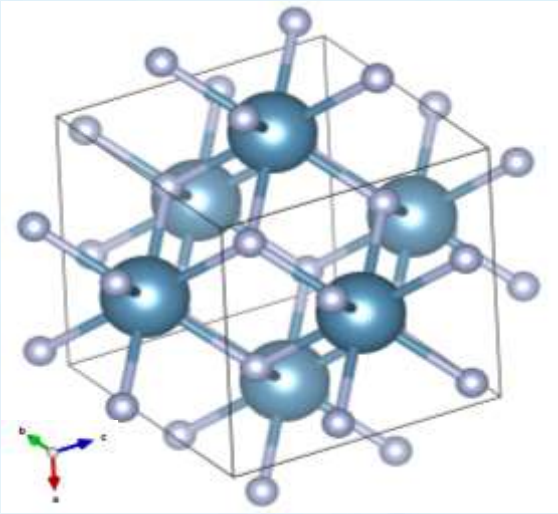
德硅凯氟

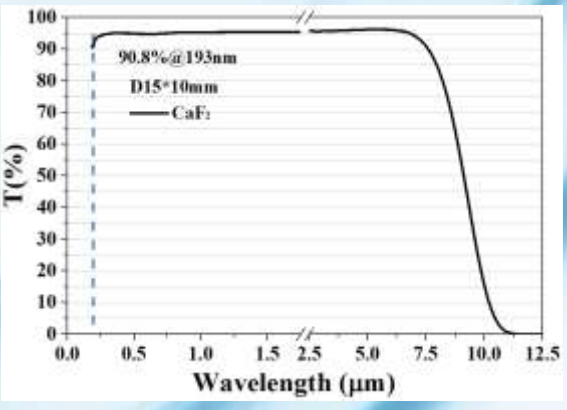
DESIOPTOE

Calcium fluoride (CaF_2)

Calcium fluoride is a window material with excellent performance from vacuum ultraviolet to infrared wavelength, and it is also an irreplaceable apochromat lens material, which is widely used in a series of optical instruments such as ultraviolet lithography, astronomical observation, laser, aerospace exploration and high-resolution microscope; At the same time, calcium fluoride crystal is also one of the most popular materials for basic theoretical research on material structure, ionic kinetic properties, luminescence properties and so on.



Molecular structure of calcium fluoride



Internal transmittance curve of calcium fluoride (under air atmosphere)

DESIOPTOE can provide high-quality calcium fluoride products with strict performance requirements such as lithography grade, ultraviolet laser grade, aerospace grade large aperture, and high-precision lens.

Product grade of calcium fluoride

Grade	Internal transmittance (10mm)		Laser durability	Stress birefringence	Applicable waveband
CaF_2-A	>99.5%@193nm		LD-1	1-10 nm/cm (Customizable)	ArF: 193nm
CaF_2-B	>99.8%@248nm		LD-2		KrF: 248nm
CaF_2-C	Ⅰ>99.8%@365nm		LD-3		i-line: 365nm
	Ⅱ>99.8%@365nm		-		
CaF_2-D	Ⅰ-single crystal	-	-		UV-Visible-Infrared band
	Ⅱ-polycrystal	-	-		

Dispersive properties of calcium fluoride

Partial dispersion		Partial dispersion corresponding	
n_F-n_C	0.00456	$P_{s,t}$	0.2698
$n_{F'}$-$n_{C'}$	0.00459	$P_{C,s}$	0.5333
Deviation from partial dispersion		$P_{d,C}$	0.3046
$\triangle P_{C,t}$	-0.1935	$P_{e,d}$	0.2388
$\triangle P_{C,s}$	-0.0915	$P_{g,F}$	0.5389
$\triangle P_{F,e}$	0.0183	$P_{i,h}$	0.7462
$\triangle P_{g,F}$	0.0552		
$\triangle P_{i,g}$	0.2636		

Calcium fluoride crystals

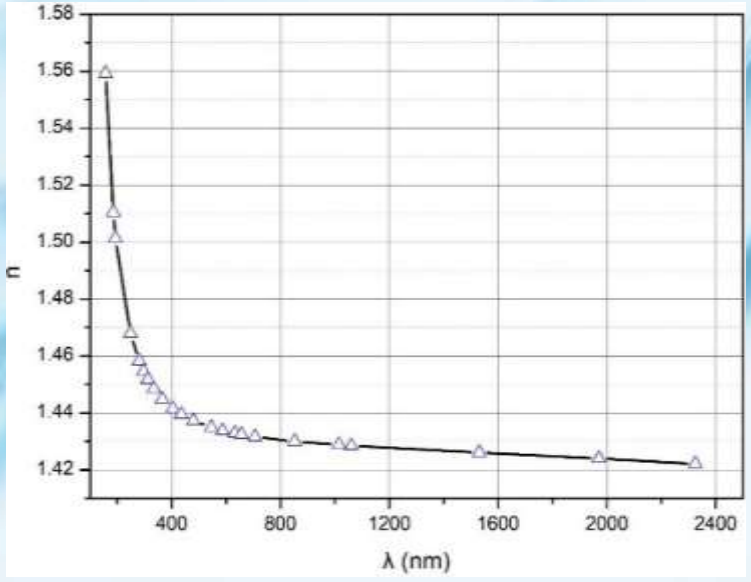
Material section

The basic physical and chemical properties of magnesium fluoride crystals

Performance		Index
Electrical/chemical properties	Crystal structure	Cubic crystal system
	Dissociation surface	(111)
	Molecular	78.08
	Lattice constant	5.462Å
	Solubility(H_2O g/100g)	0.016（20℃）
	Climate resistance CR	1级（ISO/WD 13384）
	Acid resistance rating SR	4.5级（ISO 8424）
	Alkaline resistance rating AR	2.3级（ISO 10629）
	Phosphoric acid resistance rating PR	1.3级1.3 (ISO 9689)
	Stain resistance rating FR	0级
	Dielectric constant	6.81
Thermal properties	Melting point （℃）	1420
	Specific heat capacity （J/g*K）	0.893
	Thermal conductivity （W/m*K）	9.70
	Thermal diffusivity （$10^{-7}m^2$/sec）	35.60
	Coefficient of thermal expansion (10^{-6}/℃)	18.4
Mechanical properties	Young's modulus（GPa）	146 <100>
		101 <110>
		91 <111>
	Poisson's ratio	0.21
	Knoop hardness （kgf/mm^2）	164(ISO 9385)
	Shear modulus（GPa）	34.6
	Compressive modulus（GPa）	83.8
	Mohs hardness	4
	Grindability	6（ISO 12844）
	density（g/cm^3）	3.18
Optical performance	Transmission range（μm）	0.13-7.5
	refractive index	1.6921-1.3161 (0.13-10μm)

Comparison table of refractive index parameters of calcium fluoride

	λ_{vac}[nm]	n	$\triangle n/\triangle T(N_2)$[$10^{-6}$/K]		λ_{vac}[nm]	n	$\triangle n/\triangle T(N_2)$[$10^{-6}$/K]
n_{2325}	2325.59	1.42212	—	$n_{F'}$	480.13	1.43726	-9.8
n_{1970}	1970.56	1.42401	—	n_g	435.96	1.43948	-9.7
n_{1530}	1530.00	1.42612	—	n_h	404.77	1.44149	-9.6
n_{1060}	1060.00	1.42851	—	n_i	365.12	1.44488	-9.4
n_t	1014.25	1.42879	-9.6	n_{334}	334.24	1.44848	-9.1
n_s	852.35	1.43002	-9.7	n_{312}	312.66	1.45173	-8.8
n_r	706.71	1.43166	-9.7	n_{296}	296.82	1.45463	-8.5
n_C	656.45	1.43245	-9.8	n_{280}	280.43	1.45824	-8.1
$n_{C'}$	644.03	1.43267	-9.8	n_{248}	248.35	1.46791	-6.9
n_{He-Ne}	632.98	1.43288	-9.8	n_{194}	194.23	1.50060	-3.2
n_D	589.46	1.43380	-9.8	n_{193}	193.37	1.50143	-3.2
n_d	587.73	1.43384	-9.8	n_{184}	184.95	1.51055	-2.5
n_e	546.23	1.43493	-9.8	n_{157**}	157.63	1.55927	—
n_F	486.27	1.43701	-9.8	*Test conditions: refractive index n(N_2) (22°C, N_2 environment, 1013hPa);			



Refractive index curve of calcium fluoride

Optical properties of calcium fluoride crystals

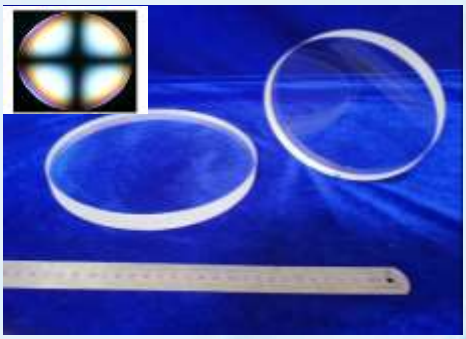
Refractive index	n_d=1.43384 n_e=1.43492
Abbe number	ν_d=95.23 ν_e=94.69

Magnesium fluoride (MgF_2)

Properties of magnesium fluoride

- Wide light transmission range: from 0.11 μm in the deep ultraviolet to 7.5 μm in the mid-infrared band;
- Excellent physical and chemical properties: high mechanical strength, good chemical stability and moisture resistance;
- Excellent anti-irradiation performance: it can be applied to applications such as deep ultraviolet lasers;
- It has birefringence properties: it can be used as a polarizing element, etc.

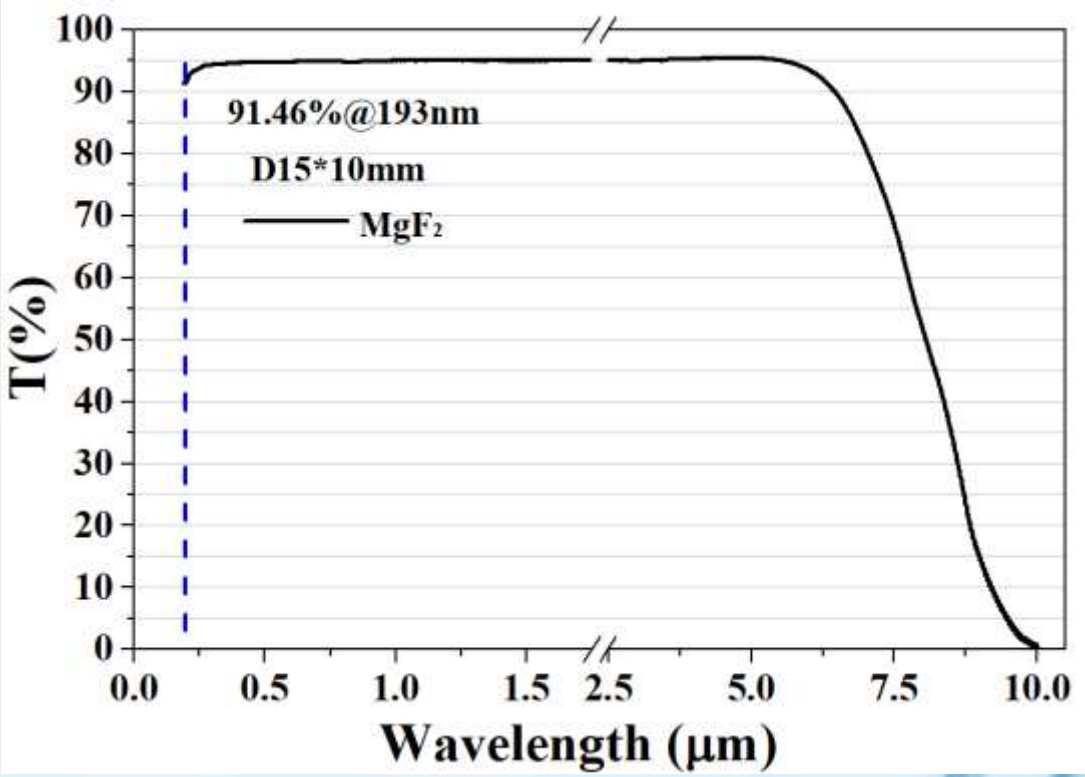
DESIOPTOE can provide MgF_2 crystals with a maximum blank diameter of φ120. Its ultraviolet transmittance is 99%/cm@193nm high, and the deep ultraviolet radiation damage threshold is high. DESIOPTOE can provide customized products with different crystal directions according to user needs: (001), (110), (100).



Magnesium fluoride crystals

The basic physical and chemical properties of magnesium fluoride crystals

Performance	Index	Performance	Index
Crystal structure	Tetragonal crystal system	Transmittance (0.193~6μm)	>90%
Lattice constant	a=4.64, c=3.06	Reflection loss (@1μm)	5.1%
Dissociation surface	(100), (110)	Young's modulus (GPa)	138.5
Melting point (℃)	1255	Poisson's ratio	0.276
density (g/cm^3)	3.177	Knoop hardness (kgf/mm^2)	415
Thermal conductivity (W/mK) @300K	21(∥C), 33.6(⊥C)	Mohs hardness	6
Coefficient of thermal expansion (10^{-6}/℃)	13.7(∥C), 8.9(⊥C)	Shear modulus (GPa)	54.66
Specific heat capacity (J/g*K) @300K	0.92	Compressive modulus (GPa)	101.32
Dielectric constant (@1HMZ)	4.87(∥C), 5.44(⊥C)		
Thermo-optic coefficient (dn/dt:*10^{-6})	2.3		



Internal transmittance curve of magnesium fluoride (under air atmosphere)

Refractive index parameters of magnesium fluoride (@19°C):

λ(μm)	n_o	n_e	β (n_e -n_o)	λ(μm)	n_o	n_e	β (n_e -n_o)
0.20	1.42309	1.43657	0.01348	0.92	1.37411	1.38575	0.01164
0.24	1.40567	1.41859	0.01292	0.96	1.37384	1.38546	0.01162
0.28	1.39620	1.40877	0.01257	1.00	1.37358	1.38519	0.01161
0.32	1.39040	1.40275	0.01235	1.40	1.37134	138281	0.01147
0.36	1.38656	1.39875	0.01219	1.80	1.36908	1.38040	0.01132
0.40	1.38387	1.39594	0.01207	2.20	1.36649	1.37763	0.0114
0.44	1.38189	1.39389	0.01200	2.60	1.36346	1.37440	0.01094
0.48	1.38040	1.39233	0.01193	3.00	1.35995	1.37063	0.01068
0.52	1.37923	1.39111	0.01188	3.40	1.35591	1.36631	0.01040
0.56	1.37829	1.39013	0.01184	3.80	1.35133	1.36141	0.01008
0.60	1.37752	1.38932	0.01180	4.20	1.34618	1.35589	0.00971
0.64	1.37688	1.38865	0.01177	4.60	1.34043	1.34972	0.00929
0.68	1.37633	1.38808	0.01175	5.00	1.33404	1.34288	0.00884
0.72	1.37585	1.38758	0.01173	5.10	1.32699	1.33532	0.00833
0.76	1.37543	1.38714	0.01171	5.80	1.31923	1.32700	0.00777
0.80	1.37506	1.38674	0.01168	6.20	1.31072	1.31786	0.00714
0.84	1.37472	1.38639	0.01167	6.60	1.30142	1.30787	0.00645
0.88	1.37440	1.38606	0.01166	7.00	1.29125	1.29694	000569

Barium fluoride (BaF_2)

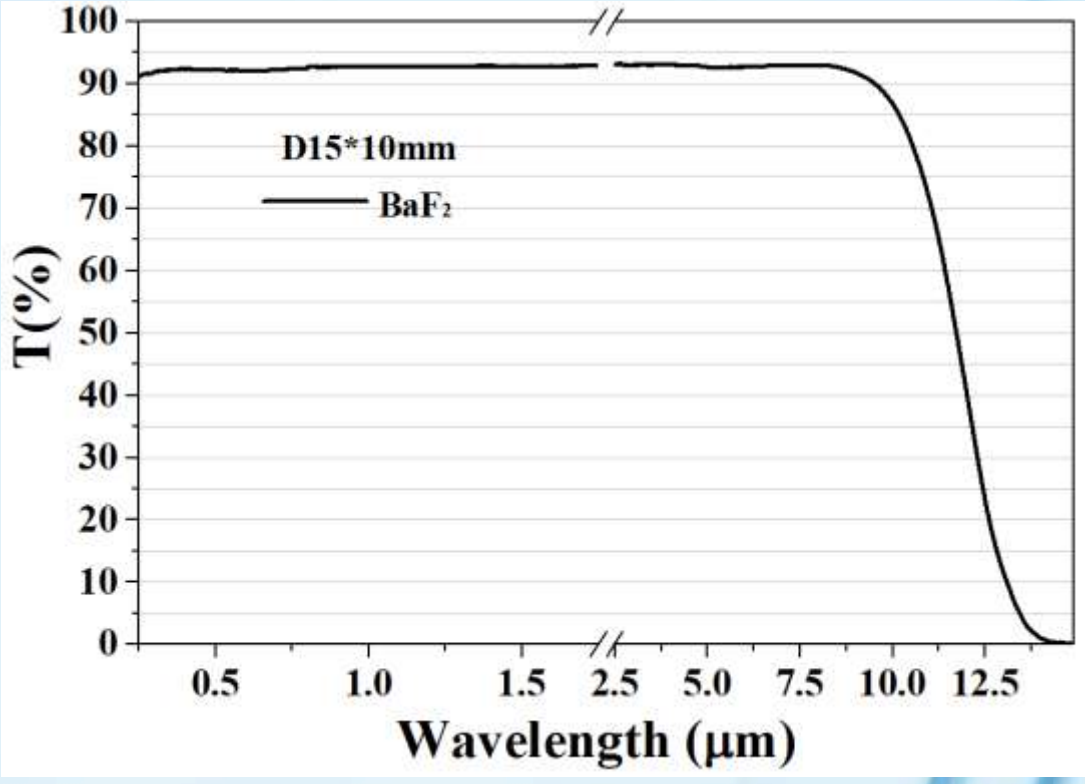
Barium fluoride crystal belongs to the cubic crystal system, its melting point is 1290 °C, and the light transmission range is wide, in the wavelength range of 0.13-12.5 μm has good light transmission performance, has good optical properties and mechanical properties, can be used as ultraviolet and infrared optical window. At the same time, it has excellent scintillation performance and has become an important crystal material in the fields of high-energy physics, nuclear physics, and nuclear medicine.

DESIOPTOE can provide products within the diameter of BaF_2 crystal blank φ110 mm in batches, and we can provide customized services according to customer needs.

Barium fluoride crystals

The basic physical and chemical properties of barium fluoride crystals

Structure	Cubic	Young's modulus (GPa)	53.07
Melting point (℃)	1280	Poisson's ratio	0.343
Density (g/cm^3)	4.89	Knoop hardness (kgf/mm^2)	82
Thermal conductivity (J/Kms) @186K	11.72	Mohs hardness	3.5
Thermal expansion coefficient (10^{-6}/℃)	18.1 (-100~+200℃)	Shear modulus (GPa)	25.4
Specific heat (J/g*K) @300K	0.410	Compressive modulus (GPa)	56.4
dn/dt (10^{-6}%)	15.2@400nm, 12.7@3390nm(- 60℃), 15.2@3390nm(60℃)		



Internal transmittance curve of barium fluoride (under air atmosphere)

Refractive index parameters of barium fluoride (@25°C)

λ[nm]	n	λ[nm]	n	λ[nm]	n	λ[nm]	n
265.2	1.51217	366.3	1.48869	1014.0	1.46847	3243.4	1.46018
280.4	1.50668	404.7	1.48438	1128.7	1.46779	3422.0	1.45940
289.4	1.50390	435.8	1.48173	1367.3	1.46673	5138.0	1.45012
296.7	1.50186	486.1	1.47855	1529.5	1.46613	5343.0	1.44878
302.2	1.50044	546.1	1.47586	1681.0	1.46561	5549.0	1.44732
313.0	1.49782	589.3	1.47443	1701.2	1.46554	6238.0	1.44216
325.5	1.49521	643.8	1.47302	1970.1	1.46472	6633.1	1.43899
334.1	1.49363	656.3	1.47274	2152.6	1.46410	6855.9	1.43694
340.4	1.49257	706.5	1.47177	2325.4	1.46356	7044.2	1.43529
346.6	1.49158	852.1	1.46984	2576.6	1.46262	7268.0	1.43314
361.1	1.48939	894.4	1.46942	2673.8	1.46234	9724.0	1.40514
**Irving H. Malitson, Refractive properties of Barium Fluoride*, Journal of the Optical Society of America, 1964, 54(5):628-632.*						10346.0	1.39636

Optics

According to the needs of customers, we can process various types of optical materials such as flat sheets, lenses, prisms, wedge angle pieces and special-shaped lenses, and our products are widely used in lasers, lithography, detectors, imaging lenses and other fields.

DESIOPTOE has always adhered to the concept of high-quality, high-standard and high-precision optical component processing, with an existing processing workshop of 3,000 square meters, and the equipment production line covers flat, spherical and customized special-shaped lenses.

Processing diameter range: D5-300mm.

All kinds of processing indicators can be customized by customers.

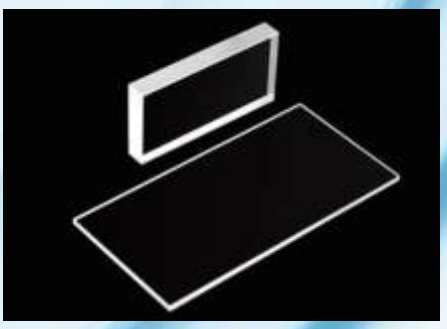
1.Windows

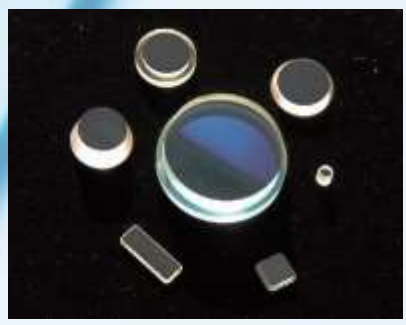
It includes flat films, square films, step window sheets, etc. It protects electronic sensors or detectors without obstructing the line of sight, while maintaining high transmittance and excellent transmitted wavefront.

The important parameters of the window are: light transmittance, surface accuracy, thickness, parallelism, substrate material and other attributes, and the window with suitable parameters can be selected according to the specific application.

Substrate materials: calcium fluoride, magnesium fluoride, fused silica and other materials are the mainstay.

You can customize the flat window with a finish of 10/5, a surface shape of λ/10, and a parallelism of <10", and the coating is optional; It can also be customized with wedge corners, steps, perforated special-shaped windows.





Window processing capabilities

Size range/mm	Finish	Surface/ wavefront (pv)	Parallelism
5-50	10/5 ~ 20/10	λ/10 ~ λ/4	10"
50-100	20/10 ~ 40/20	λ/8 ~ λ/2	30"
100-300	40/20 ~ 60/40	λ/4 ~ λ/2	30"

2、Lens

It includes plano-convex lenses, plano-concave lenses, biconvex lenses, meniscus lenses, etc., which are used for beam expansion and focusing of optical paths.

Base material: calcium fluoride, magnesium fluoride, fused silica, etc.

You can customize: according to different applications such as laser, lithography, imaging and so on, you can choose the appropriate substrate material, size, surface accuracy and surface grade (such as finish: 10/5, surface type λ/10), and can be coated with the appropriate coating material according to your needs.

For CaF_2 products, products that meet the optical non-uniformity < 2ppm and stress < 5ppm can be customized.

Lens processing capabilities

Size range/mm	Finish	Surface/ wavefront (pv)	Eccentricity accuracy
5-50	10/5 ~ 20/10	λ/10 ~ λ/4	30″ ~ 1′
50-100	20/10 ~ 40/20	λ/8 ~ λ/2	30″ ~ 1′
100-300	40/20 ~ 60/40	λ/4 ~ λ/2	30″ ~ 1′

3、Prism

Optical prisms include right-angle prisms, equilateral prisms, DOVE prisms, pentagonal prisms, ridge prisms, dispersive prisms, spectroscopic prisms, etc. In the optical path, the prism has the effect of changing the angle of the outgoing light and the incident light, shifting the light and changing the direction of the image, so it is widely used in laser optics, optical imaging, machine vision, biomedical and other fields or products.

Our company can provide: calcium fluoride, magnesium fluoride, fused silica materials, and the geometry, functional size, surface accuracy and surface grade can be customized; The surface finish of conventional products can reach 20/10, the surface shape can reach λ/8, and the angle accuracy can reach 30 seconds.

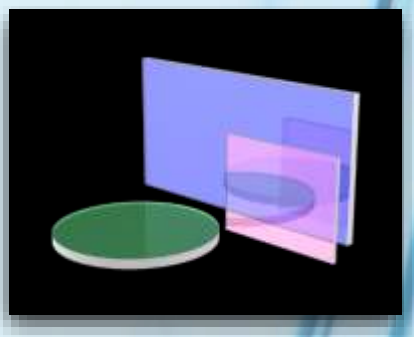


Prism processing capabilities

Size range/mm	Finish	Surface/ wavefront (pv)	Angular accuracy
5-50	10/5 ~ 20/10	λ/10 ~ λ/4	30″ ~ 1′
50-100	20/10 ~ 40/20	λ/8 ~ λ/2	30″ ~ 1′
100-200	40/20 ~ 60/40	λ/4 ~ λ/2	30″ ~ 1′

Optics

4、spectroscope



It is an optical element that divides a beam of light into two beams of light according to a certain proportion of reflection and transmission. Beamsplitters are common optical components, usually used in laser optics, illumination optics, and spectrometer optical systems, and can be divided according to the specific application requirements according to the intensity of transmission and reflection percentage, and the polarization state of transmitted and reflected light.

Substrate materials: calcium fluoride, magnesium fluoride, barium fluoride, N-BK7 glass, ultraviolet fused silica, etc.

5、reflector

Substrate materials: calcium fluoride, magnesium fluoride, N-BK7 glass, ultraviolet fused silica, etc., all materials can be selected without coating or coated with high reflective coating.

6、Wave plates

Phase retard: It is an optical element that changes the polarization state of light by producing an optical path difference (or phase difference) by combining two polarization components orthogonal to each other.

Substrate material: quartz, MgF_2, etc.

Wavelength Range: Multiple ranges are available.

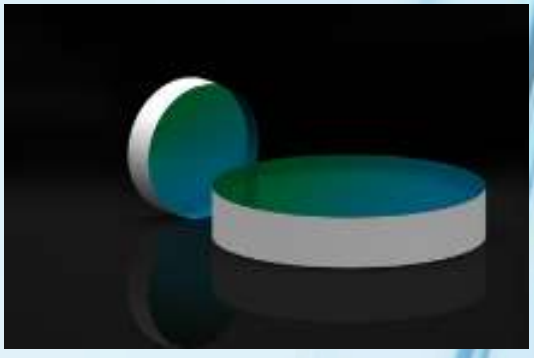
Performance: Flat response over each wide spectral range, providing λ/4 and λ/2 latency.

7、Filters

Substrate material: fused silica (active high-energy optical system), colored glass, etc. (passive optical system).

Surface Quality: Finish 10/5, Transmitted Wavefront, RMS: ≤λ/4 @ 633nm.

8、Optical flat crystal



It is used to measure the flatness error and grinding performance of high-finish surfaces, and has high-precision planarity.

Substrate materials: calcium fluoride, H-K9L glass, fused silica, etc.
Wavelength range: 248nm, 266nm, 355nm, 532nm, 1064nm, 2940nm, etc.

9、All kinds of special-shaped products

Optical guides such as cylindrical mirrors, microlenses, rod mirrors, optical wedges, wedge lenses and special-shaped parts, etc.