

Лазерная оптика MgF₂, CaF₂

Описание

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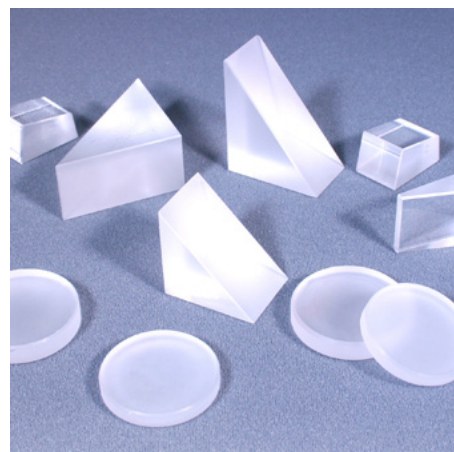
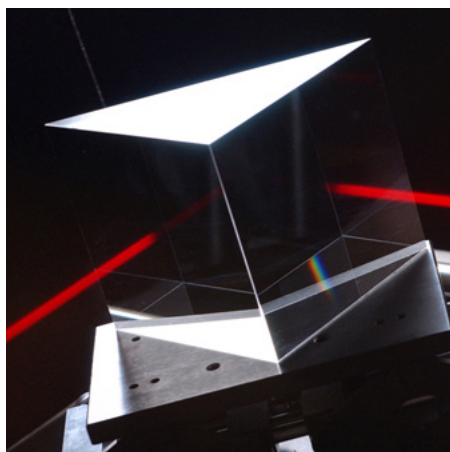
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The Corning logo is displayed in white, serif, all-caps font against a solid blue rectangular background.

Corning® Magnesium Fluoride (MgF₂)

Fluoride Crystal Materials

Corning is a premier provider of fluoride crystal materials, one with the expertise and resources required to provide complete end-to-end optical solutions. Our crystal growth operation regularly produces Magnesium Fluoride crystals of exceptional quality for use at a variety of wavelengths and in a multitude of applications. In addition to growing crystal materials, Corning also offers designing, fabrication, polishing, and coating capabilities. With the ability to do it all under one roof, let Corning be the supplier of choice for your most complex optical requirements.

Magnesium Fluoride is a durable crystal with low absorption, suitable for high-powered laser, space, and other UV applications. MgF₂ is also naturally birefringent, making it an ideal material for use where this property can be exploited, such as retardation plates and polarizing elements, particularly in the wavelength range from 0.13-0.30 μ m. Single crystal ingots are grown exclusively in the USA from highly purified materials using Corning's proprietary process, ensuring consistent supply. A full range of geometries and finishes, from ingots and blanks to complex multi-faceted, highly polished parts are available. Standard (001) orientation as well as specifically oriented parts and materials are offered. A variety of finishes and coatings can be customized and combined to meet individual customer specifications.

Physical and Chemical Properties

General Properties

CAS#	7780-40-6
Molecular Weight	62.302 g/mol
Structure	Tetragonal, TiO ₂ Rutile type, space group P4 ₂ /mmn, a ₀ = 4.623Å, C ₀ = 3.52Å
Density	3.177 g/cm ³ at 20 °C
Melting Point	1255 °C
Boiling Point	2260 °C

Mechanical and Electrical Properties

Bulk Modulus	101.3 GPa
Shear Modulus	54.7 GPa
Young Modulus	139.0 GPa
Poisson's Ratio	0.271
Elastic Constants Elastic Stiffness (GPa)	$C_{11} = 123.7$ $C_{33} = 177.0$ $C_{44} = 55.2$ $C_{12} = 73.2$ $C_{13} = 53.6$ $C_{66} = 95.1$
Dielectric Constant	4.87 along C axis, 5.45 perpendicular between 95KHz and 42MHz
Hardness	415 Knoop

Thermal Properties

Heat Capacity

T[K]	Cp [J/g · K]
80.00	0.238
95.00	0.319
114.00	0.428
135.00	0.538
155.00	0.627
176.00	0.706
196.00	0.771
216.00	0.830
236.00	0.877
256.00	0.922
276.00	0.955

Thermal Conductivity

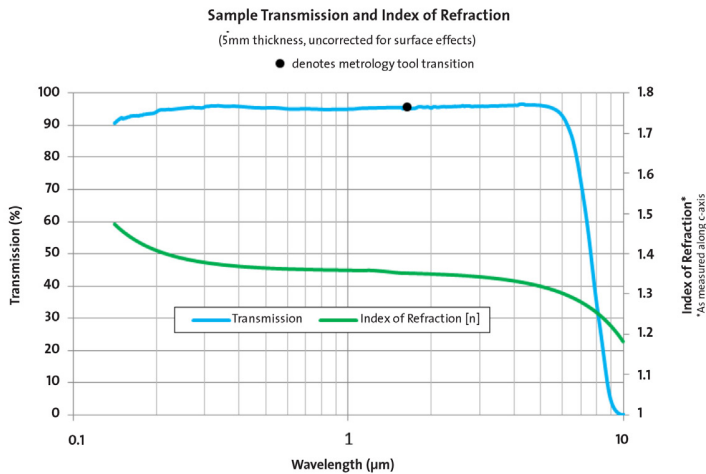
T[°C]	[W/(m·K)]
18	11.6

Linear Thermal Expansion Coefficient

T [°C]	T [K]	Coefficient [x10 ⁻⁶ /K]	
		Perp c axis	Parallel c Axis
-180	93	0.72	2.90
-160	113	1.63	4.45
-140	133	2.65	5.95
-120	153	3.64	7.39
-100	173	4.58	8.86
-80	193	5.45	9.82
-60	213	6.23	10.86
-40	233	6.93	11.74
-20	253	7.52	12.47
0	273	8.04	13.07
20	293	8.48	13.70
40	313	8.88	14.09
60	333	9.25	14.54
80	353	9.60	14.94
100	373	9.93	15.32
120	393	10.22	15.67
140	413	10.49	16.00
160	433	10.71	16.33
180	453	10.91	16.67
200	473	11.10	17.00

Optical Properties

Transmission Range	Useful range of 0.11 μm to ~750 μm, depending on thickness
Energy Gap	11eV
Restrahl Frequency	17.5, 20.8, 24.7, 34.5, and 37.0 μm
Reciprocal Dispersive Power	100

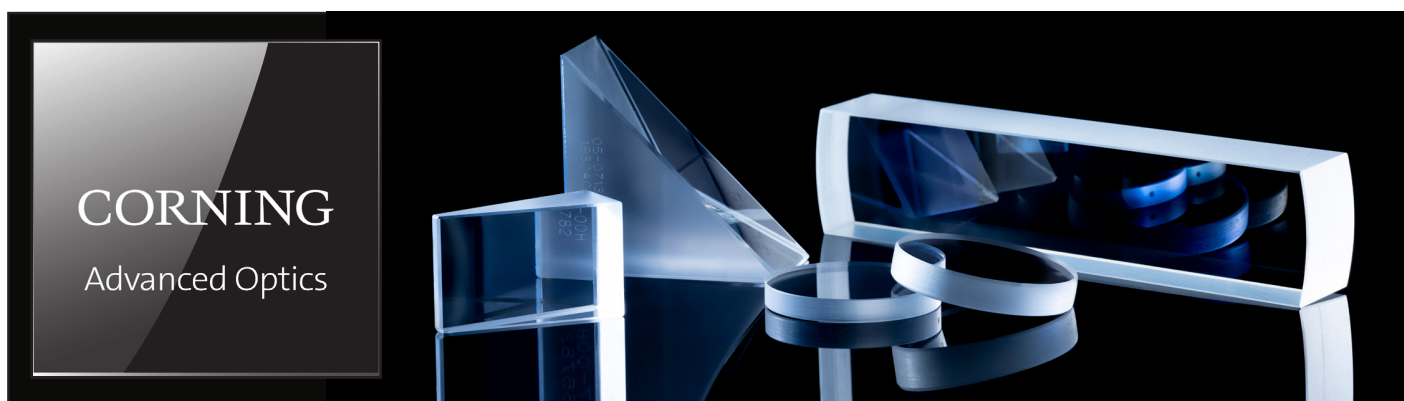


Available Grade and Additional Information

Corning® Magnesium Fluoride material is classified as Excimer ArF grade. For the most demanding high-fluence applications, Corning® Calcium Fluoride 193 nm Laser Durability Grade is also available.

Corning's crystal experts work actively with every prospective customer to determine the most appropriate and cost-effective solution for each application. Depending on the application of interest, some or all of the following attributes may be considered in the selection process:

Internal transmittance	>99.0% @ 193.3nm
Stress Birefringence	Naturally birefringent
Bubbles/Inclusions	ISO 10110 - 1/1 x 0.02
Scratch dig	To 10/5 available
Micro-roughness	To 2 Å available
Available raw material diameters	1.7", 2.4", 3.5" and 5" (typical), others upon request
Orientation	Typically at least one face parallel to (001), which is perpendicular to the optical "C" axis [001], others upon request
Finish	Saw cut, fine ground, polished, super-polished, enhanced super-polished
Coatings	Anti-reflective, highly reflective, partially reflective, low absorption, custom solutions upon request



Corning® Laser Durable Grade Calcium Fluoride (LDG CaF₂)

High Quality Calcium Fluoride Optimized for Microlithography and Laser Optics Applications

Corning Advanced Optics is a trusted, premier supplier of calcium fluoride crystal components. For harsh laser exposure levels, or where maximizing optic lifetime and equipment uptime are critical, Corning® LDG CaF₂ is optimized to be the material of choice. Corning offers a range of geometries and finishes, including complex multi-faceted and highly polished parts. With its comprehensive coating engineering expertise, Corning also provides design engineering, fabricating, polishing and coating capabilities. Let Corning be the supplier of choice for your most complex laser optic requirements.

Products

- Windows
- Lenses
- Mirrors
- Prisms
- Beam Splitters
- Optical Modules

Surface Finishes

Industry leading metrology to assure:

- Low surface roughness (<4 Å) with < 10/5 cosmetics
- Ultra-low sub surface damage
- Wavefront errors <1/10 wave
- Surface cleanliness to enable high laser durability

Custom Coatings

- Anti-Reflective
- Highly Reflective
- Partially Reflective
- Low Absorption
- Protective/Enhanced Durability
- Custom Solutions Upon Request

Our coatings are designed to ensure optimum performance and durability. Cutting-edge technology for finishing and coating is available for maximizing optic lifetime for highly transmissive, highly reflective, or partially reflective optics with high fluence. Our rigorous manufacturing process enables us to produce high-quality components to meet customer specifications. Every component is tested using state-of-the-art interferometers and optical profilers.

Corning's LDG CaF₂ has unmatched durability to withstand the high energy levels of deep ultraviolet lasers.

Physical and Chemical Properties

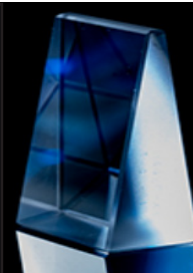
Molecular Weight	78.075 g/mol
Crystal Structure	Cubic, fluorite type, space group Fm3m
Lattice Constant	5.462 Angstroms
Cleavage Plane	(111)
Density	3.18 g/cm ³ at 25°C
Melting Point	1420°C
Thermal Conductivity	9.71 W/cmK at 25°C
Dielectric Constant	6.76 at 1 MHz

Mechanical and Elastic Properties

Young's Modulus (E)	146 GPa <100>, 89.6 GPa <111>
Shear Modulus (G)	60.4 GPa <100>
Bulk Modulus (K)	84.8 GPa
Poisson Ratio	0.21 <100>
Elastic Compliance	S ₁₁ = 0.6829 S ₁₂ = -0.1448 S ₄₄ = 2.9563
Elastic Stiffness (x 102 GPa)	C ₁₁ = 1.653 C ₁₂ = 0.445 C ₄₄ = 0.338
Knoop Hardness (200 gram load)	156-168 Kg/mm ² in (111)



Corning® Laser Durable Grade Calcium Fluoride (LDG CaF₂) for Laser Optic applications



CaF₂ Refractive Index

Refractive Index of CaF₂ measured in 1 atm of N₂

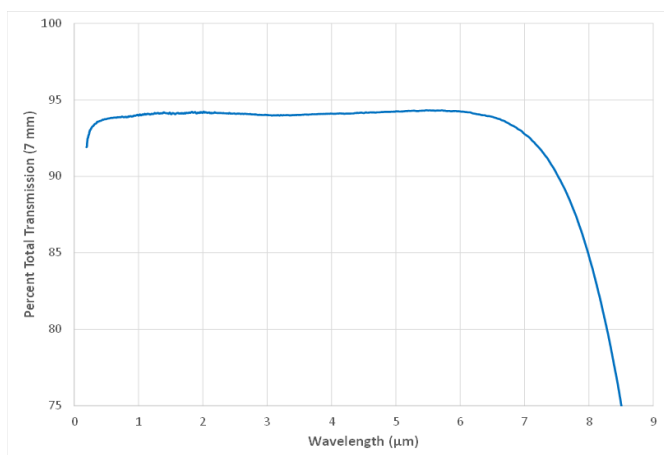
λ (nm)	Spectral Line	Measured 20°C	Measured 25°C	dn/dT x 10 ⁻⁶ K ⁻¹
2326.05		1.422132	1.422084	-9.6
1530.00		1.426143	1.426091	-10.5
852.344	[s]	1.430042	1.429990	-10.3
656.454	[C]	1.432471	1.432420	-10.2
546.227	[e]	1.434945	1.434897	-9.7
435.957	[g]	1.439480	1.439433	-9.5
365.119	[i]	1.444900	1.444852	-9.6
334.244		1.448498	1.448454	-8.9
289.444		1.456183	1.456141	-8.4
253.728		1.465997	1.465959	-7.6
228.872		1.476372	1.476339	-6.6
214.506		1.484572	1.484544	-5.7
206.266		1.490325	1.490300	-5.2
194.227		1.500606	1.500587	-3.9
184.950		1.510562	1.510546	-3.2

Additional Information

Depending on customer requirements, Corning can provide solutions ranging from crystal blanks to complete turnkey optical packages. Corning can precisely manufacture a wide variety of laser optic components including: windows, prisms, mirrors, plano convex, plano concave, and hemispherical optics. With its comprehensive coating engineering expertise, Corning can customize final optical performance to enhance transmission, reflectivity, and/or laser durability to customer specification in order to provide a comprehensive optical path solution.

Internal Transmittance	> 99.9% @ 193.3 nm
Stress Birefringence	< 2 nm/cm or < 5 nm/cm (max), [111], measured @ 592 nm
Bubbles/Inclusions	ISO 10110 - 1/1 x 0.02
Orientation	(111) ±3° typical, others upon request

Total Transmission



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