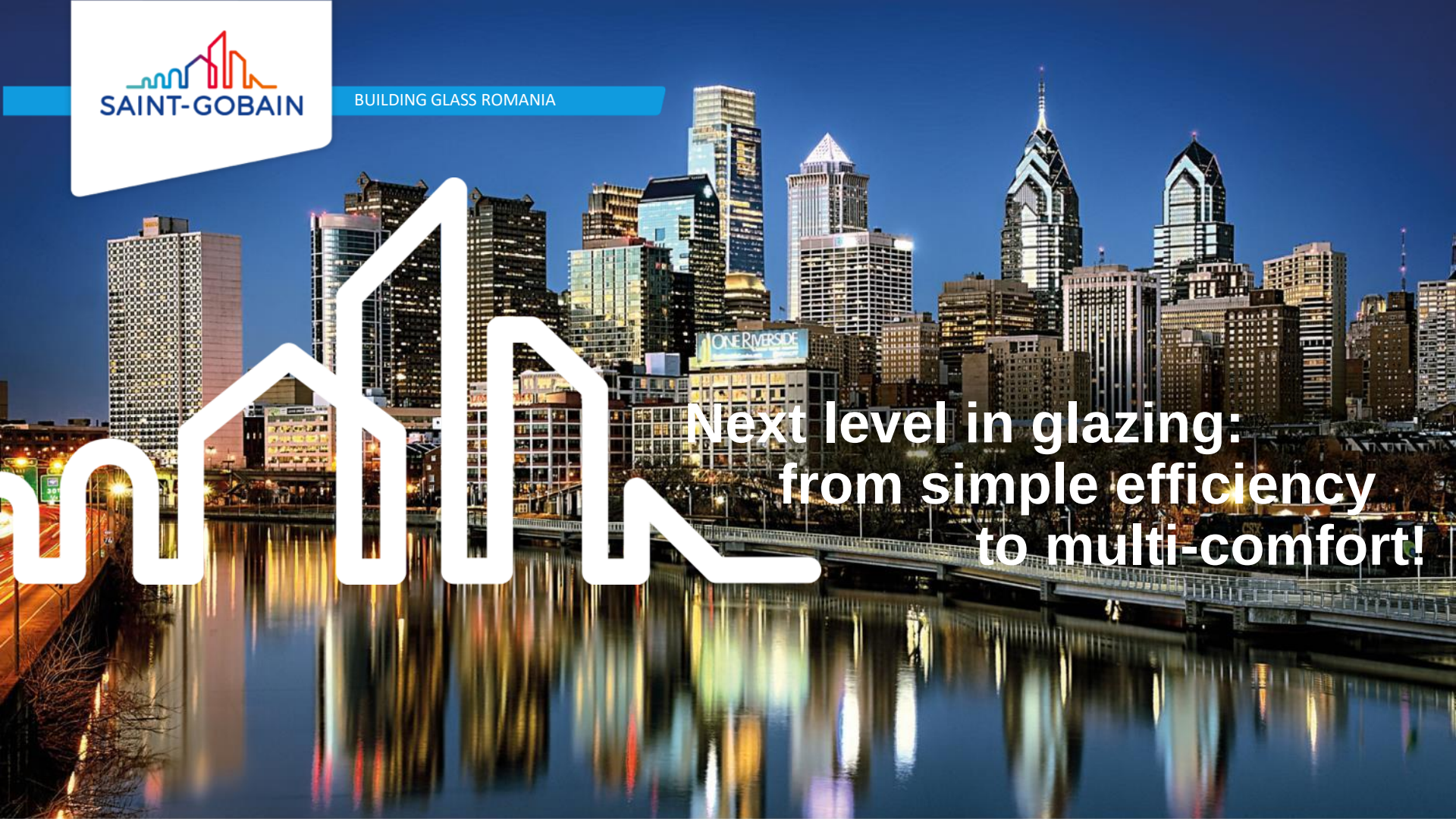
SAINT-GOBAIN

BUILDING GLASS ROMANIA



Next level in glazing: from simple efficiency to multi-comfort!

AGENDA

MARCH 2019

The Saint-Gobain Group

Saint-Gobain, 354 years of industrial history

1665
Creation of the Manufacture royale des Glaces

1688
Invention of glass table casting

1850-1900
Saint-Gobain expands in Europe: Germany, Italy, Belgium and Spain

1900-1950
Saint-Gobain diversifies into new markets and new products

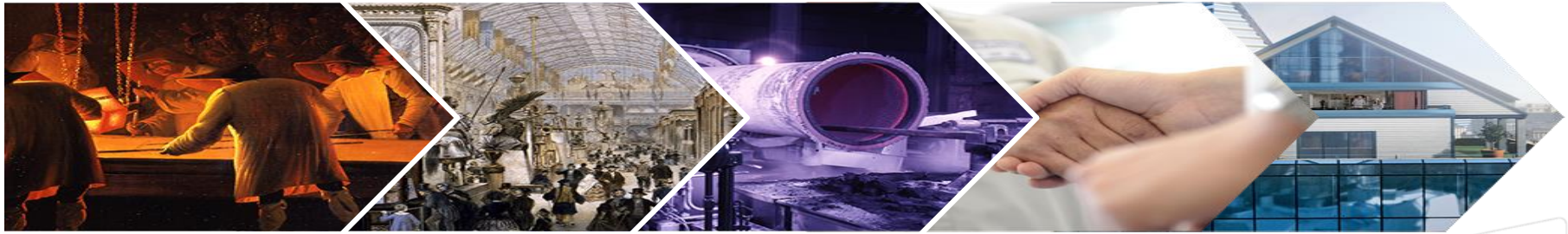
1970
Merger between Pont-à-Mousson and Saint-Gobain. Ongoing internationalization

1990 years
Refocus on materials with a high technology content and entry into building distribution and plasterboard

2007
Saint-Gobain focuses its strategy on habitat

2015
Saint-Gobain celebrates its 350th anniversary

2016
Saint-Gobain introduces its new positioning and new visual identity



A STRONG GLOBAL GROUP

One of the top

100

industrial groups in the world with around 1,000 manufacturing facilities

Operating in

67

countries

Created more than

350

years ago

SAINT-GOBAIN

More than

180,000

employees and 100+ nationalities represented

About

4 000

sales outlet

2018 sales

€41.8BN

OUR MISSION

Saint-Gobain designs, manufactures and distributes materials and solutions which are key ingredients in the wellbeing of each of us and the future of all. They can be found everywhere in our living places and our daily life: in buildings, transportation, infrastructure and in many industrial applications. They provide comfort, performance and safety while addressing the challenges of sustainable construction, resource efficiency and climate change.

SAINT-GOBAIN

INNOVATION MINDSET

3 700
researchers

8 cross-business R&D centers

1 product out of 4 sold by Saint-Gobain today didn't exist 5 years ago

Nearly
400
patents filed in 2018

About
100 development units

2018–19
DERWENT TOP 100 GLOBAL INNOVATOR
Clarivate Analytics

NOVA BY SAINT-GOBAIN

SAINT-GOBAIN

CLIMATE COMMITMENTS

Environmental targets (2010-2025)

- 50%
of non-recovered waste,
0 long term

- 15%
of energy consumption

- 20%
CO_2 emissions

- 80%
of waste water discharges in liquid form, 0 long term

Extraction of
9,025,000
tons of virgin materials
avoided in 2018

Internal carbon price
integrated into decision-making procedures on investments and R&D projects

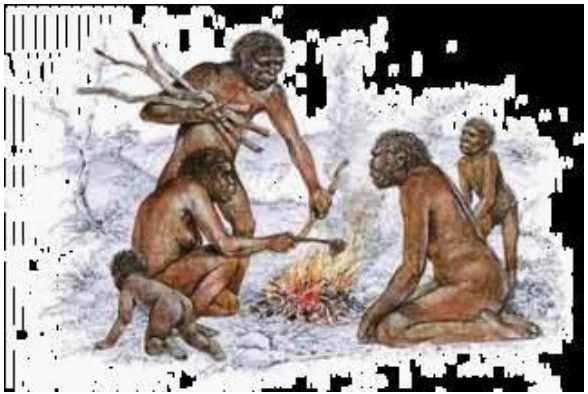
Saint-Gobain appears for the first time on
CDP's Climate Change A List

FROM SIMPLE EFFICIENCY TO MULTICOMFORT

Next level in glazing: from simple efficiency to multi-comfort!

Simple efficiency:

- **Prehistory…stone age… → protection against wind, rain,…**



Next level in glazing: from simple efficiency to multi-comfort!

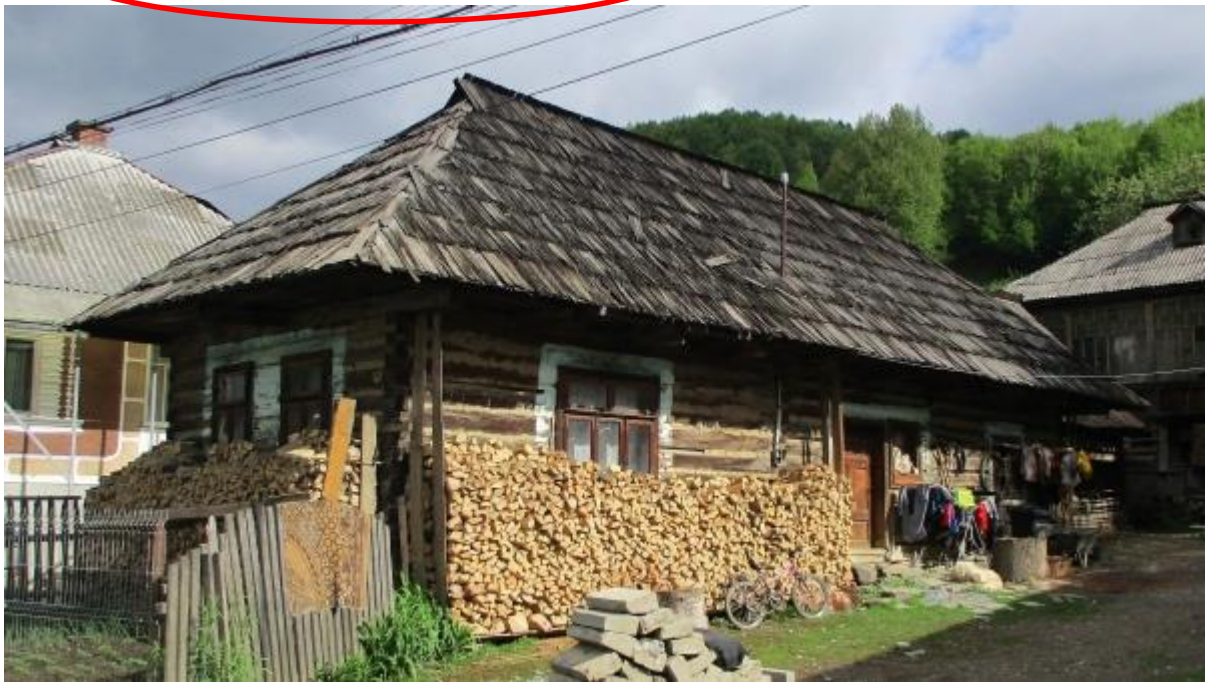
Simple efficiency:

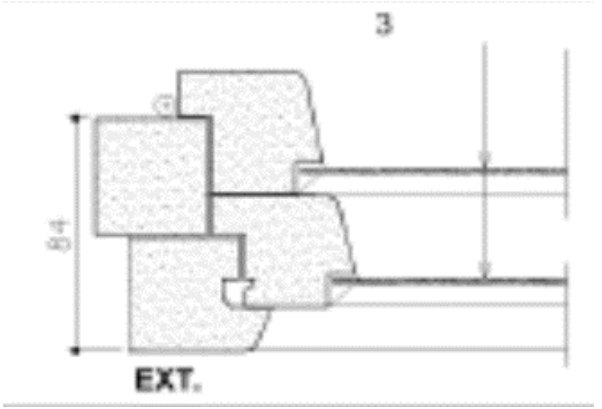
- **Light transmittance**
- **Poor thermal insulation and solar protection**

Next level in glazing: from simple efficiency to multi-comfort!

Simple efficiency:

- **Better thermal insulation**





SAINT-GOBAIN

Next level in glazing: from simple efficiency to multi-comfort!

Simple efficiency:

- **Good thermal insulation → “Low E”**

Next level in glazing: from simple efficiency to multi-comfort!

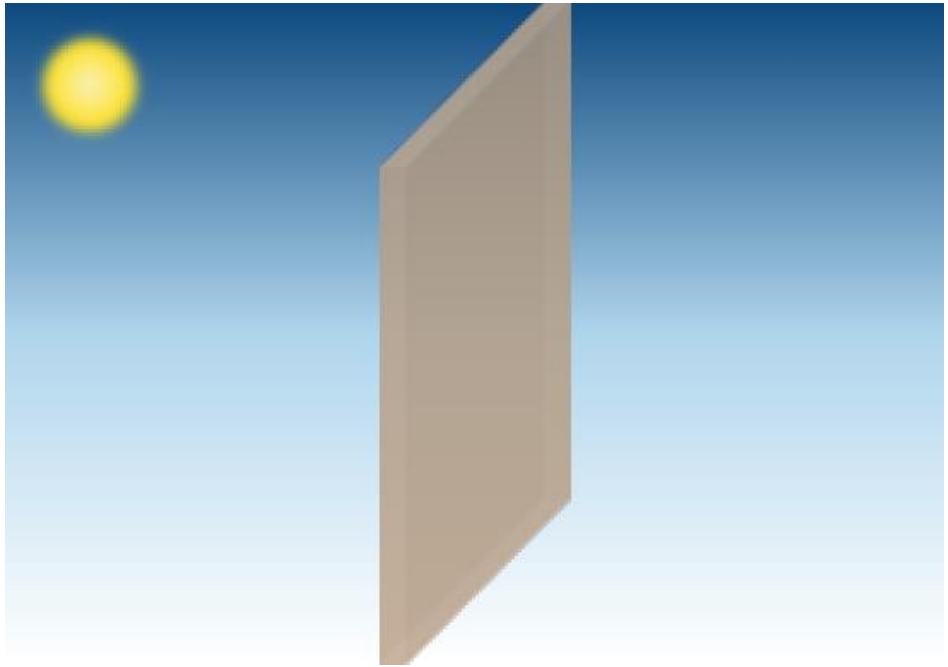
High Thermal insulation

Triple Glazed Unit

Next level in glazing: from simple efficiency to multi-comfort!

Solar protection

Body tinted glass



Parsol Bronze

g = 0.60

LT = 49%

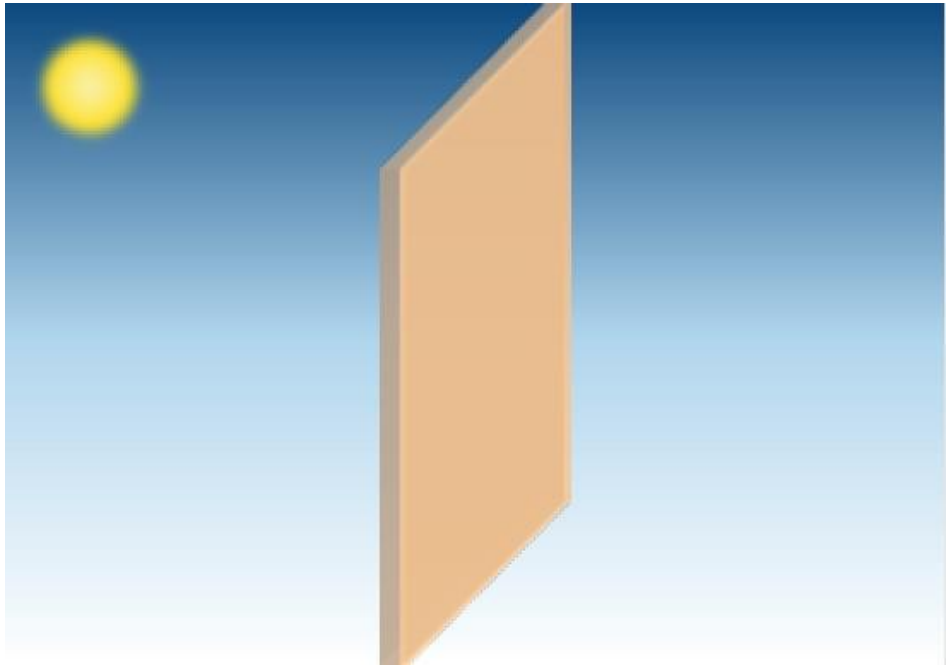
($g_{Planiclear}$ = 0.87)

LT = 90%

Next level in glazing: from simple efficiency to multi-comfort!

Solar protection

Reflexive glass



Antelio Havana

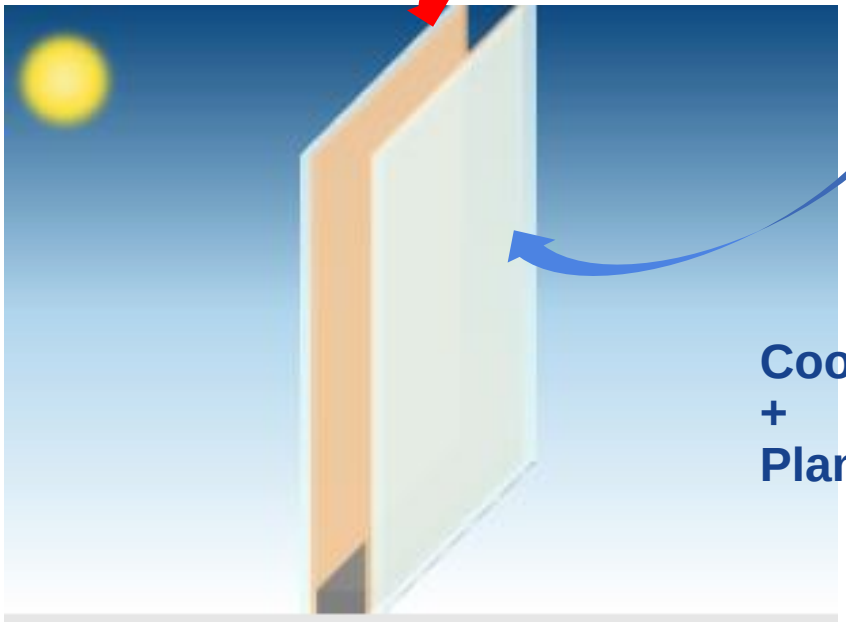
g = 0.43

LT = 24%

Next level in glazing: from simple efficiency to multi-comfort!

Efficiency:

- **Thermal insulation**
- **Solar protection**



Solar protection glass
+
“LowE” glass

Cool-Lite® ST-range
+
Planitherm® XN

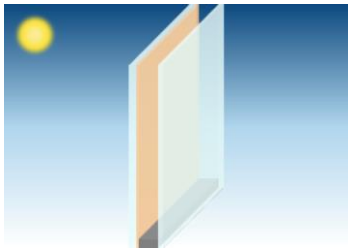
Next level in glazing: from simple efficiency to multi-comfort!

Very Good Efficiency:

- **Thermal insulation**
- **Solar protection**
- **Light transmittance**

Selective glass

“Multi-functional” glass



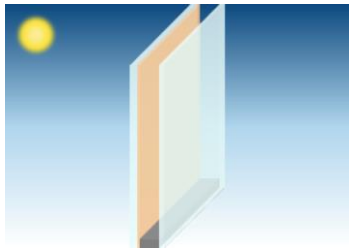
Planitherm® 4S EVO

Cool-Lite® KN 166 II

Next level in glazing: from simple efficiency to multi-comfort!

High Efficiency:

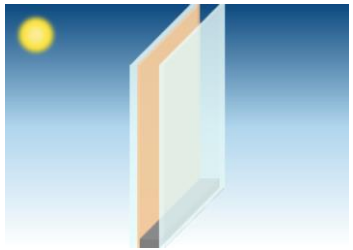
- **Thermal insulation**
- **Solar protection**
- **High LT**



Next level in glazing: from simple efficiency to multi-comfort!

Super Efficiency:

- **Thermal insulation**
- **Solar protection**
- **High LT**



Next level in glazing: from simple efficiency to multi-comfort!

Solar protection vs Light Transmittance

Daylight is necessary…

Next level in glazing: from simple efficiency to multi-comfort!

Solar protection vs Light Transmittance

…but with a good control!

Glare…

Overheating …

BUILDING GLASS ROMANIA

SAINT-GOBAIN

Next level in glazing: from simple efficiency to multi-comfort!

Solar protection vs Light Transmittance

…Selectivity, S = TL/g

g = 0.37 ÷ 0.39

DGU: Cool-Lite ST 150 + Plt XN (Ug = 1.1 W/m2K):
g = 0.38, LT = 46% → S = 1.21

DGU: Plt 4S Evolution + Planiclear (Ug = 1.0 W/m2K):
g = 0.38, LT = 60% → S = 1.58

DGU: Planistar SUN Plus + Planiclear (Ug = 1.0 W/m2K):
g = 0.38, LT = 70% → S = 1.89

Next level in glazing: from simple efficiency to multi-comfort!

Solar protection vs Light Transmittance

…Selectivity, S = TL/g

LT = ~ 60 %

DGU: Cool-Lite ST 167 + Plt XN (Ug = 1.1 W/m2K):
LT = 61%, g = 0.49 → S = 1.24

DGU: Cool-Lite KN 166 II + Planiclear (Ug = 1.0 W/m2K):
LT = 60%, g = 0.38 → S = 1.58

DGU: Cool-Lite SKN 165 II + Planiclear (Ug = 1.0 W/m2K):
LT = 61%, g = 0.34 → S = 1.79

DGU: Cool-Lite Xtreme 60/28 II + Planiclear (Ug = 1.0 W/m2K):
LT = 60%, g = 0.28 → S = 2.14

Main criteria

Performances

Energy savings
Sound protection
Safety & Security
Fire protection

Aesthetics

Color in reflection
Color in transmission
Color Homogeinity

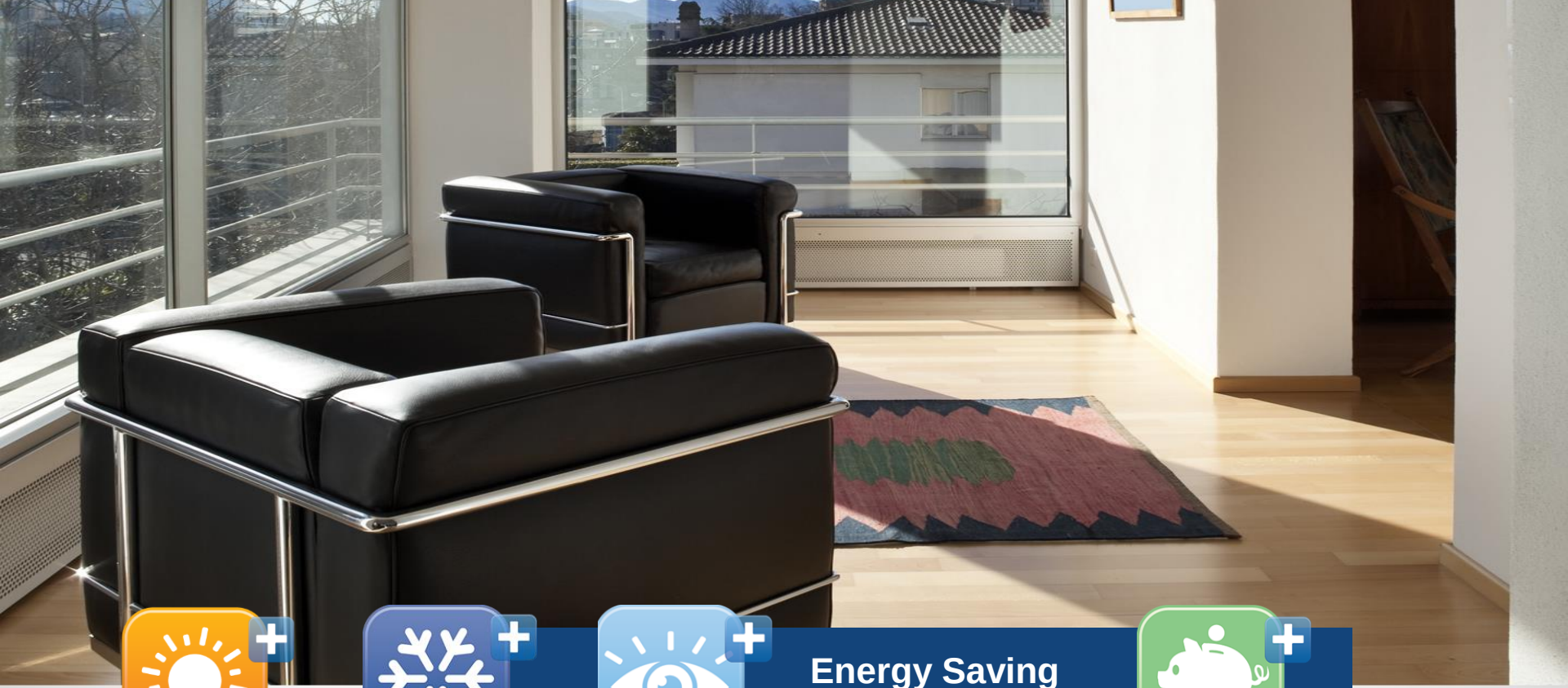
Processing

Tempering
Enameling
Screen-printing
Curving

Sustainability

LEED
BREEAM
DGNB
HQE

Performance



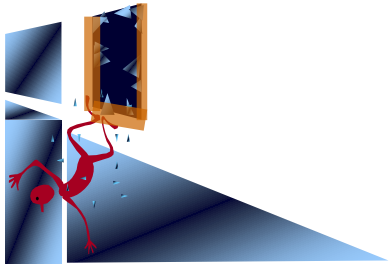
Energy Saving

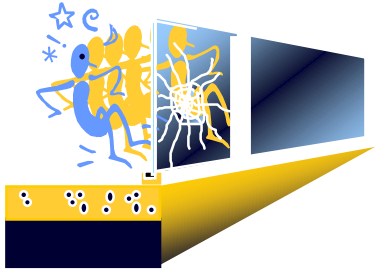
Sound Proofing

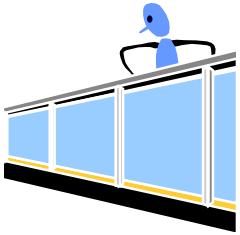
SAINT-GOBAIN

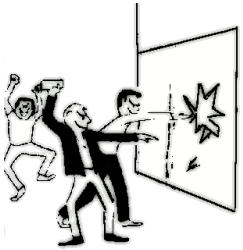
Sound Proofing

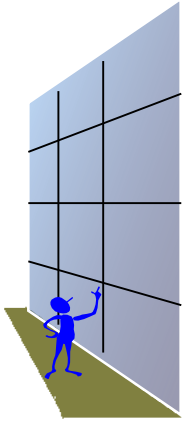
Safety and Security

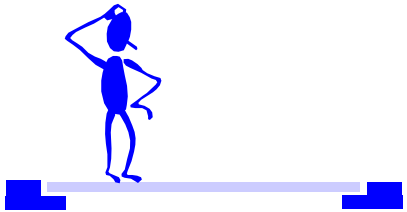












Safety and Security

SAINT-GOBAIN

Fire Protection

E – Integrity

- No flames
- No gas
- No Heat reduction

EW – Radiation control

- No flames
- No gas
- Heat reduction

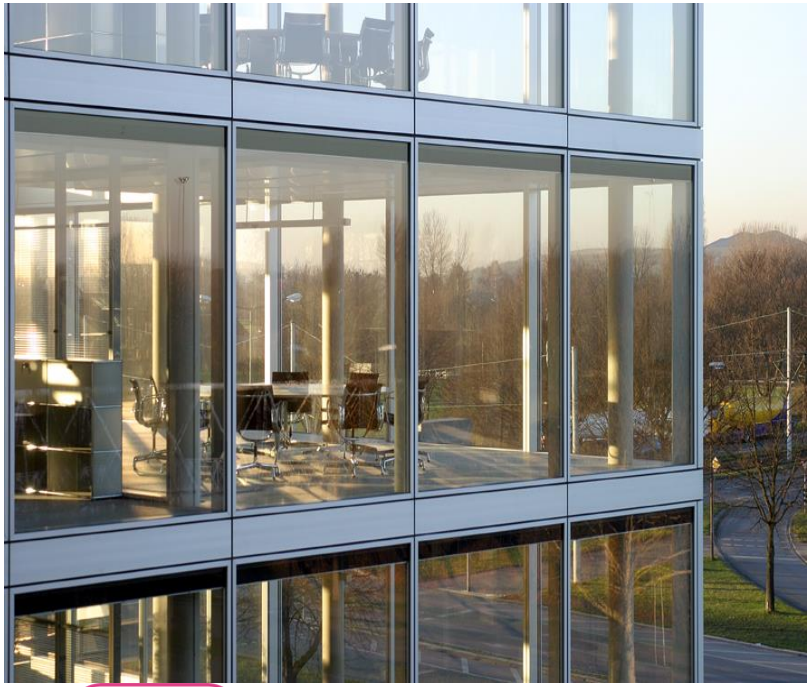
EI – Insulation

- No flames
- No gas
- No heat

Fire Protection

SAINT-GOBAIN

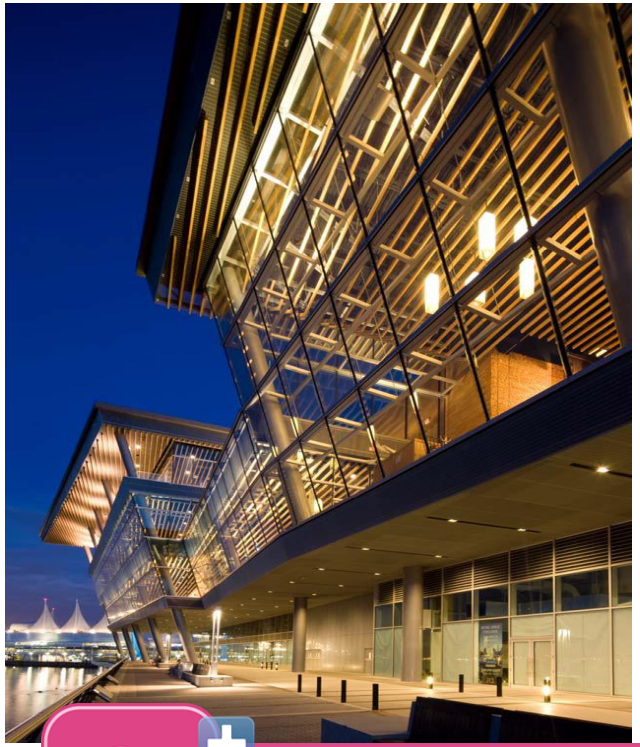
Aesthetic

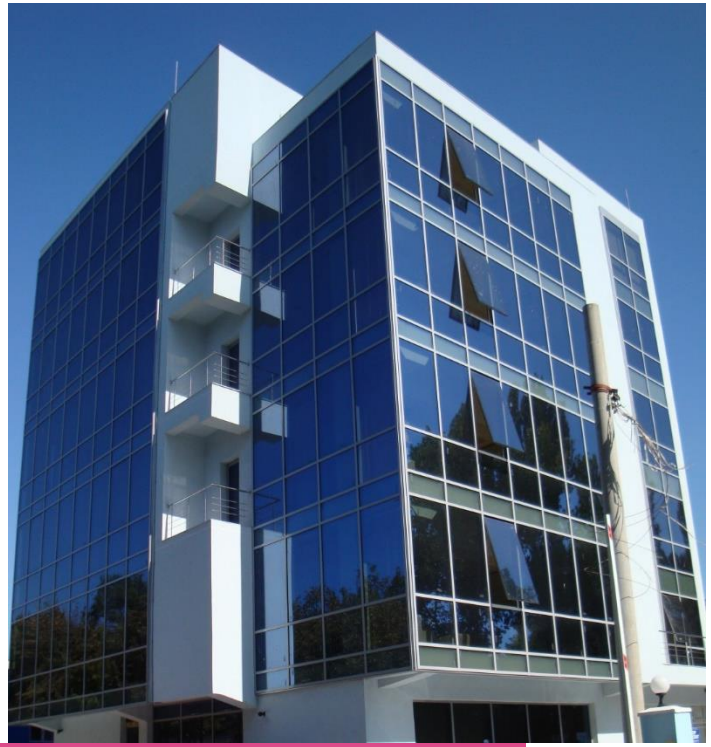


Transparency

Gelsenwasser, Germersheim
Cool-Lite SKN 176 II

North Gate, Bucharest
Cool-Lite ST 436





Color: neutral, blue, green, silver, gray, …

Convection Center – Vancouver
SGG DIAMANT

RENEL office – Constanta
SGG STB 136

Reflectivity

SGG Vision Lite

SAINT-GOBAIN

Processability

Curved glass

SGG COOL-LITE KN II
SGG COOL-LITE SKN II
SGG COOL-LITE XTREME II
SGG COOL-LITE ST

Curved glass


Big, Flat, Clear

INNOVATIVE MATERIALS SECTOR

XL – Glass yesterday

8 m x 3.2 m @ **Eckelt Glas**

- **Laminated* glass**
- **Fully tempered (heat strengthened) glass**
- **Heat soak test**
- **Insulating glass**
- **Screen printing****

Broad Museum – LA
DGU > 7 m with multiple laminated glass – SentryGlass, holes and screen print

*8m x 3.21m
**6m x 3.21m

SAINT-GOBAIN


Screen printed, Enameled

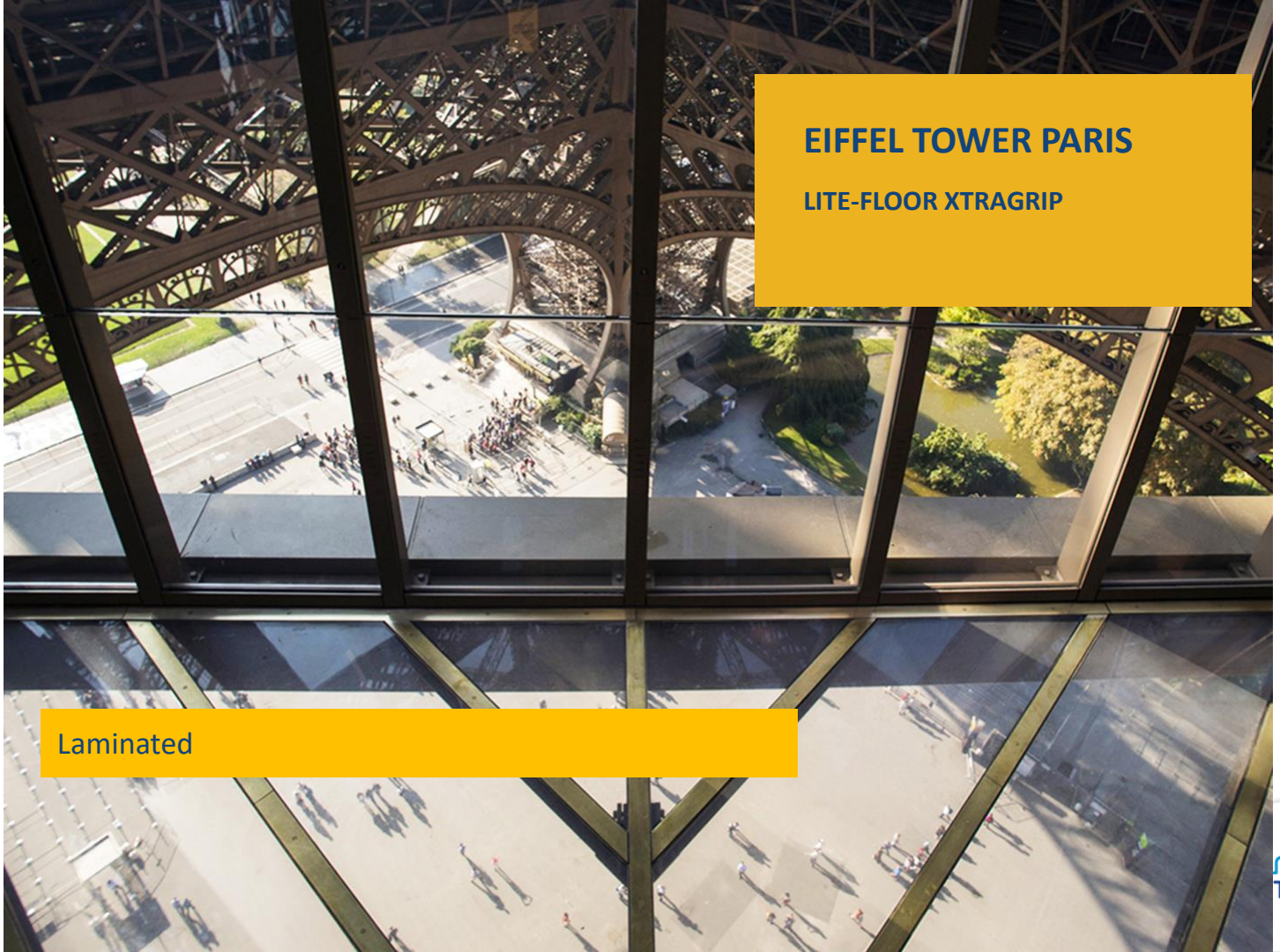
Screen printed, Enameled

Screen printed, Enameled

ST Bright Silver

Ideal for double skin

Single glazing



EIFFEL TOWER PARIS

LITE-FLOOR XTRAGRIP

Laminated

Laminated

Lipscani
Diamant

SAINT-GOBAIN

Specialities

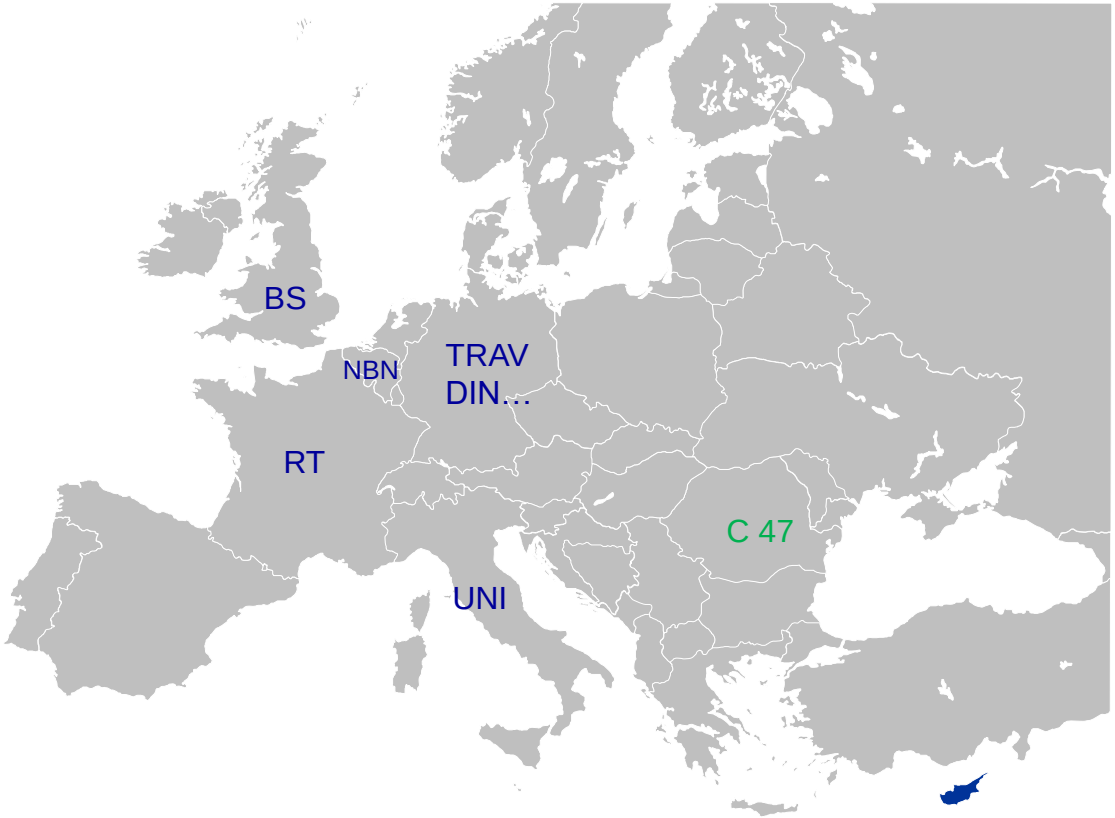
SAINT-GOBAIN

Next level in glazing: from simple efficiency to multi-comfort!

Simple efficiency → more comfort:

- **Thermal insulation**
- **Solar protection**
- **Natural light transmission**
- **Acoustic comfort**
- **Safety & Security**

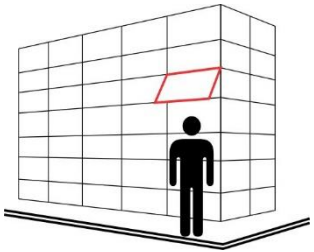
SAFETY & SECURITY IN USE

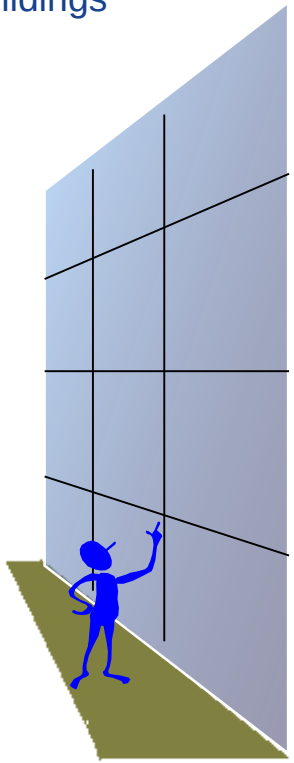


SAFETY & SECURITY IN USE

Different applications

- Walkable areas near buildings

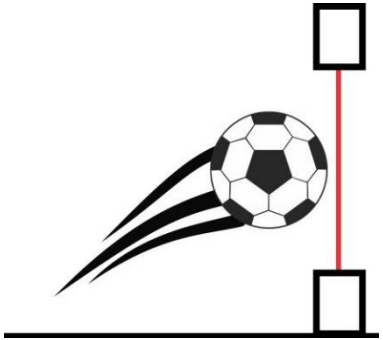


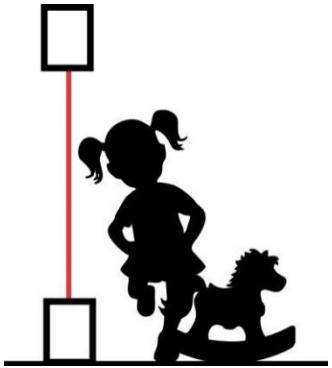


Tempered
or
Laminated

SAFETY & SECURITY IN USE
Different applications

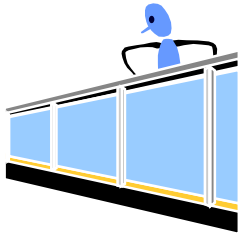
- Schools, sport halls



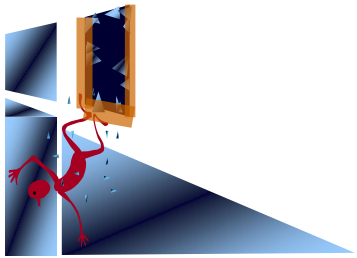


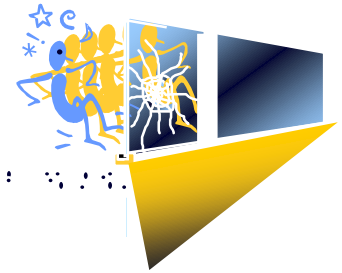
Tempered
or
Laminated

SAFETY & SECURITY IN USE
Different applications



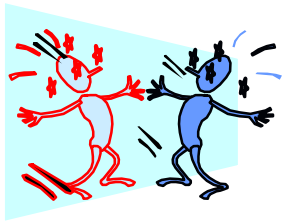
- Risk of direct contact and <u>falling from height</u>





Laminated
(annealed, or heat strengthened, or tempered)

- Risk of direct contact

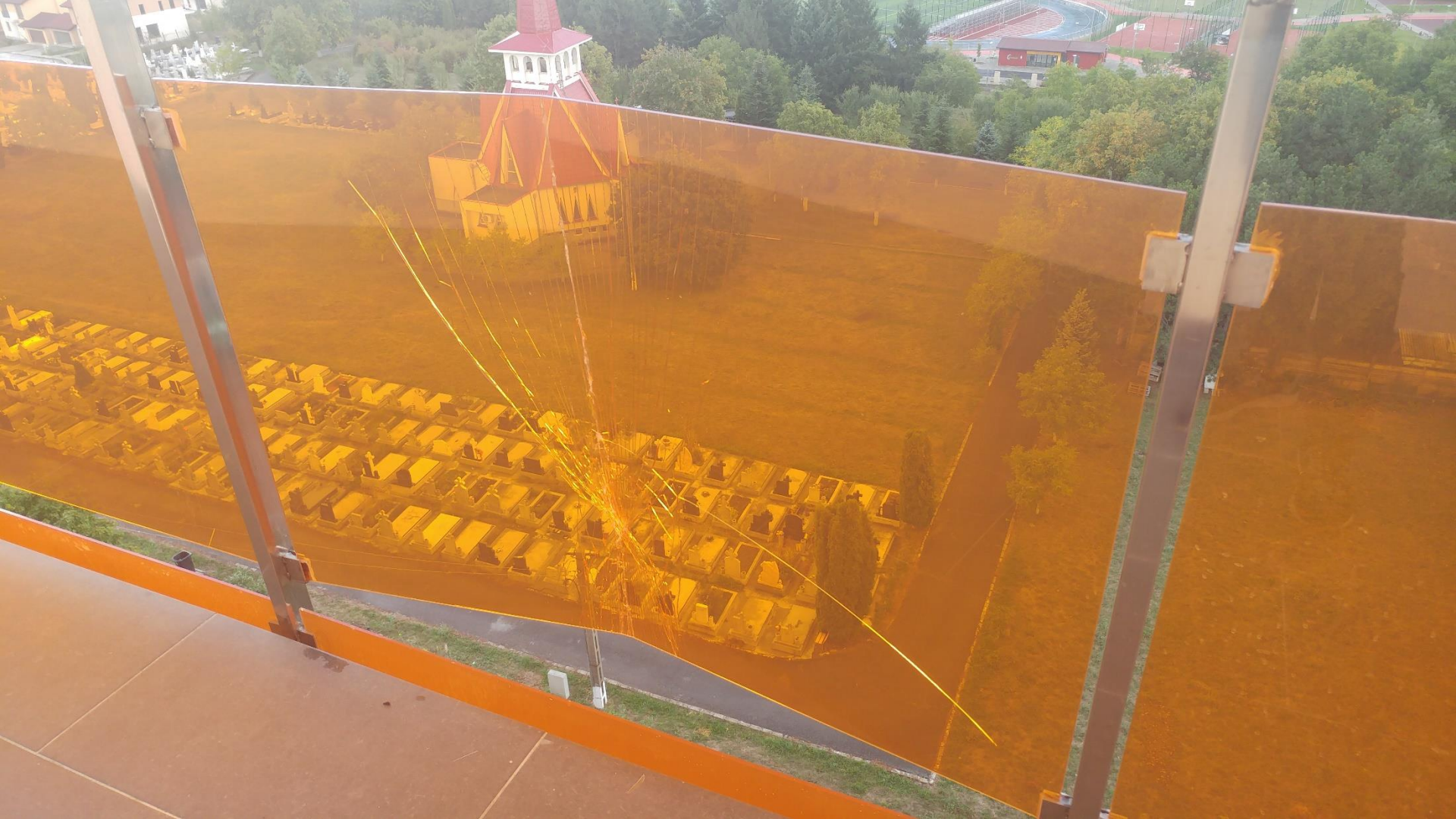


Tempered
or
Laminated

SAINT-GOBAIN

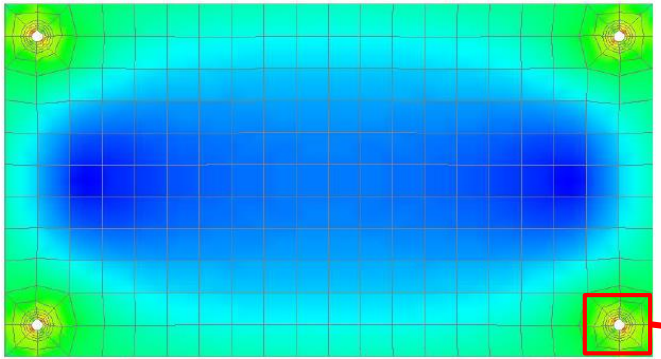
LUXURY APARTMENTS
Romania

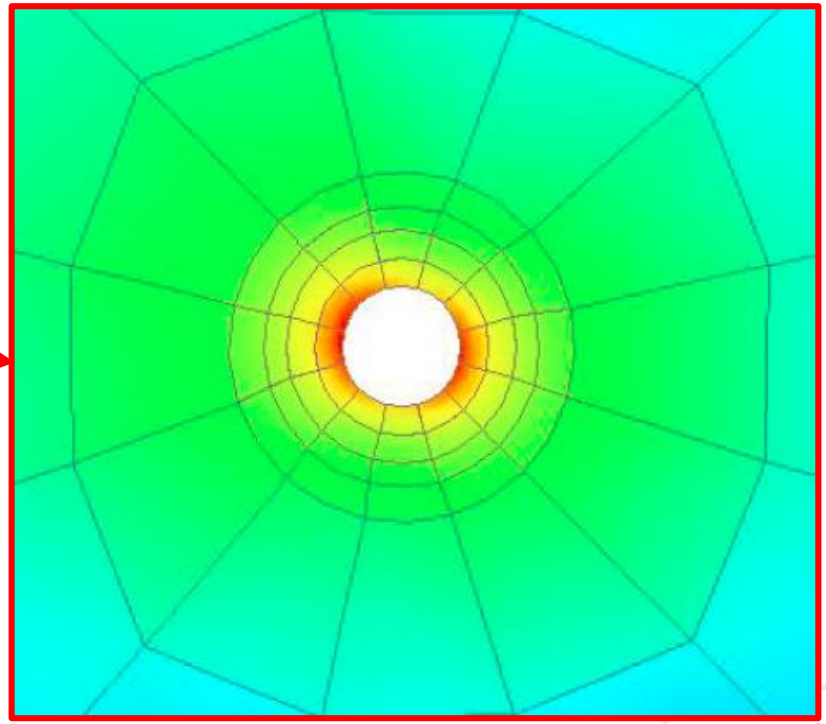
SAINT-GOBAIN



HIGH LEVEL OF INDUCED STRESS

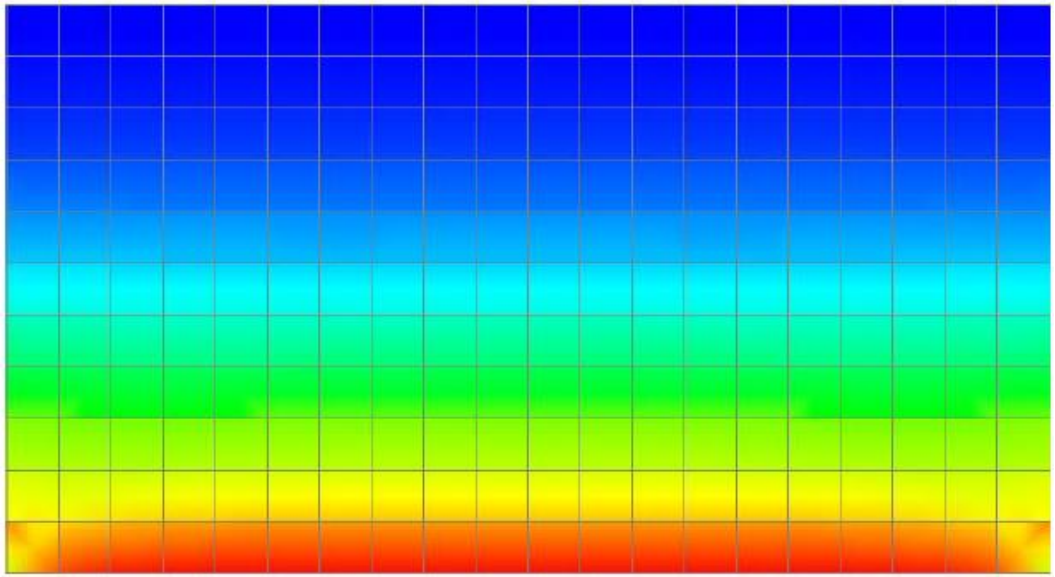
Point fixing





HIGH LEVEL OF INDUCED STRESS

Bottom edge clamping



Structural bonded glass balcony

Tested acording with german TRAV

Glass configuration: 8.8.4 not tempered
Structural bonding with Sikasil SG 500
Max. impact height 1200mm from contact point

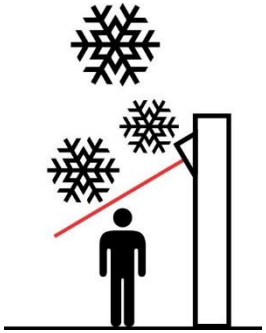
Structural bonded glass balcony

Tested acording with german TRAV

Glass configuration: 10.10.4 tempered
Structural bonding with Sikasil SG 500
Max. impact height 1200mm from contact point

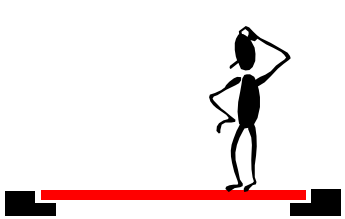
SAFETY & SECURITY IN USE
Different applications

- Overhead glazing



Laminated
(annealed, or heat strengthened,
or tempered)

- Floors, stairs

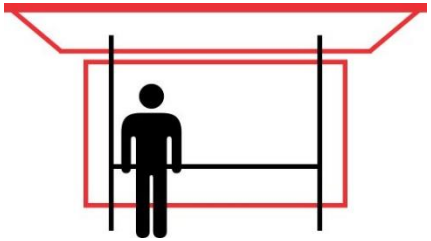


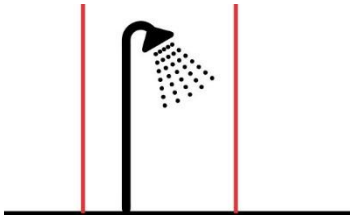
Multi-Laminated
(tempered & anti slippery + annealed
or heat strengthened + tempered)

SAINT-GOBAIN

SAFETY & SECURITY IN USE
Different applications

- Bus station, shower cabin, elevators, phone cabin…



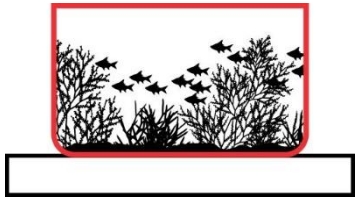


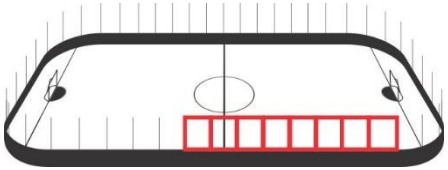
Tempered
or
Laminated
(annealed, or heat strengthened, or tempered)

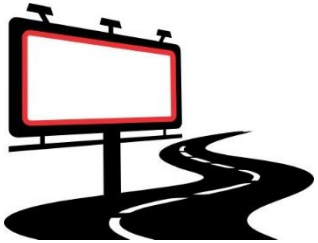
SAINT-GOBAIN

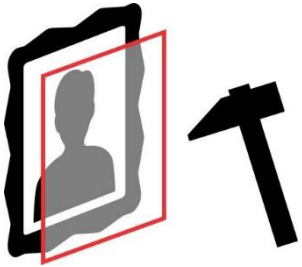
SAFETY & SECURITY IN USE
Different applications

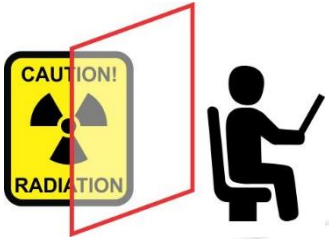
- Many other applications…

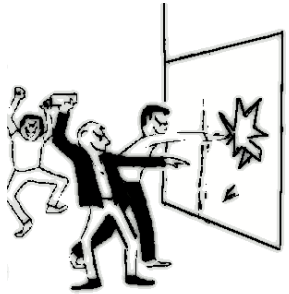












SAFETY & SECURITY IN USE
Tempering process

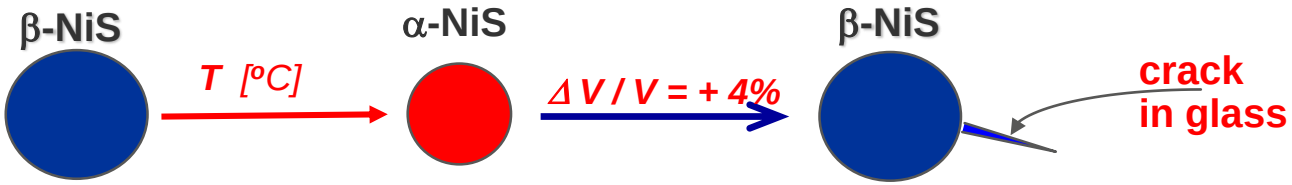
SAFETY & SECURITY IN USE
Tempering process

- Advantages
  - Safety in use: when it brakes → thousands of small rounded pieces
  - 5 times stronger than annealed glass
  - For fixing methods where high stresses are induced (spider system, clamping…)
  - Resistant to hailstones
  - More resistant to scratches

SPONTANEOUS BREAKAGE DUE TO NIS INCLUSIONS

Nickel sulfide - the failure mechanism

- Allotropic transformation of Ni



- During heating **β-NiS** goes to **α-NiS**
- During quench + cooling, the cooling rate being very high, the allotropic transformation does not have time enough to take place (metastable phase, kinetic inhibition)
- Transformation into **β-NiS** occurs very slowly at room temperature: spontaneous failures happen even after few years

ESG - NiS breakage "spontaneous breakage"

Point load - short-term - dynamic - strong intensity

Type of glass	Only tempered glass, not for partially tempered glass (TVG)
Examples	Very rare; occurs mostly after few months up to few years after ESG production; possible with all ESG types; can be excluded as far as possible by Heat Soak Test
Beginning	Clear butterfly structure at the fracture center; always the small nickel sulfide inclusion is present as a black dot on the butterfly centerline within the glass.
Run	Radially reticulated starting from the center; typical ESG crumb picture; small fragments; full-surface fracture.
Discharge / End	All over, countless, on all edges, always to the edge.
Other	Crumb structure over entire surface; no shells in the break center; not visible with single pane, as in the case of break destruction and collapse of the pane; Visible from ESG at ESG / VSG; in case of insulating glass with small spacer width, visible in strongly inclined glazing, if outer pane affected and resting on inner pane; larger fragments especially in the edge area possible;

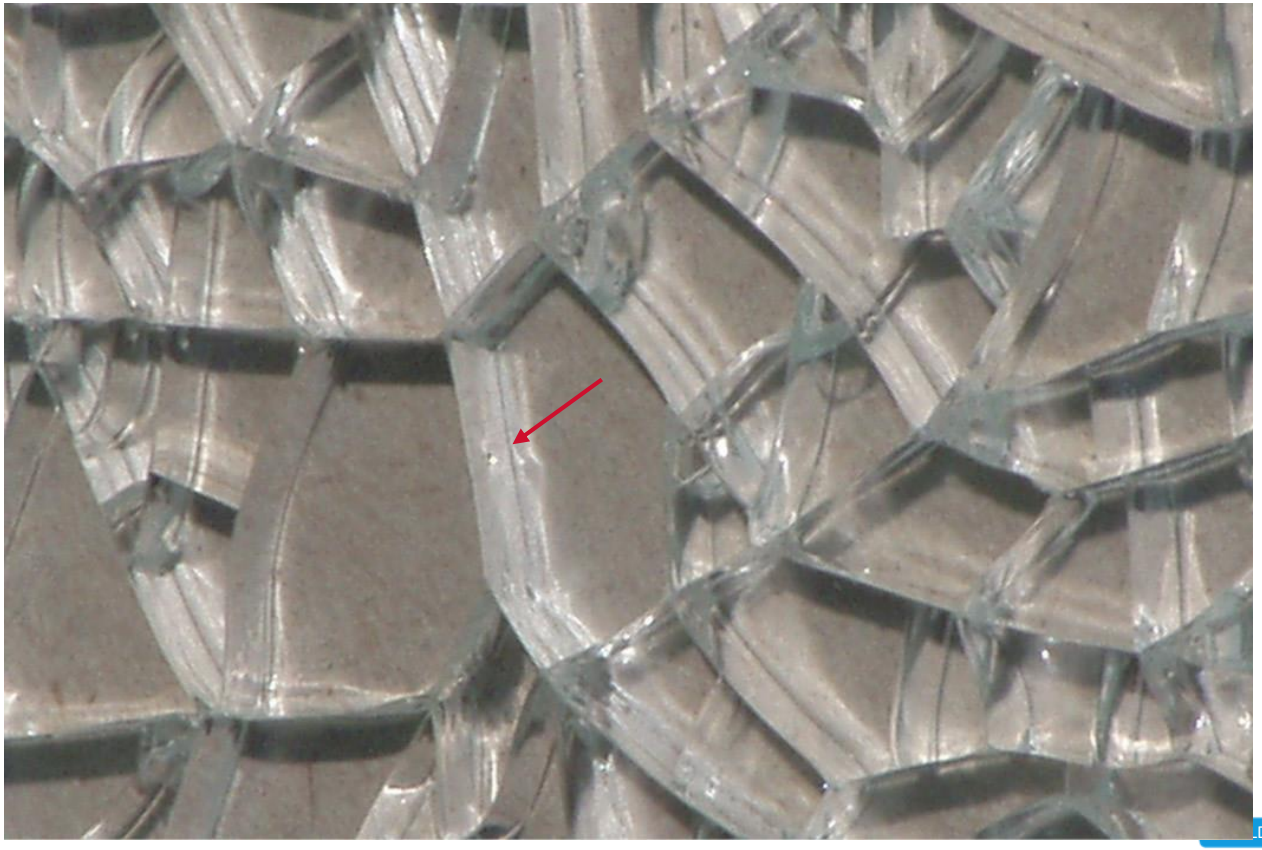
ESG - NiS breakage "spontaneous breakage"

Point load - short-term - dynamic - strong intensity

Nickel-sulphide breakage on laminated safety glass from 2 x ESG, butterfly shape with NiS point in the center

ESG - NiS breakage "spontaneous breakage"

Point load - short-term - dynamic - strong intensity

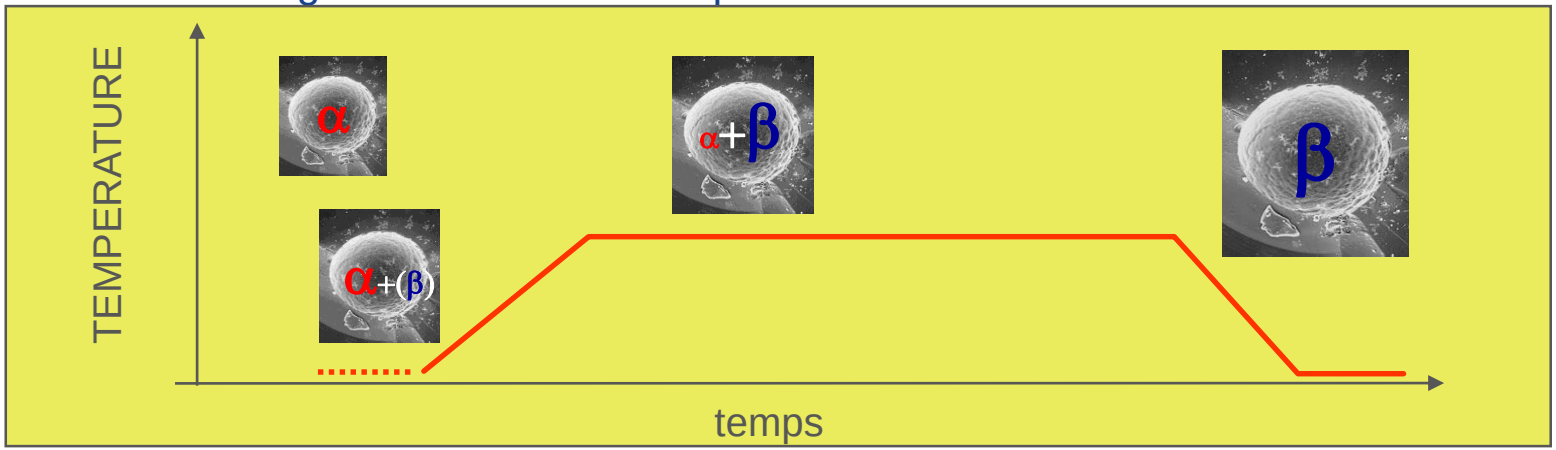


Enlarged break origin with visible black NiS point in the center

HEAT SOAK TEST → EN 14179 - 1

Destructive test (process) applied on final product:

- ↗ To heat up the panes slowly (2h … 5h) to temperature 280 ... 300°C;
- ● To keep this temperature constant some time (> 4 h, “holding time”).
- ↘ To cool down slow enough to not to break the panes.



The allotropic transformation is accelerated.

→ Every glass pane breaks when it contains a critical NiS inclusion.

+

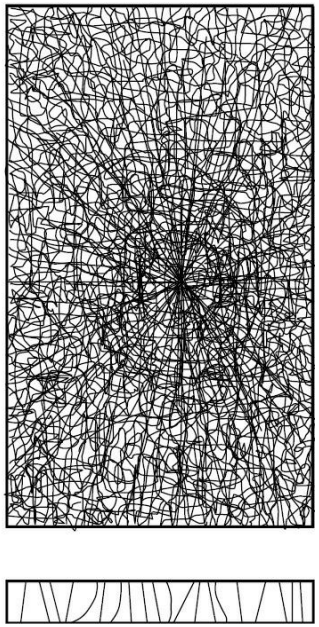
→ Also sheets containing other defects affecting the stability of toughened glass (stones > 500μm; big bubbles) are mostly eliminated.

SAINT-GOBAIN

ESG – Punctual mechanical shock breakage

Point load - short-term - dynamic - medium / high intensity

Type of glass	Only tempered glass, not for partially tempered glass (TVG)
Examples	Hammer punch with point; Bullet; Falling rocks;
Beginning	Fracture center visible, punctiform with shells.
Run	Radially reticulated starting from the center; typical ESG crumb picture; small fragments; full-surface fracture.
Discharge / End	All over, countless, on all edges, always to the edge.
Other	Crumb structure over entire surface; Shelling in the rupture center on the attack side; not visible with single pane, as in the case of break destruction and collapse of the pane;



ESG – Punctual mechanical shock breakage

Point load - short-term - dynamic - medium / high intensity

Mechanical butterfly break at ESG, no
NiS break.

ESG – Punctual mechanical shock breakage

Point load - short-term - dynamic - medium / high intensity

Detail view: Clearly visible fracture-inducing glass destruction on the surface due to mechanical action.

SAFETY & SECURITY IN USE
Laminating process

SAFETY & SECURITY IN USE
Laminated glasses

- Advantages
  - Safety against injuries: when it brakes → it remains fixed and glass pieces remains stacked on film
  - Safety against falling → EN 12600 – Pendulum test
  - Security against vandalism, intrusion → EN 356 – Steel ball drop test
  - Improved sound protection → Stadip Silence
  - Protection against UV → T_{UV} < 1%
  - Available with all the other properties:
    - Thermal insulation → Stadip Planitherm
    - Solar protection, etc. → Stadip SKN, Stadip Xtreme,…

GREEN CERTIFICATION

- LEED
- BREEAM
- …

Next level in glazing: from simple efficiency to multi-comfort!

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Thank you!