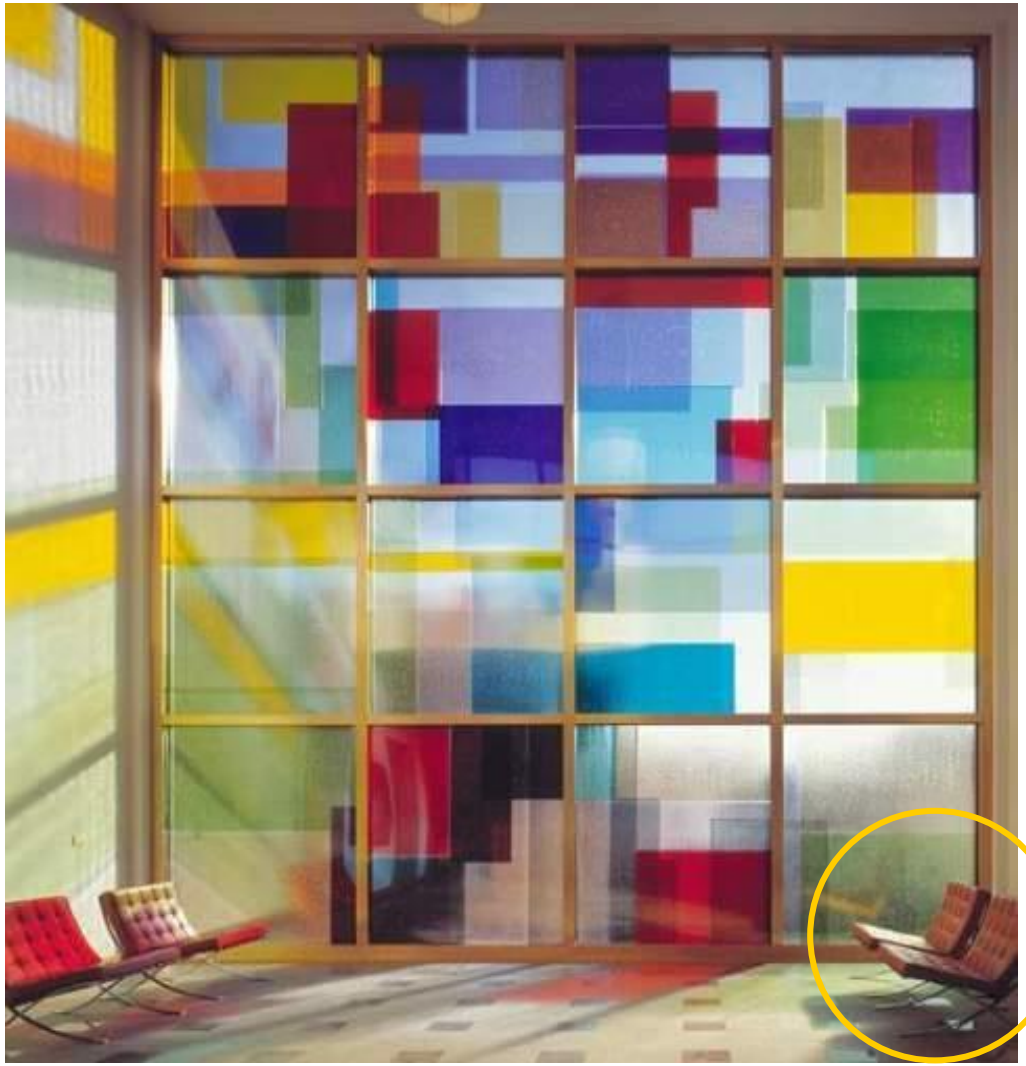
Architects:
Alsop, Lyall and Störmer

Composition:
Laminated safety glass each made of a thermally tempered pane:
- IMERA® 4218, 5 mm
- Float glass, 12 mm

The individual panes were mounted onto a steel substructure using plates and non-corrosive steel clamps.
Approx. 800 m² of IMERA® 4218 was utilized for a surface of 405 meters in length and 28 meters in width.

German State Central Bank, Meiningen

German State Central Bank, Meiningen



Location:
Meiningen

Processing:
Fusing as insulation glazing

Architects:
Prof. Hans Kollhoff / Helga Timmermann, together with Nicolas Perren

Window design:
Prof. Helmut Federle

Composition:
Insulation glass unit consisting of:
- white glass as toughened safety glass, 8 mm
- three fused panes each of ARTISTA®
- Laminated safety glass consisting of two 6 mm thick panes each made of toughened safety glass using white glass

Centocelle San Bernardo, Rome

Casino in Bad Füssing

Backlit domelight made of ARTISTA®

Hilton Hotel, Omaha

Fused ceiling lighting based on ARTISTA®

Fully Glass Door

Detail:

Glass door entirely made of ARTISTA® as toughened safety glass

Fully Glass Door

Glass door entirely made of IMERA® colored glass as toughed safety glass

Wellness Area inside “Burj Al Arab“ Hotel, Dubai

Fused foyer made of ARTISTA®

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Marsh and McClennon Lawyers‘ Office, New York

Partition made of ARTISTA®, matte finish

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University of Jena Hospital

“Glassy Waves“ made of ARTISTA® as laminated safety glass

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Lloyd´s Bistro, Bremerhaven

Decorative Glass RIVULETTA®

- ✓ finely defined pattern glass
- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass
- ✓ very clear glass

Partition wall

Partition made of RIVULETTA® as toughened safety glass

Fully Glass Door

Glass door entirely made of RIVULETTA® as toughened safety glass

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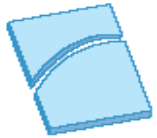
Kitchen Furniture

Cabinet glazing with RIVULETTA®

White Flashed Opal Glass OPALIKA®

Using OPALIKA® by SCHOTT, you can achieve diffused lighting similar to daylight and with very little shadow.

- ✓ distributed light very evenly through white flash layer
- ✓ excellent color reproduction



- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass

- ✓ Pleasant atmosphere thanks to very few shadows, even lighting
- ✓ low hanging height
- ✓ OPALIKA® retains its white appearance even when the lights are turned off

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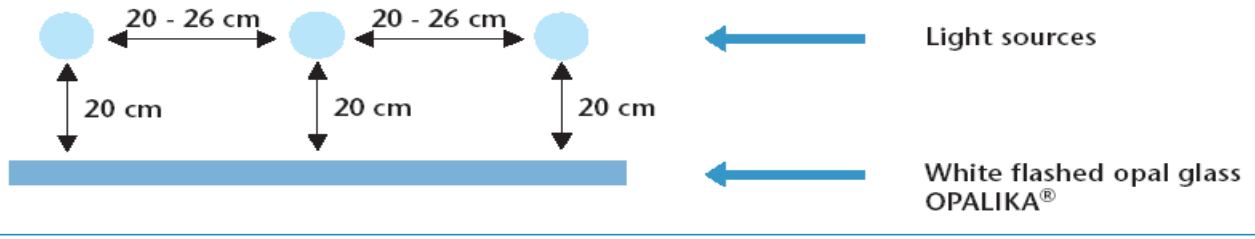
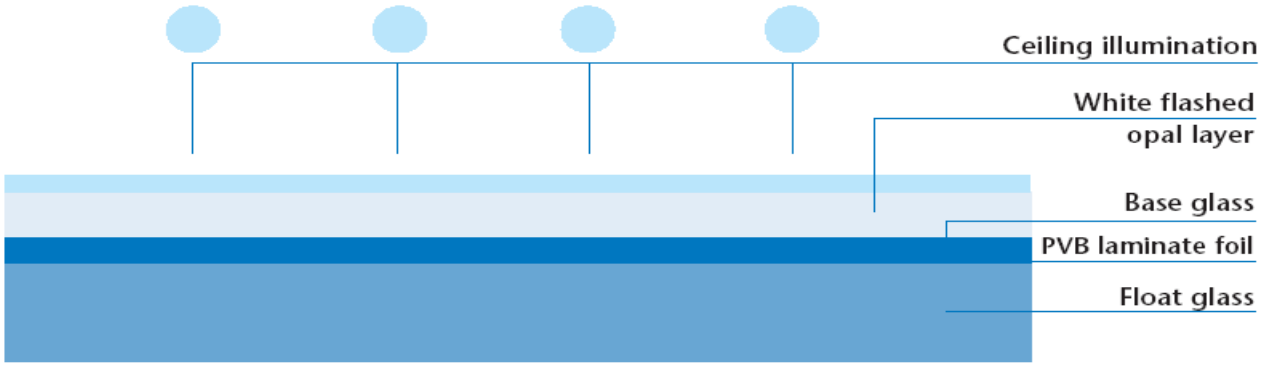
Set-up

You can achieve the optimum effect with OPALIKA® by ensuring that the spacing of the luminaires is uniform in relation to OPALIKA® as well as between luminaire and luminaire.

Example



Composition



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Advantages of OPALIKA®

- pleasant atmosphere due to very few shadows, even lighting
- excellent color reproduction
- OPALIKA® retains its white appearance even when the lights are turned off
- low hanging height
- scratch resistant
- stability of shape
- anti-static
- OPALIKA® is classified as a non-flammable building material according to DIN 4102 (Class A1 building material)
- can be thermally tempered or reshaped
- in the event of breakage, individual panes can be replaced (unlike lighted ceilings, where the entire defective ceiling has to be replaced).
- cleaning and replacement of neon lights located behind the glass is much easier with OPALIKA® than with other types of illuminated ceilings.

Sony Style Store, Berlin

OPALIKA® →

Plastic →

Sony Style Store, Berlin

Location	Berlin
Architect	Helmut Jahn
Project supervision	Rudolf A.Grabowski
Task	Creation of a generous room impression despite the many columns and a room height of only 3.40 m

Olympic stadium, Berlin

Godiva shop at Macy´s, New York

State Theater, Mainz

Contemporary Museum, Berlin

OPALIKA® in overhead glazing as laminated safety glass

Cruise Ship “Olympic Voyager“

OPALIKA® in overhead glazing as laminated safety glass

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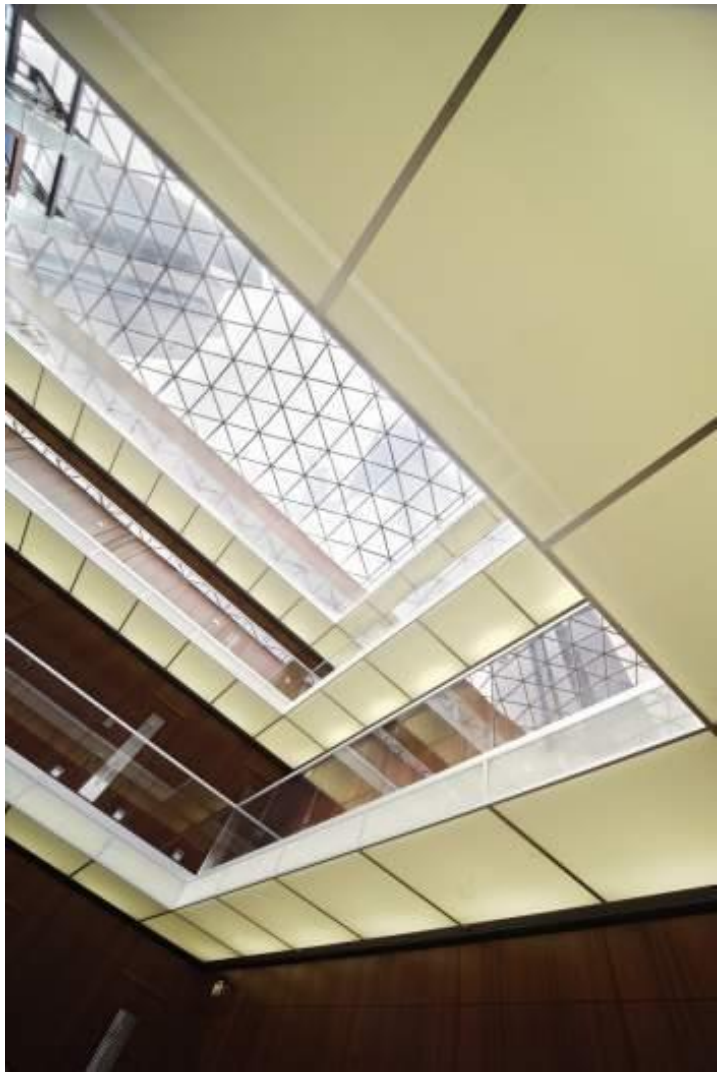
New German Stock Exchange, Frankfurt

AUDI Showroom Beijing

Allianz-Taunus-Anlage, Frankfurt



Glasses for Restoration

A new radiance for historic buildings

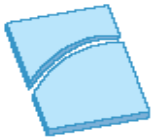
Preserve the true style during restoration

... for use in classic single pane applications

... for double glass units

... for protective glazing in colorful glazing that contains lead

- ✓ machine-drawn glasses
- ✓ available in different degrees of distortion
- ✓ resemble traditional window glass



- ✓ can be processed just like ordinary float glass, e.g. to tempered safety glass, laminated safety glass

- ✓ neutral in color
- ✓ harmonic integration into the overall look of historical windows
- ✓ consistent appearance of the surface structure

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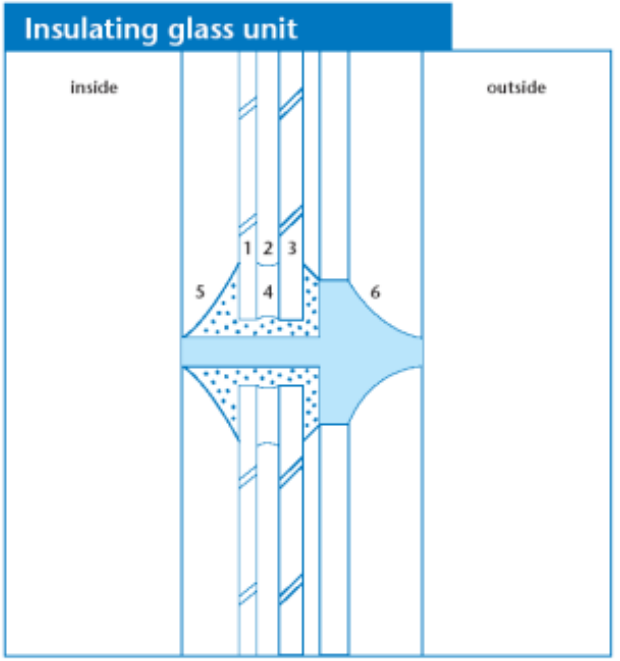
Bauhaus University, Weimar

Bauhaus University, Weimar

Location	Weimar
Architect	Henry van de Velde
Restoration	van den Valentyn Architects, Harms and Partner Engineers
Task	Technical modernization called for rescuing as many of the studio skylights as possible



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Orangerie in Schwerin Castle

Single glazing with Restover®

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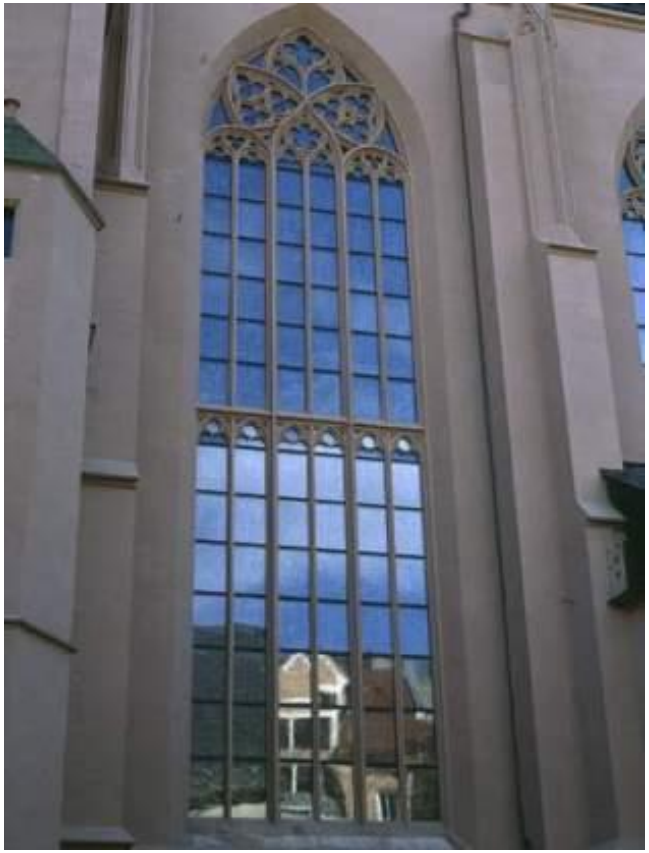
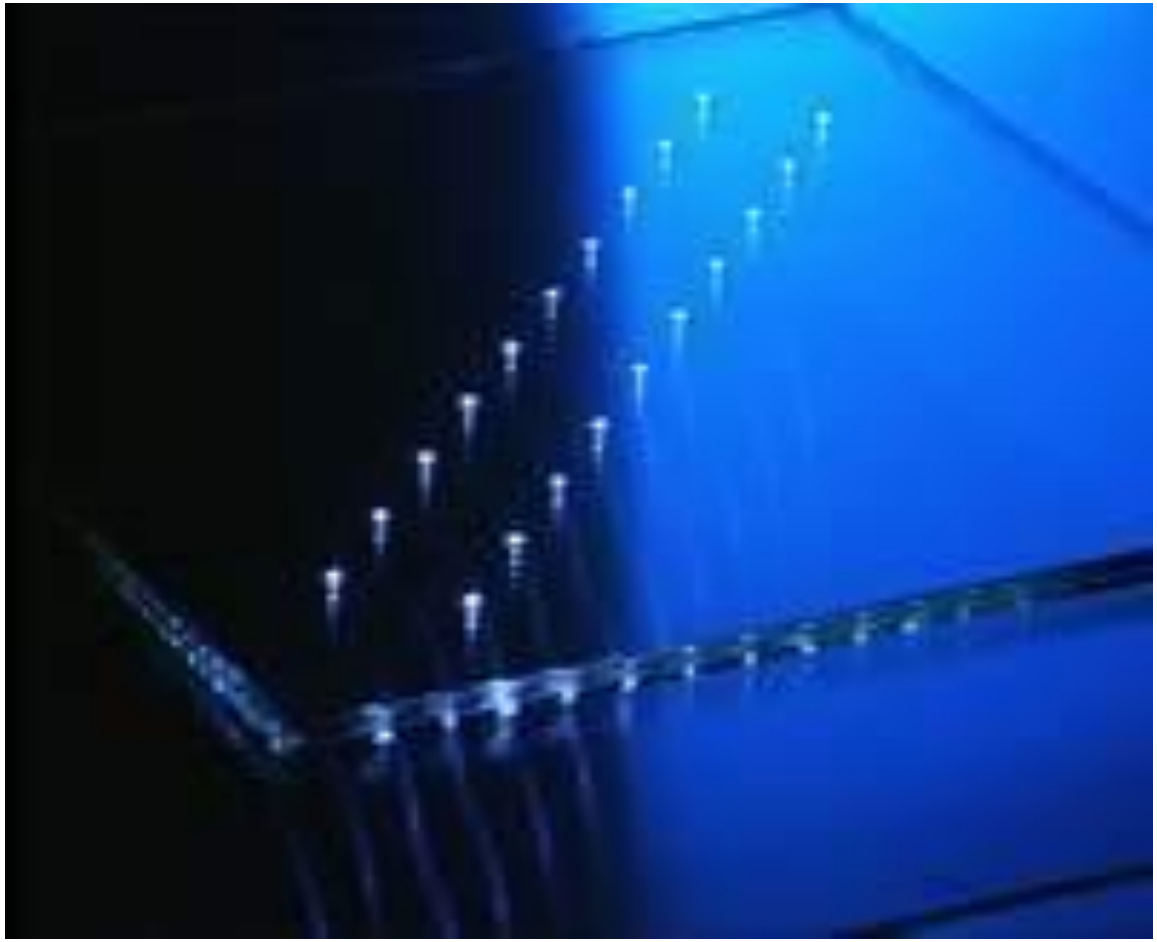
Katharinenkirche Church, Oppenheim



Protective glazing using Goetheglas

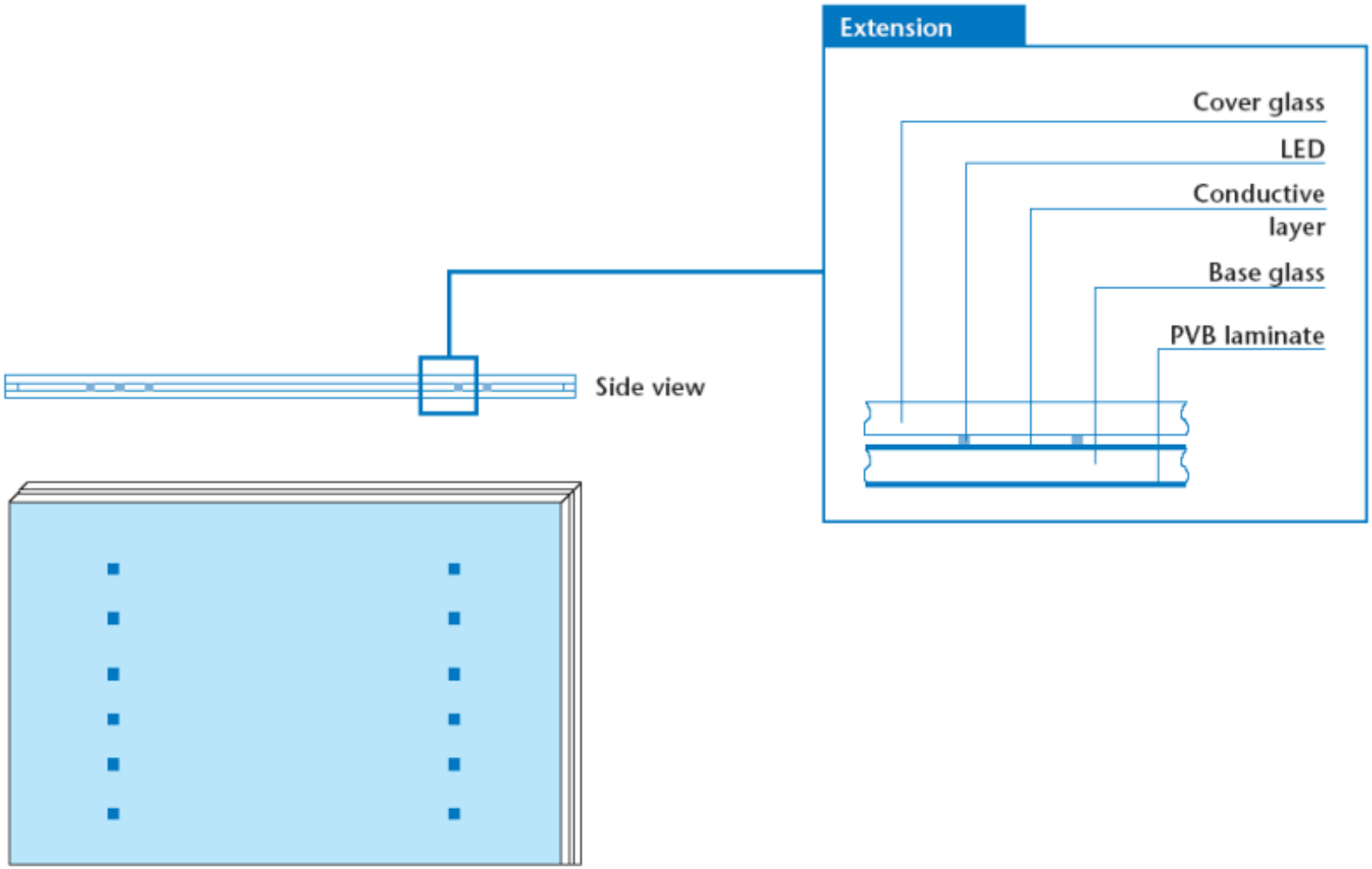
Light Inside a Flat Glass Laminate - LightPoints



- ✓ A transparent base glass pane capable of conducting electricity is equipped with (soldered) LEDs and affixed to any type of cover glass using a PVB film laminate.

- ✓ no visible cables
- ✓ the PVB film laminated glass satisfies the legal requirements for fall protection glazing and fulfills
- ✓ the soldered LEDs ensure higher stability during processing

Operating principle



Advantages

- no visible sticky edges like casting resin laminates
- the PVB film laminated glass satisfies the legal requirements for fall protection glazing and fulfills EN 12 600 (in certain cases, e.g. casting resin laminate requires approval)
- the soldered LEDs ensure higher stability during processing than other solutions
- the PVB film laminate is lightfast and insensitive to UV.
- high luminance (more LEDs on a defined surface area), due to the calculation of the structure with LightPoints

La Maladière Center, Neuchatel

La Maladière Center, Neuchatel

Location Neuchatel (Switzerland)
Architect GD Architects

Balustrade
- 105 meters on 2 floors
- 117 m² of LightPoints glass
- PVB laminated safety glass - 3 panes of toughened safety glass
- 7,300 LEDs in the colors white, blue and red
- Light animation: static light; at each full hour, the LEDs on the elevator cease to light up so that the balustrade can put on its own light choreography 100 meters in length

Elevator
- 14 meters high
- 48 m² of LightPoints glass
- PVB laminated safety glass consisting of 2 panes of toughened safety glass
- light animation: The LEDs in the individual glass panels run parallel upwards across the entire width of the elevator

Chamber of Employment, Innsbruck

LEDs inside a flat glass laminate (LightPoints)

Elevator at Place de l´Europe Luxembourg

Yahoo Office, New York

Fully Glass Door

Staircase with glass steps

Mall of the Emirates, Dubai

Counter at UMD, Barcelona

Mervis Diamond Jewelers, New York

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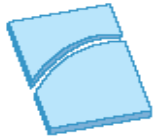
PowerKontakt

Electricity through a Flat Glass Laminate

- ✓ nearly free of glare
- ✓ highly transparent
- ✓ conserves energy

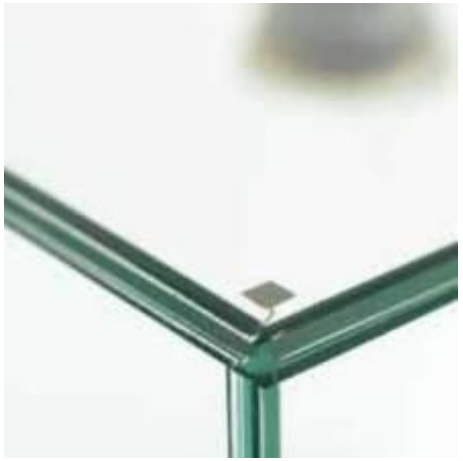


- ✓ nearly free of glare
- ✓ highly transparent
- ✓ conserves energy

Operating principle

The PowerKontakt product range comprises transparent glass conductor plates equipped with electronic devices, such as halogen spots etc.

The power supply to the electronic devices is provided via virtually invisible conducting paths on the glass. The glass conductor plate is protected by a laminated cover glass.



Show-cases application

Canopy

Glass processing capabilities

Glass processing options

An almost infinite variety of shapes and compositions can be achieved today with glass. SCHOTT processes a wide range of different types of glass in thicknesses ranging from 0.5 mm to 19 mm.

The various types of glass can be processed and refined using a wide variety of techniques, such as grinding, polishing, drilling, sandblasting, molding and toughening.

High precision cutting

Shaping glass

Complete range of glass processing

Designer Lamp, designed by Philippe Starck

Designer Lamp, designed by Florian Schulz

Further products from SCHOTT for architecture

Fire Resistant Glazings

Solar thermal

Fiberoptics

Photovoltaic

SCHOTT@Architecture ...

... well prepared for the future!

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