

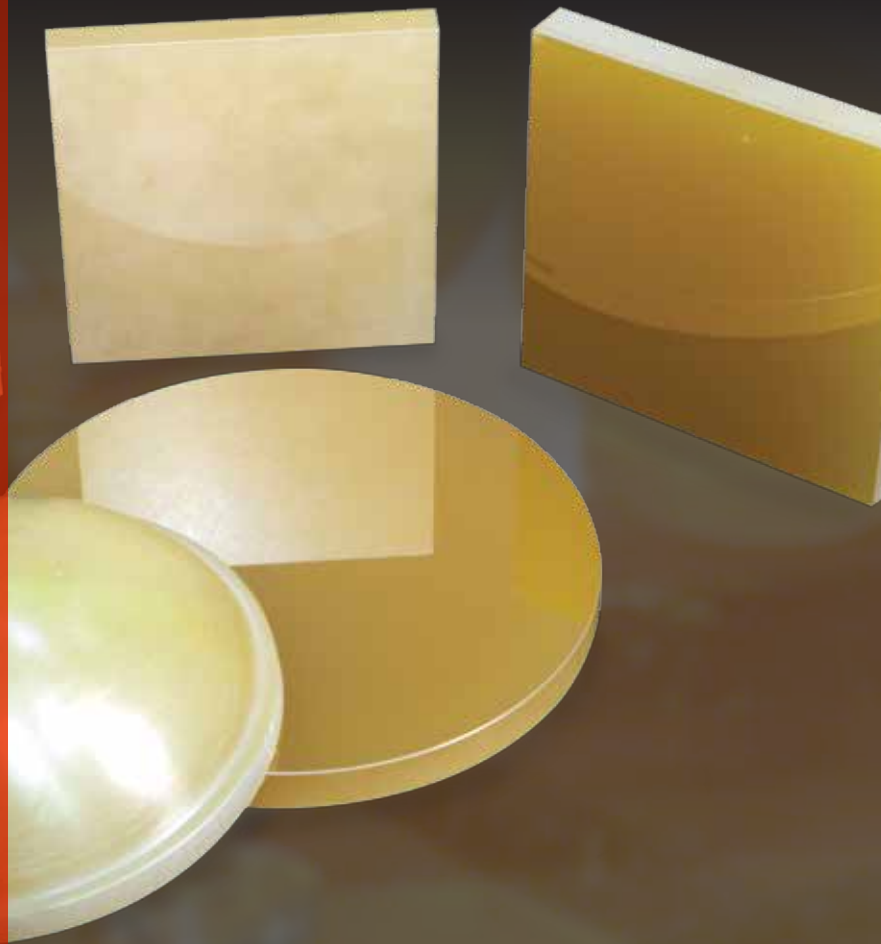
gdm

GREEN
OPTICS
MATERIAL

Materials for
Infrared Optics

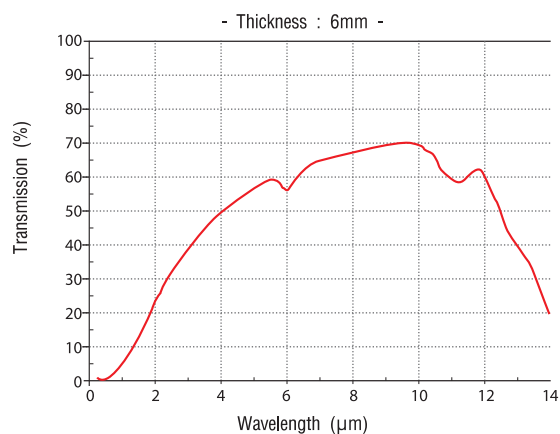


GREEN OPTICS



Zinc Sulfide (CVD-ZnS)

Polycrystalline Zinc Sulfide is grown by a Chemical Vapor Deposition (CVD) process. CVD-ZnS has high hardness and fracture strength. This material used in the 3~5 μm and 8~12 μm thermal band which is suitable for military and enhanced industry applications.



Material Properties

Optical Properties	Refractive Index @10.6 μm		2.192
	Index of Refraction Inhomogeneity @10.6 μm	ppm	<100
	Thermo-Optic Coefficient, dn/dT @3.39 μm	K^{-1}	4.1×10^{-5}
	Bulk Absorption Coefficient @10.6 μm	cm^{-1}	≤ 0.2
Physical Properties	Crystal Structure		Cubic
	Grain Size	μm	3~8
	Density	g/cm^3	4.09
	Chemical Purity	%	≥ 99.9996
Thermal Properties	Coefficient of Thermal Expansion	K^{-1} @293K	5.98×10^{-6}
		K^{-1} @373K	7.24×10^{-6}
		K^{-1} @473K	7.69×10^{-6}
	Thermal Conductivity @298K	W/mK	21.2
	Heat Capacity	J/gK	0.480
Mechanical Properties	Knoop Hardness	kg/mm^2	206-223
	Flexural Strength	psi	16,389
		MPa	113
	Fracture Toughness	$\text{MPa}^{1/2}$	1.33
	Young's Modulus	psi	12.9×10^6
		GPa	89
	Poisson's Ratio		0.28

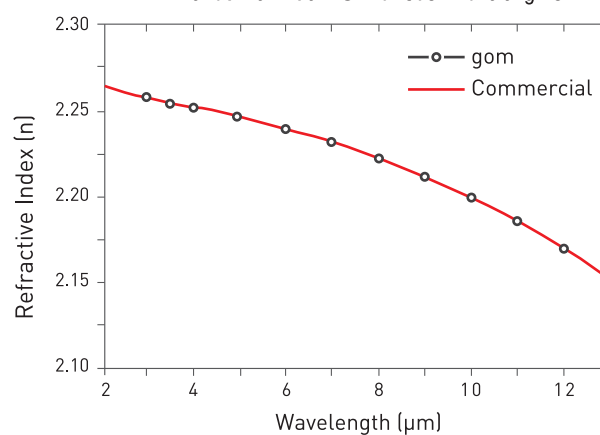
ZnS



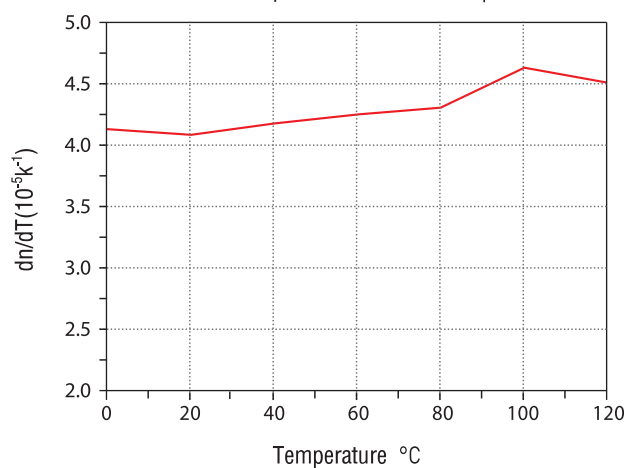
Refractive Indices

Wavelength (μm)	n
3	2.25706
3.5	2.25433
4	2.25168
5	2.24599
6	2.23940
7	2.23178
8	2.22292
9	2.21248
10	2.20048
11	2.18663
12	2.17073

Refractive Index @ Various Wavelengths



Thermo-Optic Coefficient @3.39μm



Single Crystal Sapphire

Sapphire has superior thermal conductivity & mechanical properties, high and low temperature stability and excellent optical properties. We produce high quality sapphire ingot by KY method.
Maximum ingot size is Ø360 X 420 possible.

- Peculiarity of sapphire material
- Prevent abrasion, heat resistant
- Optical: Transmissivities of UV, Visible Rays, near-infrared rays



Mechanical Properties

Crystallographic Structure	Hexagonal System, $a = 4.763 \text{ \AA}$ $c = 13.003 \text{ \AA}$ Rhombohedral Single Crystal
Reference Density	$3.97 \times 10^3 \text{ kg/m}^3$
Vickers Hardness	22.5 GPa (HV1 (Load=9.807N))
Flexural Strength	690 MPa
Tensile Strength	2250 MPa (Diameter 0.25mm Filament 25 °C)
Compressive Strength	2,940 MPa
Young's Modulus	470 GPa
Poisson's Ratio	0.18~0.29

Thermal Properties

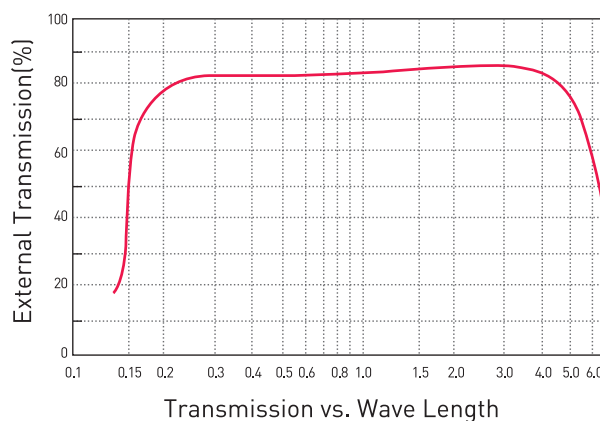
Melting Point	2,053 °C
Coefficient of Linear Thermal Expansion	40~400°C C parallel to Caxis $7.7 \times 10^{-6}/^\circ\text{C}$ 40~400°C C perpendicular to Caxis $7.0 \times 10^{-6}/^\circ\text{C}$
Thermal Conductivity	20 °C 42 W/(m · k)
Specific Heat	$0.75 \times 10^3 \text{ J/(kg · K)}$
Emissance	<0.02 ($\lambda = 2.6 \sim 3.7 \mu\text{m}$ 880 °C)

Sapphire Material



Optical Properties

Index of Reflection	$n_o = 1.768$ $n_e = 1.760 @ 589\text{nm}$
Optical Transmission	Refer to the below



Electrical Properties

Dielectric strength	$48 \times 10^6 \text{ V/m}$
Volume Resistance	20 °C $> 10^{14} \Omega \cdot \text{cm}$ 500 °C $10^{11} \Omega \cdot \text{cm}$
Dielectric Constant	C parallel to Caxis 11.5 (1MHz) C perpendicular to Caxis 9.3 (1MHz)
Dielectric Loss Angle	$< 1 \times 10^{-4}$ (1MHz)

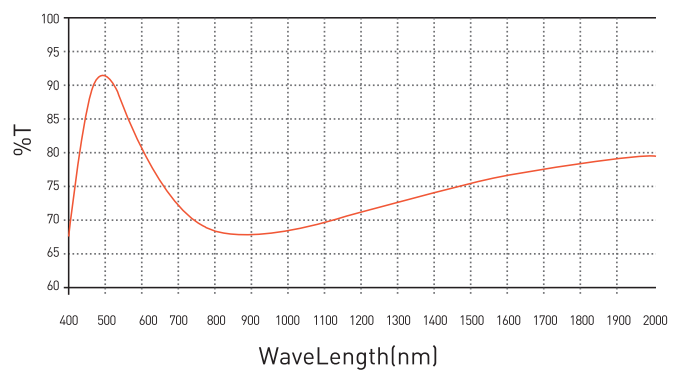
Evaporation Material (ZnS)

A piece of ZnS is supplied to customers after going through several process of rinsing to ensure high purity for the material. Purity of the material is then certified by trace metal analysis method.



CAS No.	1314-98-3
Refractive Index	2.2 / 10 μ m
Evaporation Temperature	900~1100 $^{\circ}$ C (pressure : 10^{-2} ~ 10^{-1} mbar)
Transmission Range	0.4~14 μ m
Density	4.1 g/cm ³
Source Container	Mo, Ta, W, E
Substrate Temperature	\leq 200 $^{\circ}$ C

Item No.	Dimensions	Form	Purity	Quantity	Remarks
G4-010541	1-5mm	granulate	99.99%	100g	CVD Quality
G4-010545	1-5mm	granulate	99.99%	500g	
G4-051541	5-15mm	granulate	99.99%	100g	
G4-051545	5-15mm	granulate	99.99%	500g	
G4-051551	5-15mm	granulate	99.999%	100g	
G4-051555	5-15mm	granulate	99.999%	500g	



Application

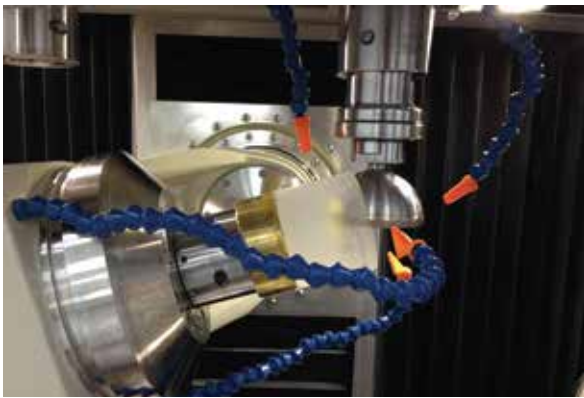
- Anti-Refraction Films
- Multi-layer Coatings
- Beam Splitters

Chemical Vapor Deposition



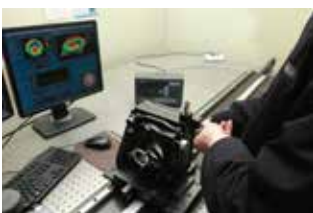
Bulk of ZnS for infrared windows is manufactured in large reactors through CVD process. Ultra High-purity, Zinc Sulfide was specifically developed with high purity raw material and semiconductor grade utility to meet the world class quality.

Fabrication



Any shape of material that meets specification for different applications such as windows, prisms, dome, lens blank and etc. can be manufactured as required by customers. To purchase the material deposited to a dome shape is much more economical & more advantageous over the processing of a flat material.

Quality Assurance



Optical testing is performed in in-house optical material testing lab to assure quality of the material.

GOM is always striving to enhance its material manufacturability and it would be glad to cooperate in helping customers to choose the high quality materials effort for manufacturability.

Total optics service

Green Optics provides super polishing and a variety of coating services for the material with the world's latest equipment with high-technology.

- Super Polishing: DTM / MRF
- Coating: E-beam Vacuum Coater / Sputter Coater / Plasma Clean System, etc.

GREEN OPTICS MATERIAL

Green Optics is Korea's leading optical company and **GOM** (Green Optics Material) is subsidiary of Green Optics that focuses mainly in manufacture of infrared material. Full cycle of CVD-ZnS development was successfully achieved in 2013 and first product release to domestic and international market is to begin in 2016.



Overseas sales

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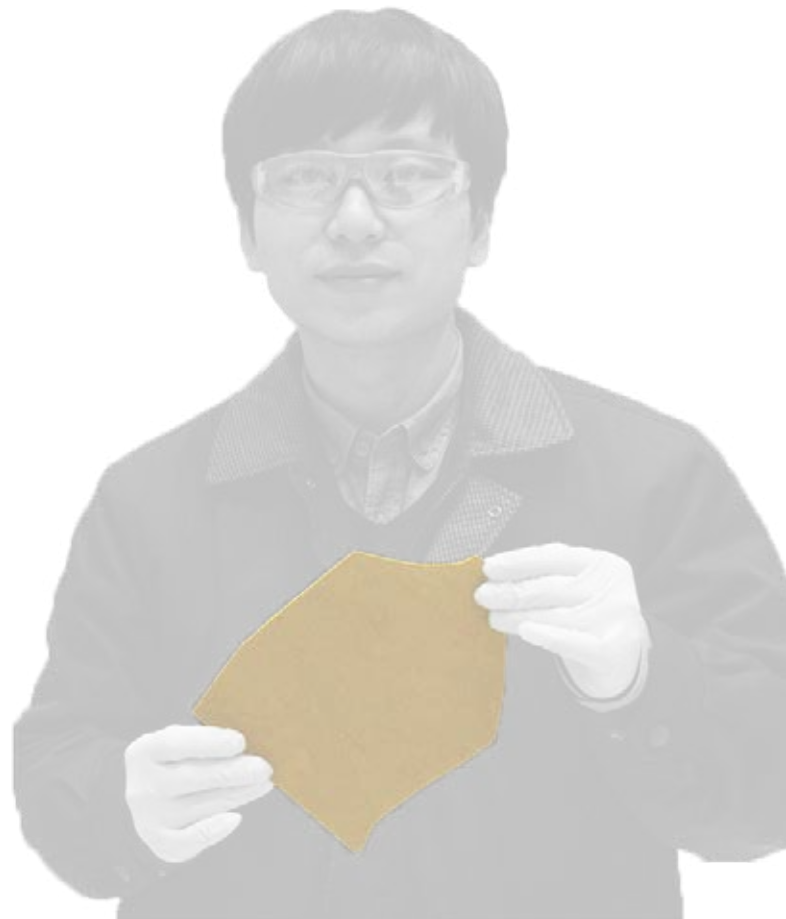
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