

Sapphire for Advanced Imaging, Sensing & Security

Polished and coated sapphire windows from SCHOTT with dimensions up to 300 mm

Product Information

Sapphire, as one of the hardest, most durable and scratch resistant materials, offers a broad transmission range from UV to mid infrared wavelengths (250–5000 nm). The material is able to withstand extreme environmental conditions and temperature changes. SCHOTT offers sapphire windows in different supply forms, dimensions, and in customized processing stages.

Material

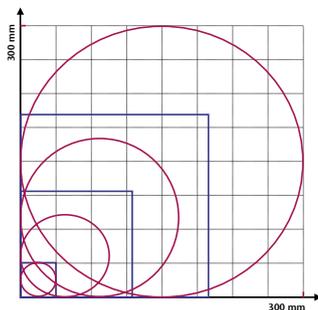
- Extreme hardness & high mechanical strength (withstands extreme environmental conditions)
- Excellent thermal conductivity/heat resistance
- High transmittance (UV to IR)
- Low dn/dT
- High electrical resistance (10^{14} Ohm x cm)
- High dielectric constant (9.39 from 1.0 MHz to 8.5 GHz)

Applications

- Infrared applications (e.g. radiometry, guidance, gas analysis, medicine, safety and security)
- High-pressure and shock-loading applications (e.g. chamber or heater windows in chemical process equipment)
- Optical applications (e.g. optical components from UV to IR)
- Scratchproof sapphire watch glasses

Supply Forms

- Various shapes from round to square



Selection of available dimensions

- Customized processing: polishing and coatings (e.g. antireflective coating)
- Plano and spherical surface

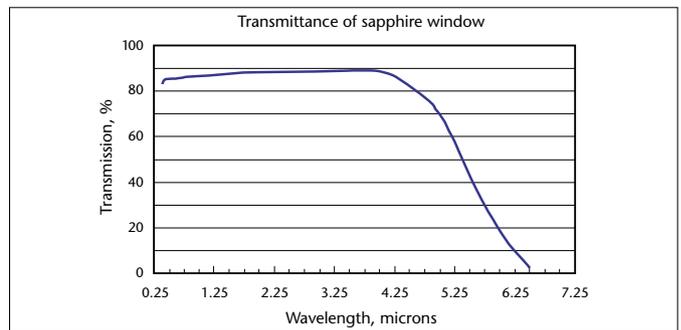
Advantages

- SCHOTT offers sapphire material in optical quality
- Customized characteristics concerning dimensions and shapes (round, square, and more, diameters up to 300 mm)
- Polished surface and customized coating for different applications



- Best Practice in sapphire processing due to longterm experiences from handling optical materials
- Usage of most advanced equipment and state-of-the-art metrology for manufacturing and quality control

Spectral Transmission



Attribute	Standard Quality	Precision Quality	Ultra Precision Quality
Size (round and square)	∅ from 10 to 300 mm □ from 10 to 210 mm		
Size Tolerance ¹	± 0.2 mm	± 0.10 mm	± 0.05 mm
Thickness ¹	From 1 to 40 mm		
Thickness Tolerance ¹	± 0.2 mm	± 0.10 mm	± 0.05 mm
Parallelism ¹	< 5 arc minutes	< 1 arc minutes	< 30 arc seconds
Surface Accuracy (PV) ¹	5λ (546 nm)	λ/2 (546 nm)	λ/10 (546 nm)
Surface Quality (scratch and dig)	According to MIL 80 – 50	According to MIL 40 – 20	According to MIL 20 – 10
Surface Roughness (Rq)	< 10 nm	< 3 nm	< 1 nm
AR Coating	Custom designed		
Order quantity	Upon customer specification. Please call sales representative.		
Delivery Time (week)	6 – 10 weeks, upon raw material availability		

¹ Upon geometry



Specifications

Thermal Properties	
Thermal conductivity (60° to c-axis) at 25 °C	27.21 W/(m x K)
Linear thermal expansion coefficient (60° to c-axis) $\alpha_{(25^{\circ}\text{C}; 800^{\circ}\text{C})}$	8.4 10 ⁻⁶ /K
Specific heat at 25 °C	774.4 J/kg x K
Heat capacity at 25 °C	77.87 J/K x mol

Mechanical Properties ²		
Tensile strength	40,000–60,000 psi (design criterion)	0.27–0.41 GPa
Flexural strength	70,000–130,000 psi (design criterion)	0.48–0.89 GPa
Young's Modulus, E (25 °C) (Modulus of Elasticity)	50 x 10 ⁶ psi	345 GPa
Compressive Modulus, K	55 x 10 ⁶ psi	379 GPa
Flexural Modulus (Modulus of Rupture)	52 x 10 ⁶ psi	358 GPa
Shear Modulus, G (Modulus of Rigidity)	21.5 x 10 ⁶ psi	148 GPa
Bulk Modulus, k (Volumetric Modulus of Elasticity) Poisson's Ratio	35 x 10 ⁶ psi 0.29	241 GPa

21 psi = 6.9 kPa

Optical Properties	
Uniaxial Negative	$n_o = 1.768$ $n_e = 1.760$
Birefringence	0.008
dn/dt (0.6 μm)	13 x 10 ⁻⁶ /°C (visible range)
Spectral Emittance	0.1 (1600 °C)
Spectral Absorption Coefficient	0.1 to 0.2 cm ⁻¹ (0.66 micron, 1600 °C)
Electrical Volume Resistivity	10 ¹⁶ Ohm x cm (25 °C) 10 ¹¹ Ohm x cm (500 °C) 10 ⁶ Ohm x cm (1000 °C)
Dielectric Strength	480,000 volts/cm (1,200 volts/mil)
Dielectric Constant	11.5 (10 ³ to 10 ⁹ Hz, 25 °C) parallel to c-axis 9.3 (10 ³ to 10 ⁹ Hz, 25 °C) perpendicular to c-axis
Loss Tangent	8.6 x 10 ⁻⁵ (@10 ¹⁰ Hz, 25 °C) parallel to c-axis 3.0 x 10 ⁻⁵ (@10 ¹⁰ Hz, 25 °C) perpendicular to c-axis
Magnetic Susceptibility	-0.21 x 10 ⁻⁶ parallel to c-axis -0.25 x 10 ⁻⁶ perpendicular to c-axis

Electrical Properties	
Volume resistivity	10 ¹⁴ Ohm x cm
Dielectric strength	480 kV cm ⁻¹
Dielectric constant E perpendicular to c-axis	9.4
E parallel to c-axis	11.5
Dissipation factor, <i>tan delta</i>	10 ⁻⁴

Physical Properties	
Chemical formula	Al ₂ O ₃
Crystal structure	Hexagonal system (rhombohedral type single crystal)
Unit cell dimension	a = 4.758 Å c = 12.991 Å
Density	3.98 g/cm ⁻³
Hardness	9 Mohs, 1525–2000 Knoop
Melting point	2040 °C

For other specifications and individual requirements regarding dimensions, material and surface quality please contact our sales department.



Advanced Optics
SCHOTT North America, Inc.
400 York Avenue
Duryea, PA 18642
USA
Phone +1 570/457-7485
Fax +1 570/457-7330
info.optics@us.schott.com

www.us.schott.com/advanced_optics

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