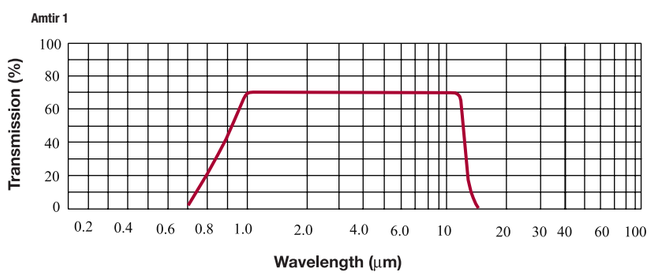
AMTIR-1 (Amorphous Material Transmitting Infrared Radiation)

AMTIR-1 is a “glass like” amorphous material with a high homogeneity, that is able to transmit in the infrared. AMTIR-1 is used for infrared windows, lenses, and prisms, when transmission in the range of .75-14µm is desired. AMTIR-1 is not water soluble. The low thermal change in refractive index (72 x 10-6/°C) is an advantage in lens design to prevent defocussing. The upper use temperature is 300°C.

AMTIR-1’s composition of Ge33As12Se55 makes it somewhat similar to Germanium in its mechanical and optical properties. It is nearly as dense as Germanium but has a lower index of refraction, making it a good option for color correction with Germanium in an optical system. AMTIR-1 peforms especially well in the 8-12µm spectral region where its absorption and dispersion are the lowest. AMTIR-1 optical grade material is generally more expensive than Germanium.

Property	**Specification**
Transmission Range	.75µm to 14µm
Density	4.4 g/cm^3
Thermal Expansion Coefficient	12x10-6 / °C
Surface Finish	Typical specifications for surface quality in the infrared are 40-20 or 60-40 scratch dig in the 1 to 7 µm spectral region and 60-40, 80-50 or 120-80 scratch-dig for the 7-14µm area, depending upon system performance requirements. Diamond Turned surface finishes of 120 Angstroms rms or better are typical.
Surface Figure	In the infrared, typical required surface figure ranges from 1/2wave to 2 waves @0.6328 µm depending on the system performance requirements.
AR Coating Options	Mostly BBAR coated for use in the 3-5µm or 8-12µm spectral regions. Many other specialized coating bands are possible between 1 and 14µm.
Typical Applications	Thermal imaging, FLIR, YAG laser systems.
Products Manufactured	Lenses, Aspheric Lenses, Binary (Diffractive) Lenses, Windows, Wedges, Prisms.



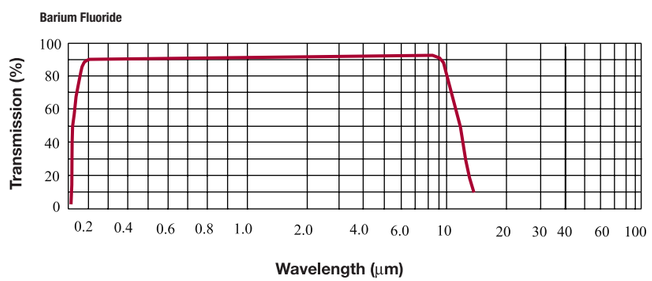
Wavelength µm	**Index of Refraction (n)**
1.00	2.606
2.00	2.531
3.00	2.519
4.00	2.514
7.00	2.506
10.00	2.498
14.00	2.483

Barium Fluoride (BaF_2)

Barium Fluoride can be used in the ultraviolet, visible and infrared spectral regions. Barium fluoride has transmission above 90% between 0.25 and 9.5µm.

Barium Fluoride is half as hard as Calcium Fluoride and also more susceptible to thermal shock. However, it is commonly used in cryogenically cooled thermal imaging systems. It is somewhat more expensive than Calcium Fluoride and not as readily available in large sizes.

Property	**Specification**
Transmission Range	0.15 to 12.5µm
Density	4.89 g/cm^3
Thermal Expansion Coefficient	18.1x10-6 /°C@20°C+/-100°C
Surface Finish	Polishes of 20-10 scratch-dig are mostly specified for use in UV and visible applications. Typical specifications for surface quality in the infrared are a 40-20 scratch dig in the 0.75 to 3µm spectral region and 60-40 scratch-dig for the 3-7µm area. BaF_2 is diamond turnable.
Surface Figure	Surface figure of a 1/10 wave to 1/2 wave @0.6328 µm are specified mostly on lenses for ultraviolet and visible use. In the infrared, typical required surface figure ranges from 1/2 wave to 2 waves @0.6328 µm depending on the system performance requirements.
AR Coating Options	Typical available coatings for BaF_2 include BBAR for 0.8 to 2.5 µm, 3 to 5µm or the 1 to 5µm spectral regions.
Typical Applications	Cryogenically cooled thermal imaging, Astronomical, Laser applications.
Products Manufactured	Lenses, Aspheric lenses, Windows, Optical Beamsplitters, Optical Filters, Wedges, Prisms.

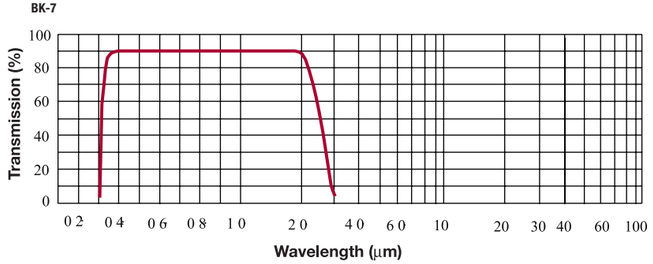


Wavelength µm	**Index of Refraction (n)**
1.700	1.466
2.152	1.464
3.422	1.459
4.000	1.455
6.238	1.442
7.268	1.433
10.346	1.396

Borosilicate Crown Glass (BK-7)

Borosilicate Crown Glass is used for windows, lenses, and prisms where transmission in the range 0.4µm to 1.4µm is desired. The refractive index varies from about 1.53 to 1.5 through this range. It is used for thermally non-critical applications.

Property	Specification
Transmission Range	0.4-2.5µm
Density	2.51 g/cc
Thermal Expansion Coefficient	7.1x10-6/°K @ -30° to +70°C, and 8.3x10-6/°K @ 20°C to 300°C
Surface Finish	BK-7 polishes extremely well and polishes of 10-5, or 20-10 scratch-dig are achieved at extra costs respectively, mainly for UV and visible applications.
Surface Figure	Surface figure of 1/10 wave to 1/4 wave @0.6328µm are specified mostly on lenses for ultraviolet and visible use.
AR Coating Options	AR @ 0.8-2.5µm, AR @ 1.064, AR @ Visible W.L.
Typical Applications	Astronomical, Thermal Imaging
Products Manufactured	Lenses, Windows, Wedges, Prism, Beam Splitters, Filters.



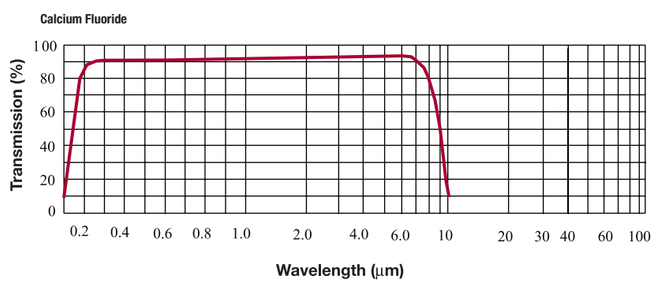
Wavelength µm	Index of Refraction (n)
0.4047	1.530
0.4800	1.523
0.5461	1.519
0.6328	1.515
0.8521	1.510
1.0600	1.507
1.5300	1.501
1.9700	1.495
2.3250	1.489

Calcium Fluoride (CaF_2)

Calcium Fluoride can be used in the ultraviolet, visible and infrared spectral regions. Calcium Fluoride has a transmission above 90% between 0.25 and 7µm.

Calcium Fluoride is twice as hard as Barium Fluoride and also less susceptible to thermal shock. However, it is commonly used in cryogenically cooled thermal imaging systems. It is less expensive than Barium Fluoride. CaF_2 is diamond turnable

Property	Specification
Transmission Range	0.13µm to 7.0µm
Density	3.18 g/cm^3
Thermal Expansion Coefficient	18.85x10-6 / °C
Surface Finish	Polishes of 20-10 scratch-dig are mostly specified for use in UV and visible applications. Typical specifications for surface quality in the infrared are a 40-20 scratch dig in the 0.75 to 3µm spectral region and 60-40 scratch-dig for the 3-7µm area.
Surface Figure	Surface figure: In the UV and Visible spectral regions, surface figure ranges from 1/10 wave to 1/4 wave @ 0.6328µm. In the infrared, typical required surface figure ranges from 1/4 wave to 2 waves @ 0.6328 µm and are specified depending on the system performance requirements.
AR Coating Options	Available coatings for CaF_2 include BBAR for 0.8 to 2.5µm, 3 to 5µm or the 1 to 5µm spectral regions
Typical Applications	Cryogenically cooled thermal imaging, Astronomical, Microlithography, Excimer Laser applications.
Products Manufactured	Lenses, Aspheric lenses, windows, Optical Beamsplitters, Optical Filters, Wedges, Prisms.

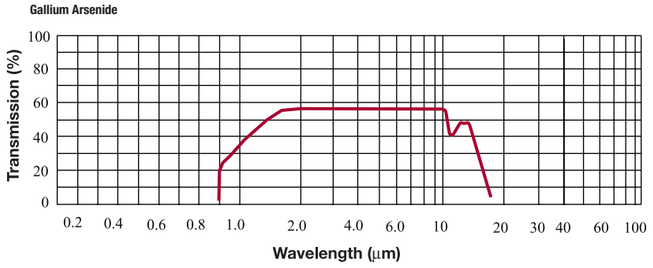


Wavelength µm	Index of Refraction (n)
1.0600	1.428
2.0582	1.424
4.0000	1.410
5.8932	1.387
8.2505	1.344
9.4291	1.316

Gallium Arsenide (GaAs)

Optical grade Gallium Arsenide is an infrared transmitting, semi-insulating material. Special Properties: Gallium Arsenide is nearly as hard, strong and dense as Germanium. It is commonly used in applications where toughness, and durability are of great importance. It has a low absorption coefficient of 0.01cm–1 from 2.5 to 12µm. GaAs optical grade material is generally more expensive than Germanium and ZnSe. GaAs is Diamond Turnable.

Property	Specification
Transmission Range	2µm to 15µm
Density	5.31g/cm^3
Thermal Expansion Coefficient	6x10-6 /°K
Surface Finish	Typical specifications for surface quality in the infrared are 40-20 or 60-40 scratch dig in the 2 to 7µm spectral region and 60-40, 80-50 or 120-80 scratch-dig for the 7-15µm area, depending upon system performance requirements.
Surface Figure	In the infrared, typical surface figure ranges from 1/2 wave to 2 waves @0.6328 µm depending on the system performance requirements.
AR Coating Options	Typical available coatings for GaAs include a BBAR for 3 to 5µm spectral region, and a BBAR for the 8 to 12µm spectral region. Many other specialized bands are possible within the 2 to 15µm spectral region.
Typical Applications	Thermal imaging, CO_2 laser systems, FLIR
Products Manufactured	Lenses, Aspheric Lenses, Windows, Wedges

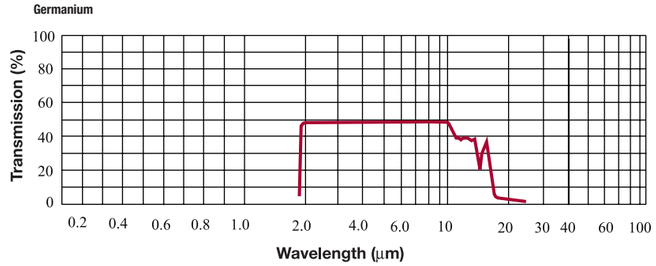


Wavelength µm	Index of Refraction (n)
4.0	3.307
10.0	3.278
14.0	3.251

Germanium (Ge)

Germanium has the highest index of refraction of any commonly used infrared transmitting materials. It is a very popular material for systems operating in the 3-5 or 8-12µm spectral regions. Germanium blocks UV and visible light and in the infrared up to about 2µm. Its high index is desirable for the design of lenses that might not otherwise be possible. Germanium has nearly the highest density of the infrared transmitting materials and this should be taken into consideration when designing for weight restricted systems. Germanium is subject to thermal runaway, meaning that the hotter it gets, the more the absorption increases. Pronounced transmission degradation starts at about 100°C and begins rapidly degrading between 200°C and 300°C, resulting in possible catastrophic failure of the optic.

Property	Specification
Transmission Range	2 to 14µm
Density	5.33g/cm^3
Thermal Expansion Coefficient	2.3x10-6 /°K @ 100°K, 5.0x10-6 /°K @ 200°K, 6.0x10-6 /°K @ 300°K
Surface Finish	Typical specifications for surface quality in the infrared are 40-20 or 60-40 scratch dig in the 2 to 7µm spectral region and 60-40, 80-50 or 120-80 scratch- dig for the 7-14µm area, depending upon system performance requirements. Diamond turned surface finishes of 120 Angstroms rms or better are typical.
Surface Figure	Surface figure: In the infrared, typical surface figure ranges from 1/2 wave to 2 waves @0.6328µm depending on the system performance requirements.
AR Coating Options	Typical available coatings for Germanium include BBAR for 3 to 5µm, 8 to 12µm, and the 3 to 12µm spectral regions. Many application specialized bands are possible between the 2 and 14µm.
Typical Applications	Thermal imaging, FLIR.
Products Manufactured	Lenses, Aspheric Lenses, Binary (Diffractive) Lenses, Windows, Optical Beamsplitters, Optical Filters, Wedges.



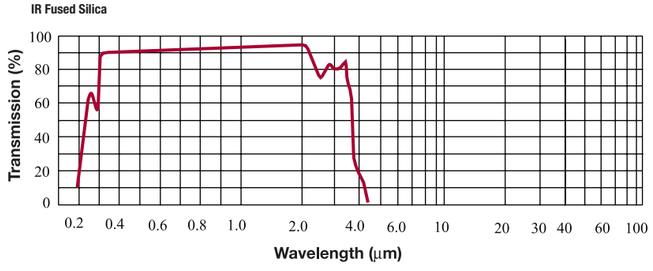
Wavelength µm	Index of Refraction (n)
2.5	4.046
3.0	4.044
4.0	4.025
8.0	4.007
10.0	4.005
12.0	4.004
14.0	4.003

Fused Silica (IR Grade) (SiO_2)

Fused silica is often used in near infrared systems performing in the 0.8-2.5µm spectral region. It is also frequently used at the popular 1.064µm Nd:YAG laser wavelength.

The material has high homogeneity and good transmission in the visible and near infrared spectral regions. Cost of the material ranges widely by type and purity. However the most common Fused Silica for infrared use is quite a bit more expensive than Silicon and slightly less expensive than Calcium Fluoride or ZnS Multi-spectral grade. Due to the materials inherently hard SiO_2 amorphous structure, the material is not diamond turnable. Typical specifications for surface quality in the near infrared regions are a 40-20 scratch dig.

Property	**Specification**
Transmission Range	0.25µm to 3.5µm
Density	2.202g/cm^3
Thermal Expansion Coefficient	5.5x10-7 / °C@20 to 320°C
Surface Finish	Fused Silica polishes extremely well and polishes of 10-5, or 20-10 scratch-dig are achieved at extra costs respectively, mainly for UV and visible applications.
Surface Figure	In the infrared, typical surface figure ranges from 1/4 wave to 2 waves @0.6328µm and are specified depending on the system performance requirements.
AR Coating Options	Typical available infrared coatings are a BBAR from 0.8- 2.5µm and an AR coating for 1.064µm wavelength.
Typical Applications	Thermal imaging, Astronomical, Microlithography, Excimer laser applications, Nd:YAG laser applications.
Products Manufactured	Lenses, Windows, Wedges, Optical Beamsplitters, Optical Filters, Prism.



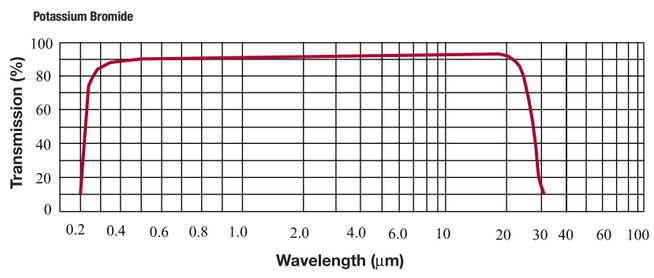
Wavelength µm	**Index of Refraction (n)**
2.0	1.438

Potassium Bromide (KBr)

Potassium Bromide is used for windows and prisms when transmission to 26µm is desired. Potassium Bromide is water soluble and must be protected against moisture degradation of polished surfaces.

The material cleaves readily, and can be used at temperatures up to 300°C. UV irradiation of Potassium Bromide produces color centers.

Property	**Specification**
Transmission Range	0.23µm to 25µm
Density	2.754 gm/cm^3
Thermal Expansion Coefficient	43x10-6/°C
Surface Finish	Generally 60-40 or 80-50 Scratch Dig in the Infrared.
Surface Figure	Generally λ/20 @ 10.6µm
AR Coating Options	Moisture Protection (Specify Wavelength of Use).
Typical Applications	IR Spectroscopic components, beamsplitters, CO_2 lasers.
Products Manufactured	Windows, Lenses, Lens Protectors, Wedges, Aspheric Lenses.



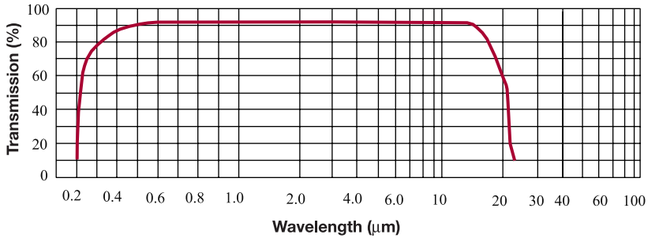
Wavelength µm	**Index of Refraction (n)**
2.440	1.537
4.258	1.535
6.692	1.532
8.662	1.529
9.724	1.527
11.862	1.522
14.290	1.515
17.400	1.504
18.160	1.501
21.180	1.487

Potassium Chloride (KCl)

Potassium Chloride is used for low cost CO_2 laser optics and infrared windows, lenses, and prisms when transmission in the range to 20µm is desired (transmission extends beyond that of Sodium Chloride). Potassium Chloride is soluble in water and polished surfaces must be protected from moisture. Maximum use temperature is 400°C.

Property	Specification
Transmission Range	0.21µm to 20µm
Density	1.989gm/cm^3
Thermal Expansion Coefficient	36x10-6/°C
Surface Finish	Generally 60-40 or 80-50 Scratch Dig in the Infrared.
Surface Figure	Generally λ/20 @ 10.6µm
AR Coating Options	Moisture Protection (Specify Wavelength of Use).
Typical Applications	IR Spectroscopic components, beamsplitters, CO_2 lasers.
Products Manufactured	Windows, Lenses, Lens Protectors, Wedges, Aspheric Lenses.

Potassium Chloride



Wavelength µm	Index of Refraction (n)
2.3573	1.475
4.7146	1.471
5.8932	1.469
8.2505	1.463
10.0184	1.457
12.9650	1.443
14.1410	1.437
15.9120	1.426
18.2000	1.409
20.4000	1.389
22.2000	1.374
24.1000	1.352
26.7000	1.300
28.2000	1.254

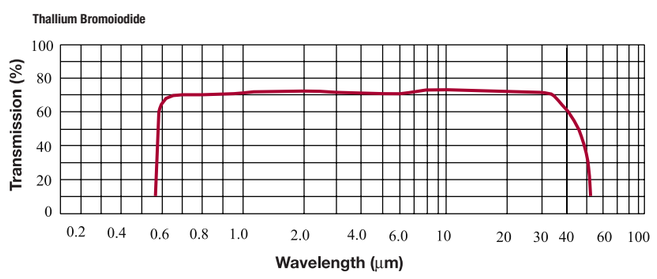
Thallium Bromoiodide (KRS-5)

Thallium Bromoiodide is widely used for optics when transmission to about 40µm is desired. KRS-5 is relatively insoluble in water and may be used in cells in contact with aqueous solutions.

KRS-5 is superior to the simple Bromide and Iodide Salts in that it is much harder. The top operating temperature is 200°C. The material does not cleave but will flow under pressure. The softness of the material limits the optical figure and surface quality that can be achieved in fabrication.

Property	Specification
Transmission Range	0.6µm to 40µm
Density	7.371 gm/cc
Thermal Expansion	58x10-6/°C
Surface Finish	Generally a Low Scatter Polish for the Infrared (80-50 Scratch Dig).
AR Coating Options	Moisture Protection (Specify Wavelegth of Use).
Typical Applications	Attenuated total reflection prisms, IR windows and lenses.
Products Manufactured	Windows, Lenses, Wedges, Prism, Aspheric Lenses, Beam Splitters.

Thallium Bromoiodide

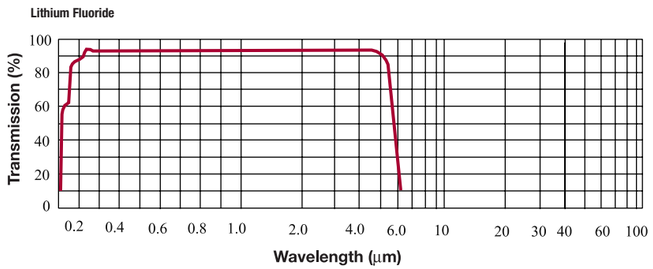


Wavelength µm	Index of Refraction (n)
2.0	2.395
4.0	2.382
6.0	2.378
8.0	2.375
10.0	2.371
12.0	2.366
14.0	2.364
16.0	2.355
18.0	2.348
20.0	2.341
22.0	2.332
24.0	2.323
26.0	2.312
28.0	2.301
30.0	2.289
32.0	2.275

Lithium Fluoride (LiF)

Lithium Fluoride has the lowest index of refraction of all the common infrared materials. LiF is slightly plastic, and has a relatively high thermal expansion coefficient. It is also the most expensive of the Fluoride series of crystals.

Property	Specification
Transmission Range	0.121µm to 5.0µm
Density	2.639 g/cm^3
Thermal Expansion Coefficient	37x10-6 / °C
Surface Finish	Typical specifications for surface quality in the infrared are a 40-20 scratch dig in the 0.75 to µm spectral region and 60-40 or 80-50 scratch-dig for the 3-7µm area depending upon system performance requirements. LiF is diamond turnable.
Surface Figure	In the infrared, typical surface figure ranges from 1/2 wave to 4 waves @0.6328µm depending upon system performance requirements.
AR Coating Options	LiF can be AR coated for use in the infrared, but generally without much improvement in transmission due to its low index of refraction and already high transmission
Typical Applications	Thermal imaging, Astronomical, Excimer laser applications.
Products Manufactured	Lenses, Aspheric lenses, Windows, Wedges, Prisms.



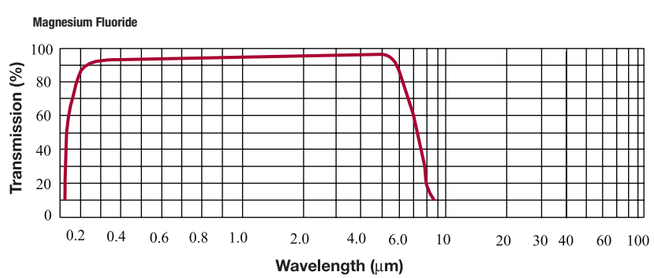
Wavelength µm	Index of Refraction (n)
1.0	1.387
2.0	1.379
3.0	1.367
4.0	1.349
5.0	1.327
5.8	1.304

Magnesium Fluoride (MgF_2)

Magnesium Fluoride is used for optical elements in both the infrared and ultraviolet. Its useful transmission range is from .19µm; to 6.5µm. The refractive index varies from about 1.48 to 1.3. Magnesium Fluoride is a birefringent material and this aspect should be taken into consideration before selection of this material in an optical design. Janos uses only VUV grade material, with the C-axis oriented to minimize birefringence. Irradiation does not lead to color centers. This VUV material is the least susceptible to radiation induced color centers.

Magnesium Fluoride is one of the lowest index infrared materials, second only to Lithium Fluoride. It is resistant to thermal and mechanical shock. The material is twice as hard as Calcium Fluoride but only half as hard as Germanium. Magnesium Fluoride is significantly more expensive than Calcium Fluoride and Barium Fluoride, but usually not more expensive than Lithium Fluoride. Magnesium Fluoride is similar to Calcium Fluoride in its resistance to water.

Property	Specification
Transmission Range	0.121µm to 7.0µm
Density	3.177g/cm^3
Thermal Expansion Coefficient	13.7x10-6 /°C Parallel to C-axis 8.48 x10-6 /°C Perpendicular to C-axis
Surface Finish	Polishes of 10-5, or 20-10 scratch-dig are achieved at extra costs respectively mainly for UV applications. Typical specifications for surface quality in the visible and near infrared regions are a 40-20 and 60-40 scratch dig in the 3 to 7µm range. MgF_2 is diamond turnable.
Surface Figure	In the UV and Visible spectral regions, surface figure ranges from 1/10 wave to 1/2 wave @0.6328µm. In the infrared, typical required surface figure ranges from 1/2 wave to 2 waves @0.6328µm and are specified depending on the system performance requirements.
AR Coating Options	Magnesium Fluoride can be AR coated for use in the infrared but generally without much improvement in transmission due to its low index of refraction and already high transmission.
Typical Applications	Thermal imaging, Astronomical, Excimer laser applications.
Products Manufactured	Lenses, Aspheric lenses, Windows, Optical Beamsplitters, Optical Filters, Wedges, Prisms.



Wavelength µm	Index of Refraction (n)
0.114	1.7805
0.118	1.6800
0.130	1.5560
0.150	1.4800
0.170	1.4470
0.190	1.4310
0.300	1.4000
0.700	1.3760

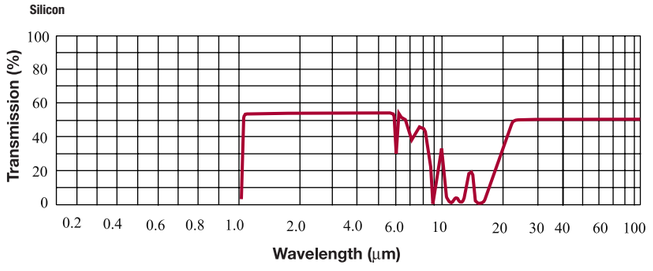
Silicon (Si)

A semiconductor material that is commonly used in infrared optical systems operating in the 3 to 5µm spectral band. The refractive index is near 3.4 throughout the range. Silicon is also useful as a transmitter in the 20µm to 300µm range.

Silicon is used as a mirror substrate for lasers because of its thermal conductivity, light weight, and hardness. It is also used for windows and lenses in the 1.2µm to 6.7µm range. Due to the strong absorption at 9µm, Silicon is not suitable for use with CO_2 lasers as a transmitting optic but is widely used for CO_2 mirrors.

Silicon has one of the lowest densities of the common infrared materials making it ideal for systems with weight constraints. The density of Silicon is only half that of Germanium, Gallium Arsenide and Zinc Selenide. Silicon is harder than Germanium and not as brittle. Silicon is the lowest material cost option of all the infrared materials.

Property	**Specification**
Transmission Range	1.2 to 7.0µm and from 25µm out to beyond 300µm
Density	2.329 g/cm^3
Thermal Expansion Coefficient	2.55x10-6 /°C@25°C
Surface Finish	Typical specifications for surface quality in the infrared are a 40-20 scratch dig in the 1.2 to 3µm spectral region and 60-40 scratch-dig for the 3-7µm area. Diamond Turned surface finishes of 120Angstroms rms or better are typical.
Surface Figure	In the infrared, typical required surface figure ranges from 1/2 wave to 2 waves @0.6328µm and are usually specified depending on the system performance requirements.
AR Coating Options	The most common anti-reflectance coating for Silicon is BBAR for 3 to 5µm. Many other specialized wavelength bands are possible within the 1.2 to 7.0µm range.
Typical Applications	Thermal imaging, FLIR.
Products Manufactured	Lenses, Aspheric Lenses, Binary(Diffractive) Lenses, Windows, Optical Beamsplitters, Optical Filters, Wedges.



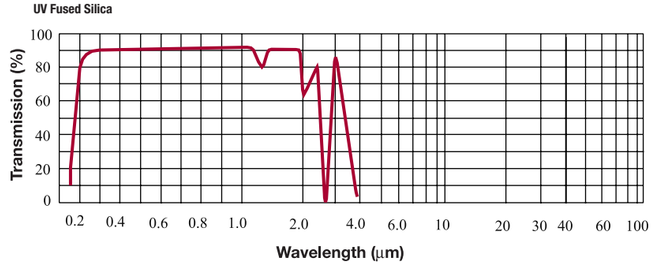
Wavelength µm	**Index of Refraction (n)**
1.5	3.484
2.0	3.456
3.0	3.436
4.0	3.429
5.0	3.426
6.0	3.424
7.0	3.423

Fused Silica (UV Grade) (SiO_2)

Fused silica is often used in near infrared systems performing in the 0.8-2.5µm spectral region. It is also frequently used at the popular 1.064µm Nd:YAG laser wavelength.

The material has high homogeneity and good transmission in the visible and near infrared spectral regions. Cost of the material ranges widely by type and purity. However the most common Fused Silica for infrared use is quite a bit more expensive than Silicon and slightly less expensive than Calcium Fluoride or ZnS Multi-spectral grade. Due to the materials inherently hard SiO_2 amorphous structure, the material is not diamond turnable. Typical specifications for surface quality in the near infrared regions are a 40-20 scratch dig.

Property	**Specification**
Transmission Range	0.18µm to 2.5µm
Density	2.202g/cm^3
Thermal Expansion Coefficient	5.5x10-7 / °C@20 to 320°C
Surface Finish	Fused Silica polishes extremely well and polishes of 10-5, or 20-10 scratch-dig are achieved at extra costs respectively, mainly for UV and visible applications.
Surface Figure	Surface figure of 1/10 wave to 1/4 wave @0.6328 µm are specified mostly on lenses for ultraviolet and visible use.
AR Coating Options	Typical available infrared coatings are a BBAR from 0.8- 2.5 µm and an AR coating for 1.064 µm wavelength.
Typical Applications	Thermal imaging, Astronomical, Microlithography, Excimer laser applications, Nd:YAG laser applications.
Products Manufactured	Lenses, Windows, Wedges, Optical Beamsplitters, Optical Filters, Prism.



Wavelength µm	**Index of Refraction (n)**
2.0	1.438

Zerodur®

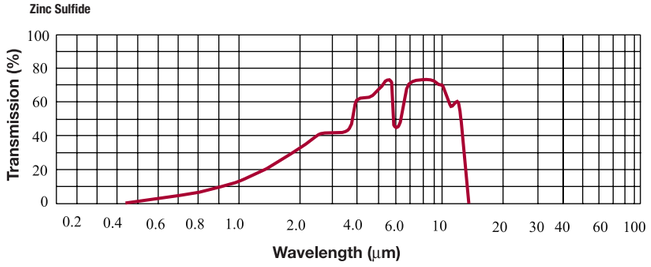
Zerodur® is used for mirror substrates where extreme thermal stability is desired. Its co-efficient of thermal expansion is less than one percent of Pyrex®.

Property	Specification
Density	2.53g/cm^3
Thermal Expansion Coefficient	0±0.10x10-6/°K from 0 to 50°C
Surface Finish	Generally 20-10, 40-20, 60-40, or 80-50, Depending Upon Application.
Surface Figure	Generally λ/10 @ 0.620µm, λ/4 @ .6328, λ/2@ .6328, or 1λ @ .6328, Depending Upon Application.
Coating Options	Protected Aluminum, Gold, Protected Gold (see mirror coatings section).
Typical Applications	Astronomical.
Products Manufactured	Plano Mirrors, Concave Mirrors, Convex Mirrors.

Zinc Sulfide (ZnS)—Regular Grade

Zinc Sulfide (ZnS), Regular Grade A Chemically Vapor Deposited (CVD) material , ZnS (regular) has good imaging quality over the 8-12µm band. It also transmits in the 3-5µm band, but with higher absorption and scatter. The material exhibits high strength and hardness, and good resistance to hostile environments. The ZnS regular is 50% harder than ZnS, multispectral grade and twice and hard as ZnSe. ZnS regular does not transmit well in the visible spectral region. It has the relatively low cost of about 2/3 the price of ZnS, multi-spectral grade or ZnSe. Zinc Sulfide is mainly used for windows and lenses in the 8µm to 12µm range. The reflective index is near 2.2. Zinc Sulfide is particularly strong and can be used for infrared windows in high speed aircraft and vacuum applications.

Property	Specification
Transmission Range	3µm to 12µm
Density	4.09g/cm^3
Thermal Expansion Coefficient	6.6x10-6 /°K @ 273°K, 7.3x10-6 /°K @ 373°K, 7.7x10-6 /°K @ 473°K
Surface Finish	Typical specifications for surface quality in the 3-12µm spectral region are 60-40, 80-50or 120-80 scratch dig depending upon system performance requirements. ZnS regular is diamond turnable.
Surface Figure	In the infrared, typical surface figure ranges from 1/2 wave to 2 waves @0.6328 µm depending on the system performance requirements.
AR Coating Options	Typical available coatings for ZnS include BBAR for the 3 to 5µm and the 8 to 12µm regions. Many other specialized wavelength bands are possible within the 3 to 12µm spectral range.
Typical Applications	Thermal imaging, FLIR
Products Manufactured	Products manufactured: Lenses, Aspheric lenses, Windows, Domes, Wedges



Wavelength µm	Index of Refraction (n)
1.0	2.292
3.0	2.257
5.0	2.246
7.0	2.232
9.0	2.212
11.0	2.186
13.0	2.152
15.0	2.106
17.0	2.045

Zinc Selenide (ZnSe)

Zinc Selenide is used for infrared windows, lenses, and prisms where transmission in the range 0.63µm to 18µm is desired. Zinc Selenide has a very low absorption co-efficient and is used extensively for high power infrared laser optics. It is non-hygroscopic.

Zinc Selenide is a relatively soft material and scratches rather easily. The low absorption of the material avoids the thermal runaway problems of Germanium. Zinc Selenide requires an anti- reflection coating due to its high refractive index if high transmission is required. ZnSe has a fairly low dispersion across its useful transmission range.

Zinc Selenide, a chemically vapor deposited material, is the material of choice for optics used in high power CO_2 laser systems due to its low absorption at 10.6µm. However it is also a popular choice in systems operating at various bands within its wide transmission range. ZnSe has a high resistance to thermal shock making it the prime material for high power CO_2 laser systems. ZnSe however is only 2/3 the hardness of ZnS multi-specral grade but the harder anti-reflectance coatings do serve to protect ZnSe. Zinc Selenide's cost is about the same as ZnS multi-spectral grade and is generally more expensive than Germanium.

Property	Specification
Transmission Range	0.6µm to 16µm
Density	5.27g/cm^3
Thermal Expansion Coefficient	7.1x10-6 /°K @ 273°K, 7.8x10-6 /°K @ 373°K, 8.3x10-6 /°K @ 473°K
Surface Finish	Typical specifications for surface quality in the infrared are 40-20 or 60-40 scratch dig in the 0.8 to 7µm spectral region and 60-40, 80-50 or 120-80 scratch-dig for the 7 to 16µm area, depending upon system performance requirements. Diamond Turned surface finishes of 150 Angstroms rms or better are typical.
Surface Figure	In the infrared, typical required surface figures range from 1/2 wave to 2 waves @0.6328 µm depending on the system performance requirements.
AR Coating Options	Typical available coatings for ZnSe include BBAR for 0.8 to 2.5µm, 3 to 5µm, 1 to 5µm, 8 to 12µm, and the 3 to 12µm spectral regions and single wavelength coating AR at 10.6µm. Many other specialized wavelength bands are possible within the 0.6 to 16µm range.
Typical Applications	CO_2 laser systems, Thermal imaging, FLIR, Astronomical, Medical
Products Manufactured	Lenses, Aspheric Lenses, Binary (diffractive) Lenses, Windows, Optical Beamsplitters and Optical Filters, Prism.

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Zinc Selenide (ZnSe)

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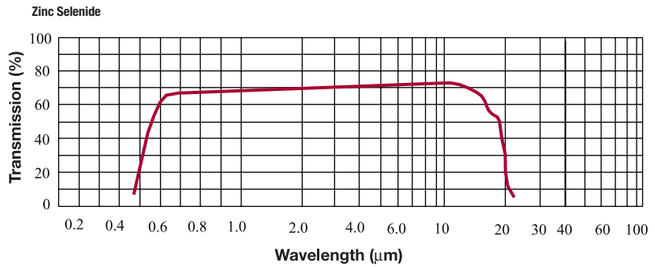

Wavelength µm	Index of Refraction (n)
1.0	2.4890
3.0	2.4380
4.0	2.4330
5.0	2.4300
7.0	2.4220
9.0	2.4120
10.6	2.4028
11.0	2.4000
13.0	2.3850
15.0	2.3670
17.0	2.3440

Additional Materials

Janos Technology has an extensive experience base in the fabrication of a wide variety of standard and exotic materials. The list of materials includes (but is not limited to) Spinel, Silicon Carbide, Aluminum, Titanium, Stainless Steel, Copper,Copper Nickel Alloy, Electroless Nickel Plating and optical plastics. We are always interested in developing fabrication methods for new materials. Contact us with your requirements.