sapphire™

TECHNICAL GLASS

SEE WHAT'S IMPORTANT

KEY FACTS ABOUT GROGLASS®

Groglass® is a world leading developer and manufacturer of anti-reflective and other high performance coatings on glass and acrylic for various industries including high-end outdoor and indoor electronic displays, cold storage, lighting, automotive, and other technical applications.

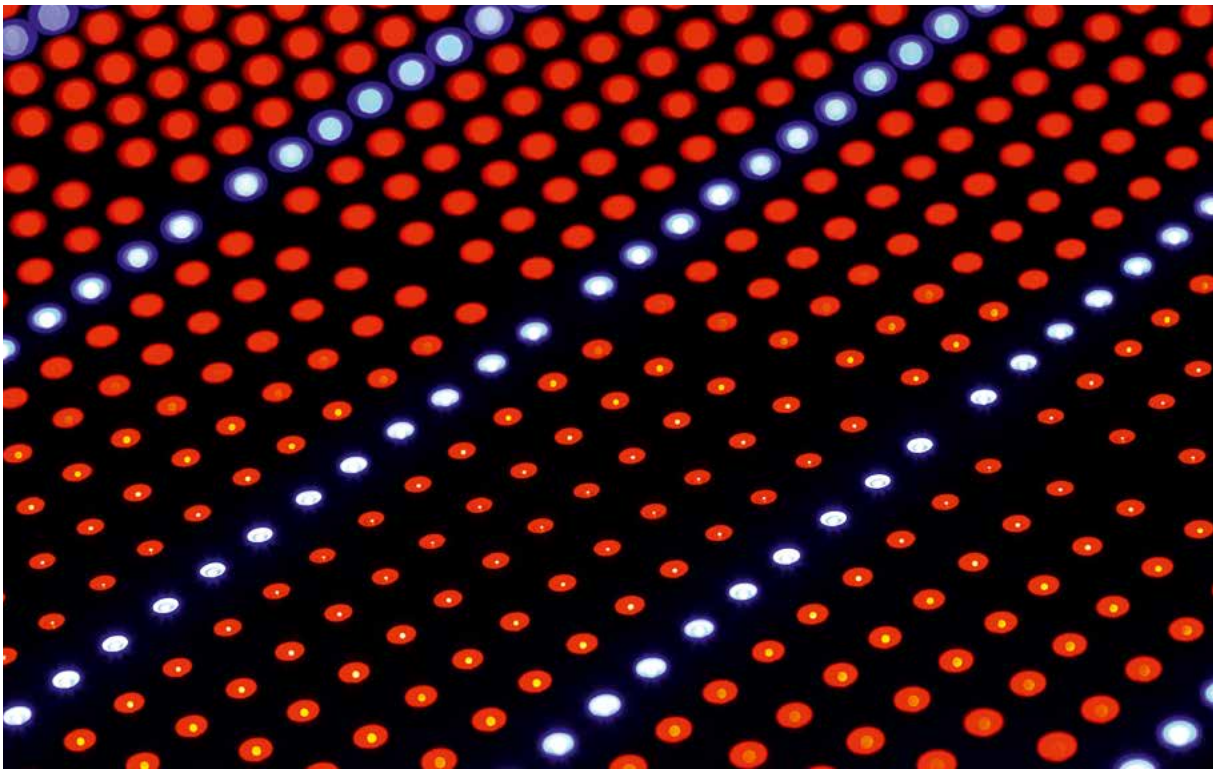
1962

Groglass® takes its technological roots from "Sidrabe" AS, which, from 1962, was the main nano materials research center for the Soviet Aerospace and Defense sector.

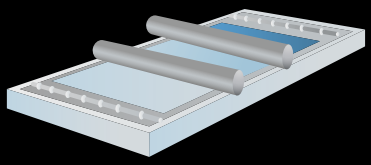
2009

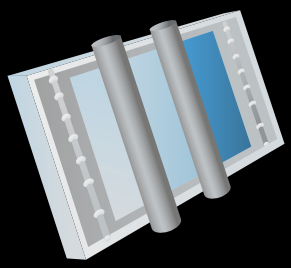
Since 2009 Groglass® has been making glass "invisible". And, today the glass is exported to more than 45 countries and is a market leader in the EU for industries like picture framing and cold storage.

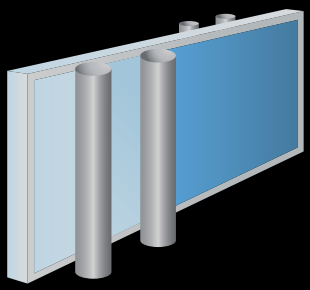
CONTENT



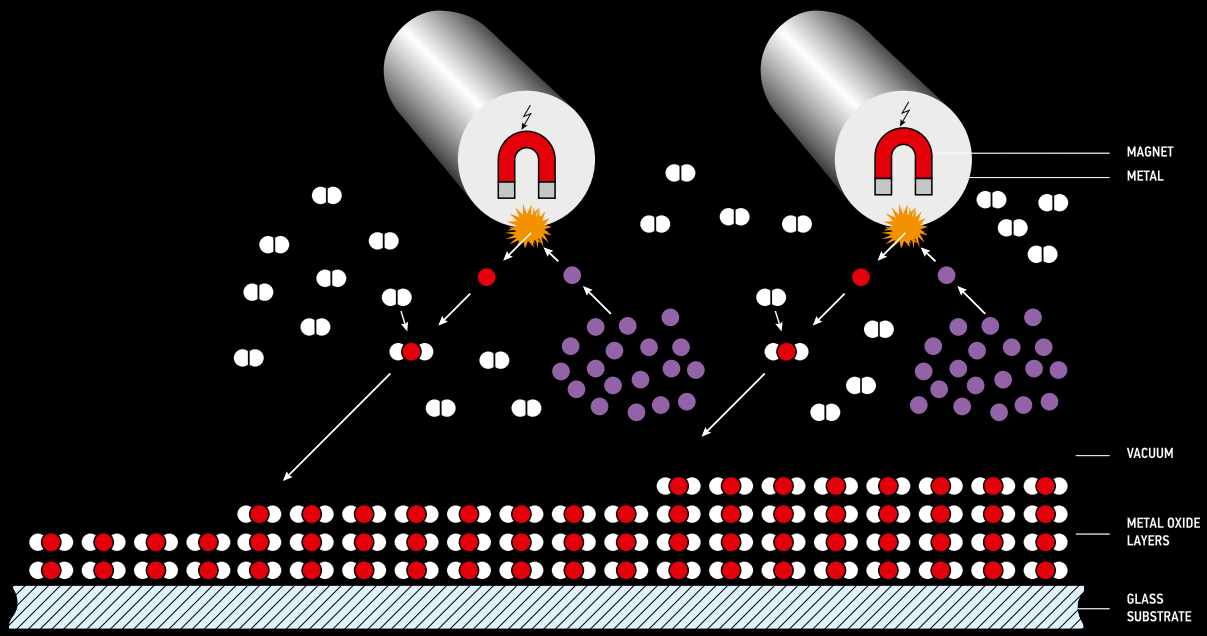
COATING TECHNOLOGY







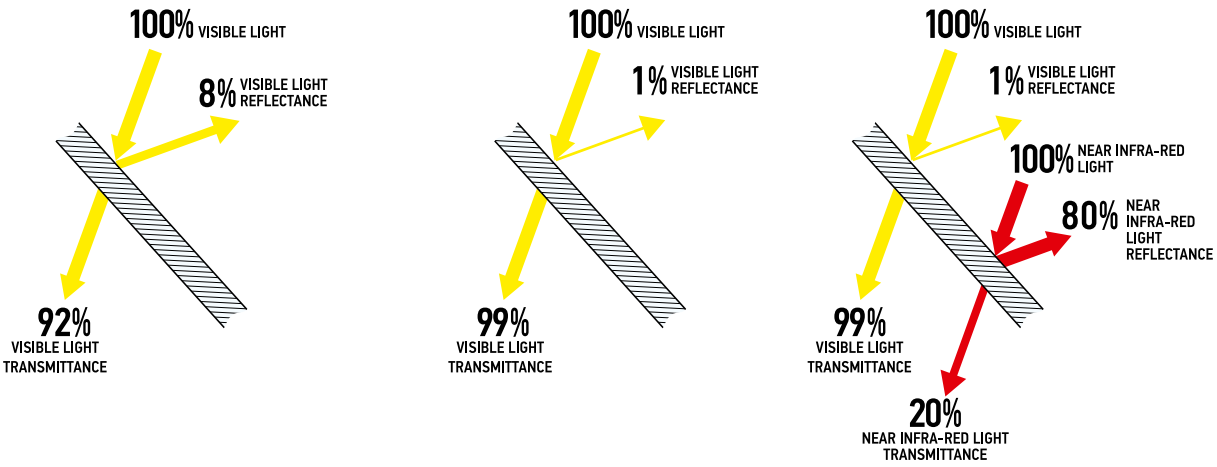
Traditional glass coating (horizontal)	Enhanced technique (semi-vertical)	Groglass® unique coating technology (vertical)
✗ Handling defects due to two-step manufacturing process. ✗ Defects due to coated side in contact with transport rollers.		✓ No debris falling on the glass. ✓ Two side coating in a single manufacturing step. ✓ No direct contact with glass surface. ✓ Achieves premium quality.
✗ Coating defects due to debris falling on glass during manufacturing process.		



Sapphire™ anti-reflective glass and acrylic is produced in the world's largest vertical double-side magnetron sputtering coater in a process where anti-reflective coating is applied in a single manufacturing step on one or both sides of the glass and consists of multiple metal oxide thin films. The vertical sputtering method ensures that during the coating process the glass surface remains untouched which ensures flawless anti-reflective glass. The coating reduces the residual reflectance of glass to < 1% two-surface total reflection and simultaneously increases the amount of transmitted light up to 99%, providing uniform and neutral reflectance color over the entire sheet.

PRODUCT DETAILS

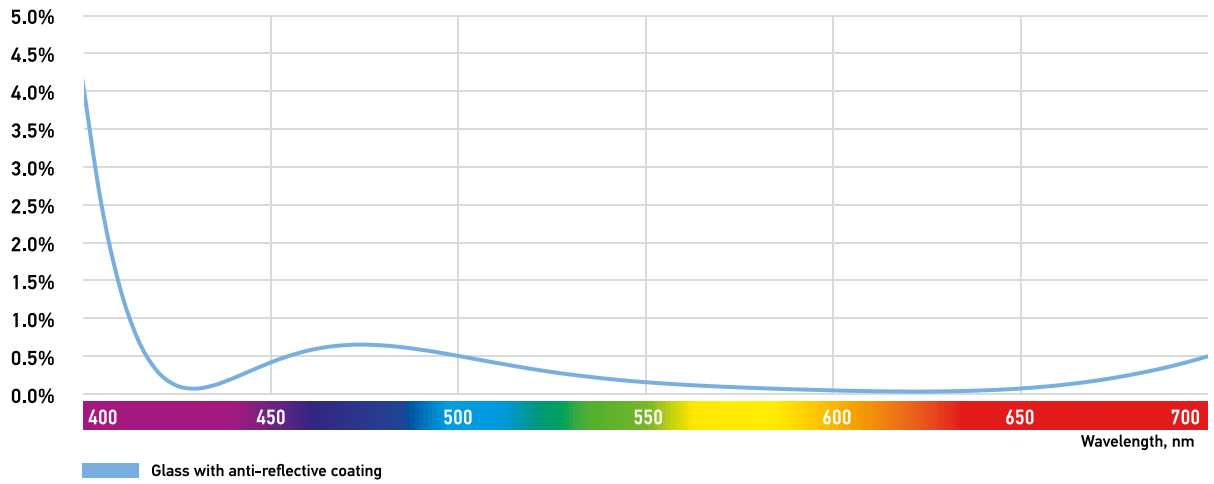
Sapphire™ is available with either one or two-side anti-reflective coating on regular float, low-iron float and conductive Near Infra-Red reflector coating as well as on other specialized substrates like acrylic, borosilicate glass and etched glass. One side coated Sapphire™ is used for bonding and lamination, while 2-side product is used for general applications.



Regular glass	SAPHIRE AR™ coated glass	SAPPHIRE™ NIR reflector*

*There are two ways to use Sapphire™ NIR reflector: 1) Bonded to electronic display e.g. "exit medium glass"
2) Attached to display leaving air gap between the glass and electronic display e.i. "exit medium air".

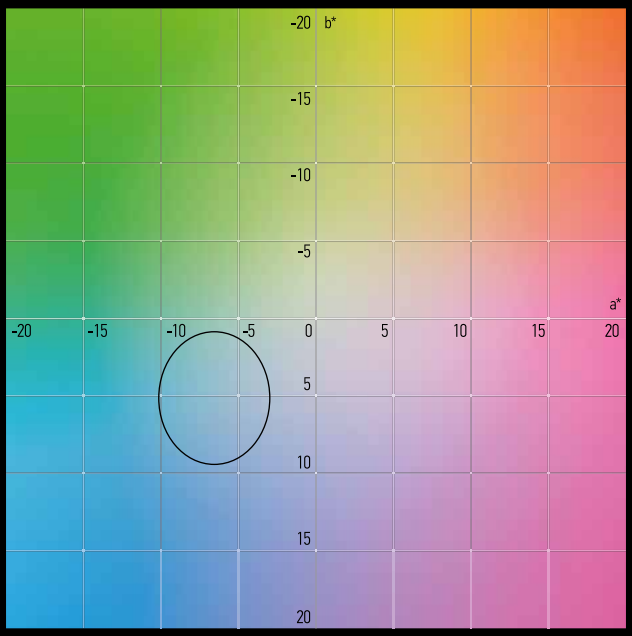
Sapphire™ virtually eliminates glare by reducing the visible reflectance to as low as 0.7%, while regular glass has a visible reflectance of around 8%.



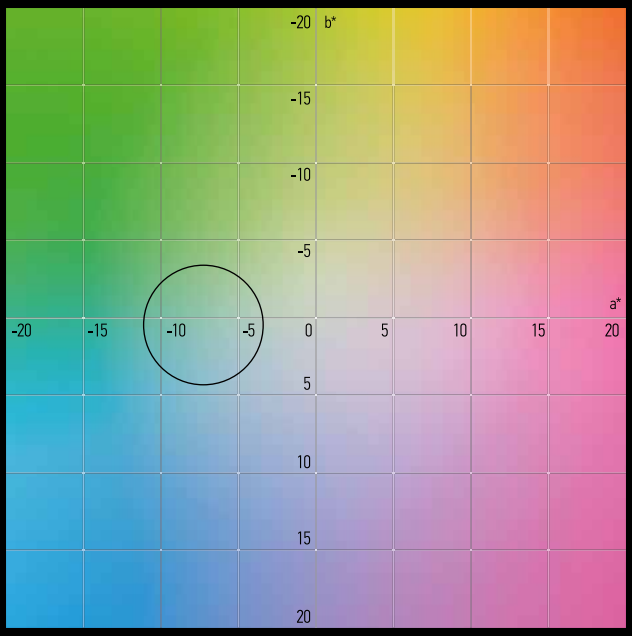
Light reflectance graph, visible light spectrum, % example.
Coating color and performance can be adjusted to customers' needs.

PRODUCT DETAILS

SAPPHIRE™ BLUE REFLECTANCE



SAPPHIRE™ GREEN REFLECTANCE

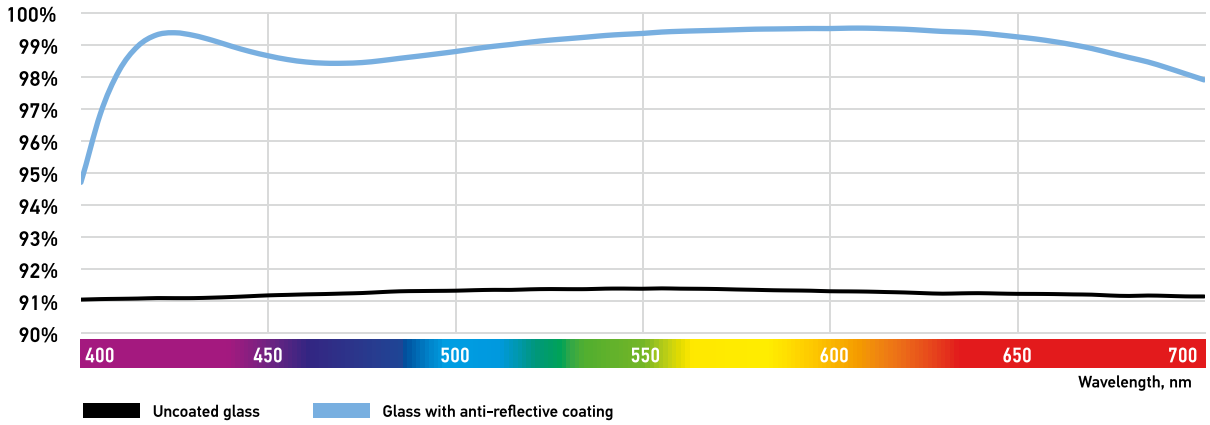


CIE 1976 color space using D65 daylight light standard, under normal angle.

PRODUCT DETAILS

Sapphire™ increases amount of transmitted light up to 99% and ensures unparalleled color rendering, according to EN 410.

The clarity of transmitted information and images makes anti-reflective coatings a must for 4k and 3D displays.



Light transmittance graph, visible light spectrum, % example.
The coating design can be customized for customer needs.

NEUTRAL COLORS IN REFLECTANCE AND NO COLOR SHIFT UNDER AN ANGLE	EASY TO PROCESS TO YOUR SPECIFICATIONS
Sapphire™ has neutral and uniform reflectance colors, and they remain stable under various angles of viewing.	• Heat strengthened; • Thermally-toughened (tempered); • Laminated; • Bent; • Printed on; • Drilled; • UV glued; • Edge-worked*.

*Please refer to Groglass® handling guidelines

DURABILITY

SAPPHIRE™ IS IDEALLY SUITED FOR OUTDOOR USE AND ITS COATING MATCHES FOLLOWING STANDARDS

EN 1096-2/Annex E; ISO 9211-4	Abrasion resistance test
EN1096-2 Annex B / Chapter 7 (class A)	UV and Condensation resistance test
EN1096-2 Annex D / Chapter 7 (class A)	Neutral salt spray resistance test
ISO 9022-2, Part 2	Humidity, temperature, frost exposure, cyclical climate
ISO 9211-4/ Part 6, Chapter 7/ (Class 0)	Coating Adhesion Test (Crosshatch test)
CE	Groglass® declares that Sapphire™ products comply with the essential requirements of the relevant EU health, safety and environmental protection legislation.

APPLICATIONS

ELECTRONIC DISPLAYS
PRODUCTS WITH ANTI-REFLECTIVE PROPERTIES

Displays require features like high precision color rendering, good contrast, screen resolution, resistance to temperature change, easy to read even in strong sunlight, and impact resistance. These features make Sapphire™ the first choice for a range of display applications:

- **Highly durable anti-reflective coating delivers clear viewing and unimpaired vision through the glass.**
- **Highest light transmittance.**
- **Optional NIR (Near Infra-Red) reflector or UV (Ultraviolet) reflector.**
- **Suitable for high resolution screens.**
- **Chemically resistant surface allows easy cleaning*.**
- **High color rendering index.**
- **Shatter protection when using laminated glass.**
- **Optional hydrophobic coating for added convenience.**
- **Clearly visible even under strong sunlight.**
- **Available in neutral blue and green reflectance color.**

*Please refer to Groglass® handling guidelines

APPLICATIONS

TECHNICAL SPECIFICATION FOR ELECTRONIC DISPLAY PRODUCTS

Design	Sapphire™ Extra Clear Glass		Sapphire™ LAMINATED GLASS	Sapphire™ Extra clear Glass- ETCHED GLASS	Sapphire™ NIR reflector
	Neutral blue reflectance	Neutral green reflectance			
Dimensions, mm	Max 2250x3210*	Max 2250x3210*	Max 2250x3210*	Max 2250x3210*	Max 2250x3210*
Thickness, mm	1.6-12*	1.6-12*	4.4-12.8	2-12*	2-12*
Reflectance, %	~1.1%	~0.7%	~0.7%	~0.7%	~0.8%
Transmittance, %**	~98%	~97%	~97%	~98%	~90%
UV protection, %	~67%	~74%	~99%	~70%	For technical specification please contact sales@groglass.com
Tempering	✓	✓	-	✓	
Weather resistance	✓	✓	✓	✓	
Shatter resistance	-	-	✓	-	
Easy to clean	✓	✓	✓	✓	
Reflectance color before tempering	Neutral blue	Neutral green	Neutral green/ blue	Neutral green/ blue	
Reflectance color after tempering	Neutral blue	Neutral green	-	Neutral green/ blue	

*For other substrates and dimensions, please contact us at sales@groglass.com
**Optical data are based on 4 mm thick glass substrate

APPLICATIONS

HIGH REFLECTIVE PRODUCTS

Sapphire AR Beamsplitter™ is well known for its „no ghosting" effect and silver/white color reflectance. This product has been manufactured for teleprompters, vision systems, flight simulators and for other applications. There are two different types of products – with 35% of visible reflectance, mostly used for teleprompters, and 50% of visible reflectance which is preferred choice for holographic display producers. Sapphire AR Beamsplitter™ has elegant silver color reflectance, that remains stable under various angles of viewing:

- **No ghosting.**
- **Easy to process to your specification.**
- **Exceptional cleanability and scratch-resistance.**

APPLICATIONS

HIGH REFLECTIVE
ELECTRONIC DISPLAY PRODUCTS

APPLICATIONS

HIGH REFLECTIVE ELECTRONIC DISPLAY PRODUCTS

Sapphire Semi-Transparent Mirror™ – high reflective glass, which can transform from being a regular mirror into a fully functional electronic display. It is the perfect choice for data displays, security zones, exterior and interior designs, and in other applications. Two different types of products are available – with 35% or 52% elegant silver color reflectance, which remains stable under various angles of viewing. Customers can select 35% or 52% reflectance level based on planned use – 35% semi-transparent mirror has greater light transmittance, or 52% semi-transparent mirror when more reflectance is preferred.

- **Exceptional performance.**
- **Easy to process to your specification.**
- **High durability and long lifetime of the coating.**
- **Exceptional cleanability and scratch-resistance.**

Design	Sapphire AR Beamsplitter™		Sapphire Semi-Transparent Mirror™	
	AR Beamsplitter (BSP)	AR Beamsplitter High (BSP50)	HR35	HR50
Dimensions, mm	2250x3250	2250x3250	2250x3250	2250x3250
Thickness, mm	3; 4 and 6	4 and 6	4 and 6	4 and 6
Reflectance, %	~35%*	~50%	~35%	~52%
Transmittance, %**	~65%	~50%	~65%	~48%

*35% (at 45 angle) on the High Reflective side and < 1% (at 45 angle) on the Anti-Reflective side
**Optical data are based on 4 mm thick glass substrate

APPLICATIONS

ANTI-REFLECTIVE COATING ON ACRYLIC AND POLYCARBONATE

Sapphire AR Acrylic™ and Sapphire AR Polycarbonate™ for display applications.
The invisible anti-reflective, abrasion resistant Sapphire AR Acrylic™ delivers the best viewing experience by not making compromises in mechanical and optical properties comparing to glass. Acrylic weights less than half of the glass and it is 20 times more shock resistant than glass. These qualities make it the best choice for high quality outdoor and indoor displays.

Sapphire AR Acrylic™ is the only product available in the market that has passed all of the following rigorous tests:

MIL-C-48497A	Humidity test
ASTM B117	Salt Fog test
MIL-C- 14806A and MIL-C- 48497A	Severe abrasion test
EN-1096-2	Abrasion test

MIL- M13508C	Abrasion test
MIL-C-48497A	Temperature test
MIL-C-48497A	Salt solubility test
MIL-C-48497A	Water solubility test
MIL-C-48497A	Adhesion test

APPLICATIONS

When even more impact resistance is required, Sapphire AR Polycarbonate™ will be the right choice. Sapphire AR Polycarbonate™ has 200 times the impact resistance and is 50% lighter than glass.

Design	Sapphire AR Acrylic™	Sapphire AR Polycarbonate™
Dimensions, mm	2200x1650	2200x1650
Thickness, mm	3*	3
Reflectance, %	~1%	~1%
Transmittance, %**	~98%	~98%
UV protection, %	~99%	~99%
Weather resistance	√	For technical specification please contact sales@groglass.com
Shatter resistant	√	
Easy to clean	√	
Anti-Static	√	
Non-Yellowing	√	
Abrasion Resistance	√	
Reflectance Color	Neutral green	

*For other plastic substrates and dimensions, please contact us at sales@groglass.com
**Optical data are based on 3 mm thick glass substrate

APPLICATIONS

COLD STORAGE

The Sapphire™ cold storage anti-reflective glass offers visibility close to open cabinets and it allows consumers to have a clear view of the products inside the refrigerated cabinet while significantly improving temperature uniformity in the cabinet to prevent microbial pathogen growth. Compared to open refrigerators, a cabinet covered with Sapphire™ cold storage glass is up to 70% more energy efficient. The temperatures vary in open refrigerated cabinets to a much greater level than in closed cabinets. A lower variation in temperature reduces the energy required for cooling products and helps maintain recommended temperature for product storage.

APPLICATIONS

PRODUCT FEATURES AND BENEFITS

- Virtually eliminates glare by reducing reflectance to as low as 0.7%.
- Increases light transmittance up to 98% and ensures unobstructed view of items behind the glass.
- Can be combined with Low-E coatings to achieve lower U-value.
- Sapphire™ coated glass can undergo the same processing as regular glass* and can be easily made in thermally-toughened (tempered) or bent versions.
- Sapphire™ can be easily cleaned with any appropriate cleaner*.
- Sapphire™ is interleaved with powder that ensures easy and fast processing.
- Sapphire™ product line is scratch-resistant for easier processing and use.
- Durability performance meets ISO standards. Suitable for outdoor use.

*Please refer to Groglass® handling guidelines

TECHNICAL SPECIFICATION

Product	Sapphire AR™	Sapphire AR Hard Low-E™	Sapphire AR Soft Low-E™
Substrate	Regular Float	Hard Low-E	Soft Low-E
Thickness, mm*	4 and 6	4 and 6	4 and 6
Dimensions, mm	2250x3210	2250x3210	2250x3210
Transmittance, %**	~98%	~92%	~92%
Light reflectance, %	~0.7%	~1%	~1%

*For other glass substrates and dimensions, please contact us at sales@groglass.com
**Optical data are based on 4 mm thick glass substrate

FOR EVEN BETTER U-VALUE, CHOOSE SAPPHIRE AR Low-E™

Design	Sapphire AR Hard Low-E™ DGU (1 pane with Low-E) 4mm glass/ 14mm Argon/ 4mm Low-E	Sapphire AR Soft Low-E™ DGU (1 pane with Low-E) 4mm glass/ 14mm Argon / 4mm Low-E
Structure		
Reflectance, %	~1.4%	~1.5%
Transmittance, %	~90%	~90%
U-value, [W/(m²*K)]	1.6	1.1
Post temperable	√	√
Scratch resistance	√	√

APPLICATIONS

LIGHTING

• Glass loses 9 to 10 percent of lighting efficiency through reflectance and absorption. Sapphire™ anti-reflective glass for lighting was designed to provide maximum performance and flexibility for lighting applications, while offering a single solution to increase light transmittance, reduce reflectance and increase the efficiency of lighting fixtures.

• By applying our UV blocking anti-reflective coating, we have created the highest possible light transmittance % combined with a 90% UV block to prevent insects from being attracted to the glass. In addition, we are also able to guarantee a smooth surface for much easier handling and processing.

• By combining the clearest glass with an advanced, absorption-free, metal oxide thin film coating, Sapphire™ increases light transmittance by 8%, compared to regular glass. This ensures up to 98% light transmittance.

• Sapphire™ coated glass can undergo the same processing as ordinary glass, such as drilling, edging, polishing, gluing and printing.

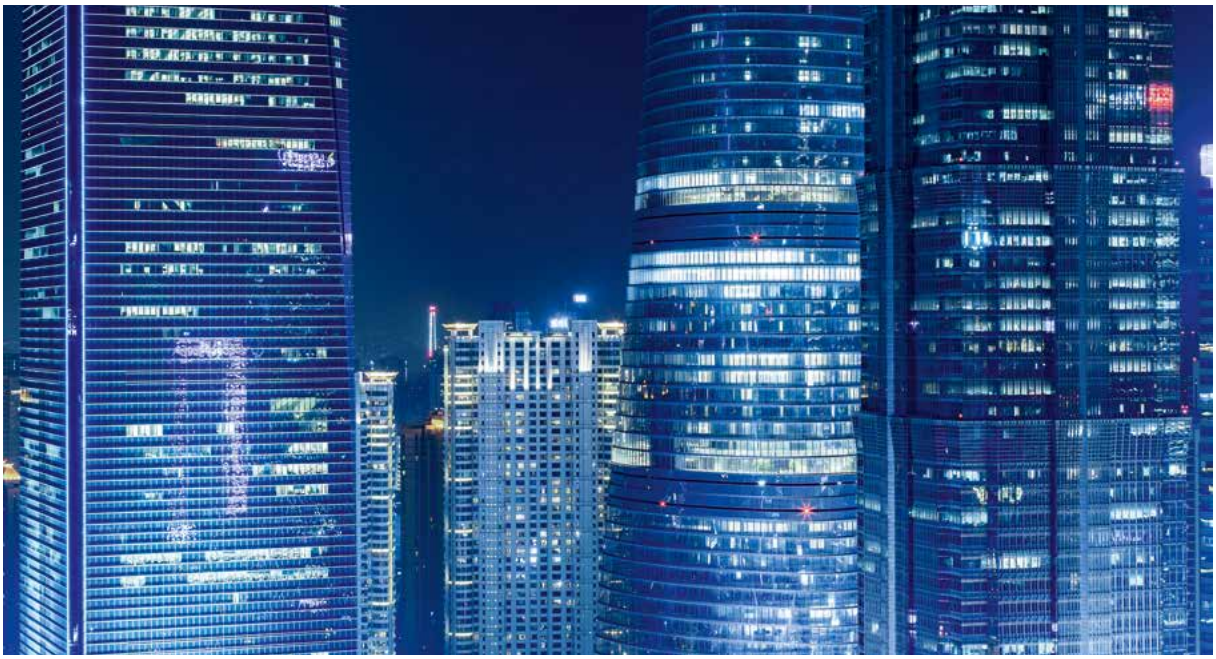
• Durability performance meets ISO standards. Suitable for outdoor use.

Design	Sapphire AR™	Sapphire AR UV™	SAPPHIRE AR NIR™ reflector
Substrate*	Extra Clear Float	Extra Clear Float laminate	Extra Clear Float
Thickness, mm*	2-4	2-4	2-12
Dimensions, mm	2250x3210	2250x3210	2250x3210
Light transmittance, %**	~98%	~98%	For technical specification please contact sales@groglass.com
Reflectance, %	~0.7%	~1.1%	
UV protection, %	~70%	~92%	

*For other glass substrates and dimensions please contact us at sales@groglass.com
**Optical data are based on 4 mm thick glass substrate

APPLICATIONS

ARCHITECTURE



Sapphire AR™ – the highest quality anti-reflective glass, used for the most innovative architectural applications. It offers unparalleled design possibilities, superior clarity and renowned durability. Sapphire™ can be tempered, bent, laminated, printed on, bonded, drilled and subjected to various kinds of edgework.

Sapphire AR Protect™ – the highest quality, virtually invisible, laminated glass. It offers the highest UV protection and is a physical safety solution. In case of breakage, Sapphire AR Protect™ remains attached to the laminating foil. Because of its durability and ease of handling, Sapphire AR Protect™ is the preferred anti-reflective glass by the world's leading designers and architects.

Design	SAPPHIRE AR™	SAPPHIRE AR PROTECT™	SAPPHIRE AR NIR™ reflector
Substrate*	Extra Clear Float	Extra Clear Float laminate	Extra Clear Float
Thickness, mm*	3-12	4.4-12.8	3-12
Dimensions, mm	2250x3210	2250x3210	2250x3210
Transmittance, %**	~98%	~97%	For technical specification please contact sales@groglass.com
Reflectance, %	~0.7%	~0.7%	

*For other glass substrates and dimensions please contact us at sales@groglass.com
**Optical data are based on 4 mm thick glass substrate

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