CLASER INC.

Crystals
Optical Components
Laser components

www.claserinc.com

Profile

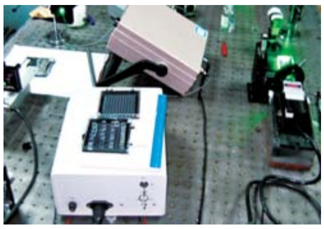
CLaser Inc (CLaser) is in inventing and developing laser components We devote into the Chinese Crystals for DPSS Lasers. We design and produce the different laser components, crystal and optics for DPSS laser application It has strong technology support in crystals grow processing coating and laser technology from university, institute.

.Being a world leading manufacturer and inventor in the Crystal, Optics and Opto-Electronics field it intends to develop and manufacture excellent crystals and laserl components.

CLaser has the integrate products line for grow, process and coating for NLO crystals and laser crystals. The all crystals from CLaser is IBS or IDA coating by Veeco or Leybold for high power application.

Claser cooperate with CAS institute, we develop the Er:Glass, Nd:Glass, TGG crystals The same we develop the high quality diffision bonding crystals for high power laser application.

CLaser always offer the competitive price for differnet laser component to down the cost and push the laser develop.



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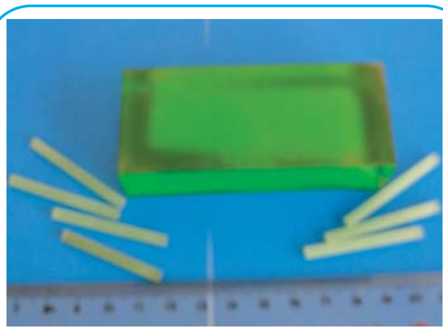
Laser Glass Properties

Glass	Er: (Cr14)	Er: (ETA14)	Yb: (YB1)	Yb: (YP1)	Nd: (N31)
Doping (wt%)			Yb_2O_3 (16.10)	Yb_2O_3 (13.75)	Nd_2O_3 (2.2)
Ion conc. (10^{20}ions/cm^3)			Yb^{3+} (14.51)	Yb^{3+} (16.80)	Nd^{3+} (2.26)
Transformation temp.(°C)	455	442	430	609	430
Softening temp.(°C)	493	470	473	650	475
Thermal conductivity (25°C) (10^{-3}W/cm°C)					5.58
Specific heat (25°C) (J/cm$^{3\circ}$C)					0.75
D_w(H_2O 100°C 1hr) (wt. Loss%)					0.09
D_A(HNO_3 pH2.2 100°C 1hr) (wt. Loss%)					0.40
Density (g/cm^3)	3.10	3.15	2.95	3.99	2.83
Young's modulus (kgf/mm^2)					5270
Posson's ratio					0.27
Knoop hardness (kg/cm^2)					630
Cross section for stimulated emission (10^{-20}cm^2)	0.8	0.8	1.3	1.65	4.0±0.3
Fluorescent lifetime (μsec)	7700	9000	2200	850	340±10
Fluorescence half-line width at 290°K (A)			506.0	518.8	201
Pump Wavelength (nm)	981.6	981.6	974	972	808
Center lasing wavelength (nm)	1535	1535	1016	1018	1059
Non-linear refractive index coeff.n_2 (×10^{-13}e.s.u)		1.20	1.48	1.96	1.1±0.1
n（center wavelength）	1.530	1.532	1.52123	1.6721	1.5280
n_d	1.5393	1.544	1.52958	1.6450	1.5375
n_F			1.53517	1.6649	1.5413
n_c			1.52691	1.6602	1.5332
Abbe value	64	65	64.1	58.42	66.2
dn/dT (10^{-6}/°C)	-5.2	-4.7	-5.3	-0.8	-4.3
Coeff. of linear thermal expansion (10^{-6}/°C)	10.3	10.0	10.8	6.5	10.7
Thermal coeff. of optical path length (10^{-6}/°C)	0.36	0.64	0.42	3.5	1.4
Chemical durability (μg/hr.cm^2)		70			

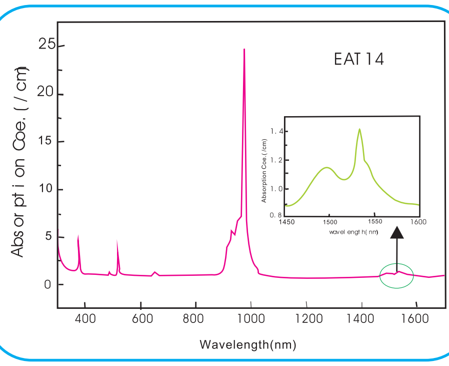
Er:Glass

Erbium and ytterbium co-doped phosphate glass has a broad application because of the excellent properties.



Mostly, it is the best glass material for 1.54um laser due to its eyesafe wavelength of 1540 nm and high transmission through atmosphere. It's also suitable for medical applications where the need for eye protection may be difficult to manage or diminish or hinder essential visual observation. Recently it is used in optical fiber communication instead of EDFA for its more super plus.

We can also produce erbium laser glass with various ions doping according to your requirement.



We have two kinds of Erbium-doped glasses for different use:
EAT14: Yb 3+ , Er 3+ co-doped phosphate glass, which is applicable in high repetition rate (1-6Hz) laser diode pumped 1535nm laser. High Yb 3+ doping can be realized to this EAT14 glass.

Cr14: Yb 3+, Cr:3+, Er 3+YbErbium phosphate glass for xenon lamp pumping laser device and laser range-finder.

Standard Doping:

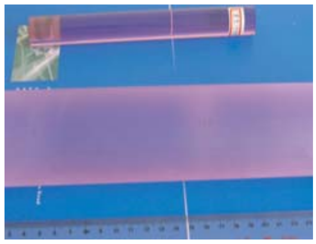
CR14:
(0.13%:Er:Yb:Cr:Glasss) Er3+ 1.3x10^19/cm3, Yb3+ 2x10^21/cm3 ,Cr4+ 1.2x10^21/cm3: Glass
EAT14:
(0.13%:Er:Yb:Glasss) Er3+ 1.3x10^19/cm3, Yb3+ 2x10^21/cm3: Glass
(0.26%:Er:Yb:Glasss) Er3+ 2.6x10^19/cm3, Yb3+ 2x10^21/cm3: Glass
(0.5%:Er:Yb:Glasss) Er3+ 5x10^19/cm3, Yb3+ 2x10^21/cm3: Glass
(1%:Er:Yb:Glasss) Er3+ 10x10^19/cm3, Yb3+ 2x10^21/cm3: Glass

Specifications:

Wavefront distortion	λ/8 per inch @ 633nm
Extinction Ratio	>25dB
Dimension Tolerances	Dia.: ±0.025mm, Length: ±0.5mm
Surface quality	10/5 Scratch/Dig per MIL-O-1380A
Parallelism	<10 arc seconds
Perpendicularity	<5 arc minutes
Flatness	<λ/10 @ 633nm
Chamfer	<0.1mm @ 45deg.
Barrel Finish	50-80 micro-inch (RMS)
AR Coating Reflectivity	<0.25%

Nd:Glass

Nd doped phosphate glass have been widely used in high average power solid state lasers, laser material processing, range finder and other industrial and scientific applications.

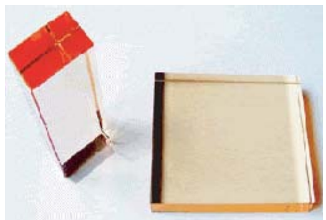


CLASER Nd^{3+} phosphate glasses are guaranteed in optical qualities such as homogeneity, striation, stress birefringence, Pt inclusions etc. The different neodymium doping phosphate glasses are ready for your quest. We have stocked 0.7%, 3.0%, and 4.0% doped N31

N31—a new Nd^{3+}: phosphate glass is specially developed for the LF12# Laser Facility—at present the most powerful laser facility in China. It exhibits the nearly same qualification with HOYA LHG8.N31 Nd:Glass has better perform than N21 in laser systems. CLASER supply the N31 glass for different customer application.

Yb:Glass

Yb^{3+}-doped glass materials are desirable for generation of ultrashort pulse and as tunable laser sources because of their broad absorption and emission bandwidths.



A new Yb^{3+} doped phosphate laser glass, YP1, has been developed. This glass has long lifetime and nearly zero temperature coefficient of optical path length. Fluorescence lifetime is above 2ms. YP1 has the temperature coefficient of optical path length of $+0.42\times10^{-6}$/°C.

Yb^{3+} doped borate laser glass, YB1, exhibits a low thermal expansion coefficient and a negative temperature coefficient of refractive index, resulting in acceptable behavior. YB1 has a high Cross section for stimulated emission of $1.65\times10^{-20}cm^2$.

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Laser Crystals Structural and Physical Properties

Crystals	$Nd:YVO_4$	$Nd:GdVO_4$	Nd (Cr:Yb;Ho;Er):YAG	Ti:Sapphire
Crystal structure	Zircon Tetragonal	Zircon Tetragonal	Cubic	Hexagonal
Space group	D_{4h}-I4/amd	D_{4h}-I4/amd		
Cell parameters	a=b=7.1193, c=6.2892	a=b=7.212, c=6.350	12.01Å	a=4.758, c=12.991
Melting point	1825	1780	1970°C	2040°C
Mohs hardness	4-5	4-5	8.5	9
Density	4.22g/cm^3	5.47	4.5g/cm^3	3.98g/cm^3
Thermal expansion coe.	$\alpha_a=4.43\times10^{-6}$/K $\alpha_c=11.37\times10^{-6}$/K	$\alpha_a=1.5\times10^{-6}$/K $\alpha_c=7.3\times10^{-6}$/K	7.8x10^{-6}/K	5.8x10^{-6}/K
Thermal conductivity	//C:5.23W/m/K ⊥C:5.10W/m/K	⊥C:11.7W/m/K	15W/m/K	25.12W/m/K (@10°C)
Therm-optic coefficients	$dn_e/dT=2.9\times10^{-6}$/°K $dn_o/dT=8.5\times10^{-6}$/K	$dn_e/dT=4.7\times10^{-6}$/°C	7.3×10^{-6}/°C	13x10^{-6}/K

Laser Crystals Optical Properties

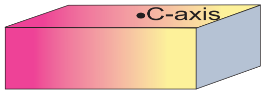
Crystals	$Nd:YVO_4$	$Nd:GdVO_4$	Ti: Sapphire	Nd(Ce): YAG	Yb: YAG	Er: YAG	Ho:Cr: Tm:YAG
Lasing wavelength: (nm)	914 1064, 1342	912 1063 1340	660-1050	947 1064 1319	1030	2940	2097
Pump wavelength	808.5nm	808.4nm	400nm-600nm	807.5nm	940nm (970nm)	600nm-800nm	400nm-800nm
Emission cross-section	15.6x10^{-19}/cm^2	7.6x10^{-19}/cm^2	3-4x10^{-19}/cm^2	6.5x10^{-19}/cm^2	2.0×10^{-20}/cm^2	3×10^{-20}/cm^2	7x10^{-21}/cm^2
Fluorescent lifetime	90μs	95μs	3.2μs	230μs	1.2μs		8.5ms
Absorption line width	4nm	3nm		1nm	8 nm		4nm
Absorption coefficient	31.4cm^{-1} @810nm	74cm^{-1} @810nm		7.1cm^{-1} @810nm			
Intrinsic loss @1064nm	0.02cm^{-1}	0.02cm^{-1}		<0.003cm^{-1} @ 1064nm			
Gain bandwidth	0.96nm @1064nm	0.8nm @1064nm		0.6nm @1064nm	9nm @1030nm		
Polarized	π polarization; //c			unpolarized			
$d_{coe.}$	>60%	>60%		>40%			

Diffusion Bonding Crystals

These Diffusion Bonded composite crystals are used to effectively decrease heat effect of Solid-State High-Power Laser.

- High damage threshold
- Improve beam quality
- Decrease thermal effect
- Improve efficiency
- Compact size

YVO_4+Nd:YVO_4+YVO_4



YVO_4+Nd:YVO_4

YAG+Nd:YAG+YAG

Cr:YAG+Nd:YAG

Composite laser rod is a crystal consisting of two, three or more parts with different dopant level. Usually, doped and undoped material used. Dopant level and rod configuration can vary as well as the number of parts. It can have different wedged structure Brewster angles etc

Standard Specification:

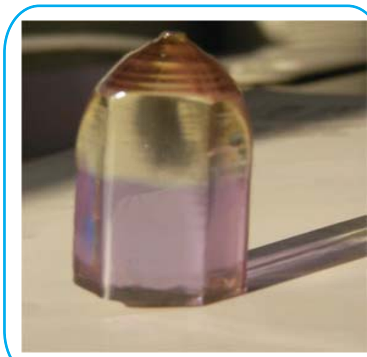
Nd:YVO_4 Doping	atm 0.2-3%
Nd:YAG Doping	0.5-1.1%
Wavefront Distortion	<λ/8 at 633nm
Orientation	±0.5deg.
Dimensional Tolerance	±0.1mm
Surface quality	10/5 Scratch/Dig per MIL-O-13830B
Flatness	λ/10 at 633nm
Clear Aperture	>Central 90%
Parallelism	<20 arc sec.
Intrinsic Loss	<0.1% cm^{-1}
Coating	AR or HR coating

Grown YVO4+Nd:YVO4 Crystals

CLaser develop the new crystal of grown YVO 4 +Nd:YVO 4 +YVO 4 or YVO 4 +Nd:YVO 4 The cw 100W 1064nm has been output from our crystals using the 885nm pumped.

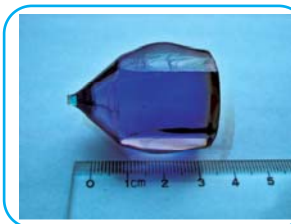
Compare with diffusion bonding crystals, the grown YVO 4 +Nd:YVO 4 crystals has following advance:

- High damage threshold.
- Better efficiency
- Less insert loss
- Improve beam quality



$Nd:YVO_4$

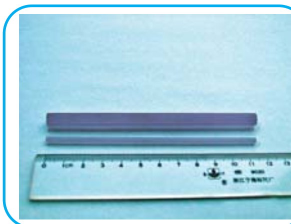
$Nd:YVO_4$ is one of the most efficient laser host crystal currently existing for diode laser-pumped solid-state lasers. $Nd:YVO_4$ is an excellent crystal for high power, stable and cost dpss laser.



- Low lasing threshold and high slope efficiency
- Large stimulated emission cross-section at lasing wavelength
- High absorption over a wide pumping wavelength bandwidth
- Optically uniaxial and large birefringence emits polarized laser

$Nd:YVO_4$ long rods

The $Nd:YVO_4$ long rods have high slope efficiency. It suitable for cw high power laser, the 70mm length $Nd:YVO_4$ rods are available.



The Sellmeier equations (λ in μm):

$n_o^2=3.77834+0.069736/(\lambda^2-0.04724)-0.0108133\lambda^2$

$n_e^2=4.59905+0.110534/(\lambda^2-0.04813)-0.0122676\lambda^2$

Laser Properties of $Nd:YVO_4$

Laser crystal	Doping (atm%)	σ ($\times 10^{-19} cm^2$)	a (cm^{-1})	t (μs)	l_a (mm)	P_{th} (mW)	h_s (%)
$Nd:YVO_4$ (a-cut)	1.0	25	31.2	90	0.32	30	52
	2.0	25	72.4	50	0.14	78	48.6
$Nd:YVO_4$ (c-cut)	1.1	7	9.2	90		231	45.5
Nd:YAG	0.85	6	7.1	230	1.41	15	38.6

Nd YVO_4's Specification:

Nd: Dopant Level	0.1-3.0 atm%
Wavefront Distortion	<λ/8 at 633nm
Orientation	±0.5deg.
Dimensional Tolerance	±0.1mm
Surface quality	10/5 Scratch/Dig per MIL-O-13830B
Flatness	λ/10 @ 633nm
Clear Aperture	>Central 90%
Parallelism	<10 arc sec.
Intrinsic Loss	<0.1% cm^{-1}

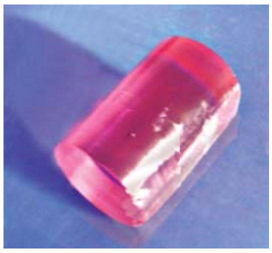
Standard Products

Doping	Dimension	Coating
2%	3x3x1mm	HR/AR Coating
1%	3x3x5mm	AR/AR Coating
0.5%	3x3x8mm	AR/AR Coating
0.2%	4x4x10mm	AR/AR Coating
0.2-1%	φ3X30-60mm	AR/AR@1064nm
0.2-1%	φ4X30-60mm	AR/AR@1064nm

AR/AR: S_1:AR@1064(R<0.1%)&532nm(R<0.5%) HT@808nm(R<5%); S_2:AR@1064&532nm

HR/AR: S_1:HR@1064(R>99.8%)&532nm(R>99%) HT@808nm(R<5%); S_2:AR@1064&532nm

Nd :YAG



Nd:YAG (Neodymium Doped Yttrium Aluminum Garnet) has been widely used laser crystal for solid-state laser. Its' laser parameters are a good compromise between the strengths and weaknesses of its competition. Nd:YAG crystals are used in all types of solid-state lasers systems-frequency-doubled continuous wave, high-energy Q-switched, etc.. Compared with others laser crystals, its fluorescence lifetime is twice more than Nd:YVO_4, and thermal conductivity is also better.

Nd:Ce:YAG is an excellent laser material used for no-water cooling and miniature laser systems. Compare with Nd:YAG, the Nd:Ce:YAG has higher absorption over a wide wavelength bandwidth, it has lower threshold, higher conversion efficiency and better beam quality. It has been used widely in military and medical laser systems.

- High Gain, Low Threshold, High Efficiency
- Low Loss at 1.06μm, High Optical Quality
- Good Mechanical and Thermal Properties
- Due to the cubic symmetry and high quality, Nd:YAG is easy to operate with TEM_{00} mode

Applications:

- Nd:YAG can produce blue laser with the frequency-doubling of 946nm
- Nd:YAG can be operated in a very high power laser up to kw level at 1064nm
- Nd:YAG can be Q-switched with Cr^{4+}:YAG directly
- Nd:YAG can be used for high power green laser for SHG@1064nm

Spectra properties with concentration

Nd-Dopant	2.5at%	2at%	1.5at%	1.3at%	1.1at%	1at%
Fluorescence lifetime	160μs	180μs	200μs	210μs	220μs	240μs
Absorption Coefficient at 800nm (cm^{-1})	7.55	6.57	5.36	4.66	3.88	3.55

Standard Products

Doping	Dimension	Coating
1% Nd	φ3X50mm	AR/AR@1064nm
1% Nd	φ4X60mm	AR/AR@1064nm
1% Nd	φ6X80mm	AR/AR@1064nm
1% Nd	φ6X100mm	AR/AR@1064nm
1% Nd	φ6X120mm	AR/AR@1064nm

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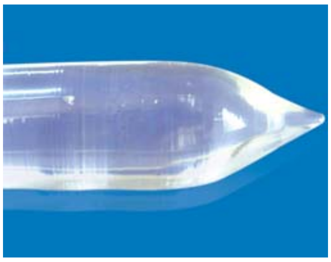
Yb:YAG

Yb:YAG is one of the most promising laser-active materials and more suitable for diode-pumping than the traditional Nd-doped systems. Compared with the commonly used Nd:YAG crystal , Yb:YAG crystal has a much larger absorption bandwidth to reduce thermal management requirements for diode lasers, a longer upper-laser level lifetime, three to four times lower thermal loading per unit pump power. Yb:YAG crystal is expected to replace Nd:YAG crystal for high power diode-pumped lasers and other potential applications.

- Very low fractional heating, less than11%
- Very high slope efficiency
- Broad absorption bands, about 8nm at 940nm
- No excited-state absorption or up-conversion at 940nm (or 970nm)
- High thermal conductivity



Er:YAG

Er:YAG is an excellent laser crystal which lasers at 2.94μm. It has wide applications in medical laser systems, and others.

- Very high slope efficiency
- Operates well at room temperature
- Operate in a relatively eye-safe wavelength range

The Sellmeier equations (λ in μm for YAG):

$n^2=2.08745+1.2081\lambda^2/(\lambda^2-0.02119)+17.2049\lambda^2/(\lambda^2-1404.45)$

Specifications Nd:YAG,Yb:YAG, Er:YAG:

Doping (atm%)	Nd:YAG: 0.5,0.7, 0.9, 1.0, 1.1, 1.3, 1.5, 2.0% Yb:YAG:10%,15%,20%,30%, Er:YAG:50%
Cut Orientation	Nd:YAG:<111>; Yb:YAG:<100>; Er:YAG<111>
Orientation Tolerance	<5°
Dimension Tolerances	Dia.: ±0.025mm , Length: ±0.5mm
Wavefront distortion	λ/8 per inch @ 633nm
Extinction Ratio	>25dB
Surface quality	10/5 Scratch/Dig per MIL-O-1380A
Parallelism	<10 arc seconds
Perpendicularity	<5 arc minutes
Flatness	<λ/10 @ 633nm
chamfer	<0.1mm @ 45deg.
Barrel Finish	50-80 micro-inch (RMS)
AR Coating	R<0.20% at center wavelength
HR Coating	R>99.8%at at center wavelength

Note: The Nd:Ce:YAG, Ho:Cr:Tm:YAG etc. are available from our company

Nd:$GdVO_4$

The Czochralski method Nd:$GdVO_4$ is a promising material for diode pumped lasers. Like Nd:YVO_4, Nd:$GdVO_4$ exhibits a larger absorption and emission cross section compared to Nd:YAG. In fact, Nd:$GdVO_4$ has a 7-times higher absorption cross section at 808nm and a 3-times larger emission cross section at 1.06μm than does Nd:YAG. Nd:$GdVO_4$ has the additional advantage over Nd:YVO_4 of a much higher thermal conductivity.

Nd:$GdVO_4$ long rods

The Nd:$GdVO_4$ long rods have high slope efficiency. It suitable for cw high power laser. The 70mm length Nd:$GdVO_4$ crystals can be available .

Index of Refraction

λ	500	630	850	1064	1300	1400	1550
n_o	2.0488	2.01685	1.99490	1.98535	1.97889	1.97683	1.97410
n_e	2.31219	2.25431	2.21482	2.19813	2.18742	2.18419	2.18009

Nd:$GdVO_4$ Specifications:

Nd: Dopant Level	1.0 atm% , 0.5% , 0.2%
Wavefront Distortion	<λ/8 at 633nm
Orientation	+/-0.5°
Dimensional Tolerance	+0.1/-0.1
Surface quality	10/5 Scratch/Dig per MIL-O-13830B
Flatness	λ/10 @ 633nm
Clear Aperture	>Central 90%
Parallelism	<10 arc sec.

HR/AR Coating:S_1: HR@1064&532nm HT@808nm S_2: AR@1064&532nm

AR/AR Coating: S_1: AR@1064nm&532nm HT@808nm S_2: AR@1064&532nm

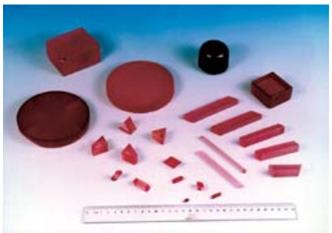
Standard Products

Doping	Dimension	Coating
1%	3x3x5mm	AR/AR Coating
0.5%	3x3x8mm	AR/AR Coating
0.2%	4x4x10mm	AR/AR Coating

Ti:Sapphire

Titanium-doped sapphire (Ti:sapphire) crystals combine supreme physical and optical properties with broadest lasing range. It's indefinitely long stability and useful lifetime added to the lasing over entire band of 660-1050nm challenge "dirty" dyes in variety of applications. Medical laser systems, lidars, laser spectroscopy, direct femtosecond pulse generation by Kerr-type mode-locking-there are few of existing and potential applications.

The absorption band of Ti:Sapphire centered at 490nm makes it suitable for variety of laser pump sources-argon ion, frequency doubled Nd:YAG and YLF, copper vapour lasers. Because of 3.2μs fluorescence lifetime Ti:Sapphire crystals can be effectively pumped by short pulse flashlamps in powerful laser systems.



CLASER have successfully produced large-sized (Dia.120x80mm) Ti:Sapphire by using the growth method of Temperature Gradient Technique (TGT). TGT is characterized by the capabilities of growing (0001) oriented sapphire with high doping level (a_{490}=7.5cm^{-1}) high gain, and high laser damage threshold.

Pulsed, quasi-cw, cw, ps and fs lasing with high efficiency have been realized using TGT grown Ti: Sapphire. It can also meet current application such as in large aperte amplifiers for high power generation and laser fusion etc.

Ti:Sapphire's specifications:

Orientation	Optical axis C normal to rod axis
Dia.	2-50mm±0.1
Length	2-100mm±0.5
Ti2O3 concentration	0.06-0.5wt%
Figure Of Merit	>250
End configurations	Flat/Flat or Brewster/Brewster ends
Flatness	λ/10 @ 633nm
Parallelism	10 arc sec
Surface finishing	10/5 scratch/dig to MIL-O-13830A
Wavefront distortion	λ/4 per inch

Note: AR Coating is available on request

Standard Products

Dimension	Brewster Cut	FOM
3x3x5mm	Brewster	>200
4x4x10mm	Brewster	>200
6x6x15mm	Brewster	>200
8x8x10mm	Brewster	>200
10x10x10mm	Brewster	>200
10x10x15mm	Brewster	>200

NLO Crystals Structural and Physical Properties

Crystals	KTP	BBO	LBO	KTA	BIBO	$LiNbO_3$	KD*P	$AgGaS_2$	RTP
Crystal stru.	Orthorhombic	Trigonal	Orthorhombic	Orthorhombic	Monoclinic	Trigonal	Tetragonal	Tetragonal	Orthorhombic
Space group	$Pna2_1$	R_{3c}	$Pna2_1$	$Pna2_1$		R_{3C}			$Pna2_1$
Point group	mm2		mm2	mm2	mm2	3m	42m	42m	Mm2
Cell para. (Å)	a=6.404 b=10.616 c=12.814 Z=8	a=b=12.532 c=12.717 Z=6	a=8.4473 b=7.3788 c=5.1395 Z=2	a=13.125 b=6.5716 c=10.786	a=7.116 b=4.993 c=6.508 Z=2	a=5.148 c=13.863		a=5.757 c=10.305	a=12.96 b=10.56 c=6.49
Melt point	1172°C	1095°C	834°C	1130°C	726°C	1253°C		997°C	~1000°C
Curie point	936°C	925 5°C		880°C		1140°C			~810°C
Hardness	≈5	4	≈6	≈5	5-5.5	≈5	2.5		~5
Density	3.01g/cm^3	3.85g/cm^3	2.47g/cm^3	3.4g/cm^3	5.033g/cm^3	4.64g/cm^3	2.355g/cm^3	4.56g/cm^3	3.6g/cm^3
Thermal expansion coe. (10^{-6}/k)		a:4 c:36	X:108 Y:-8.8 Z:3.4		X:48 Y:4.4 Z:-26.9	//a:2.0 //c:16.7	⊥z:19 //z:44	//a:28.5 //c:-18.7	a_1=10.1 a_2=13.7 a_3=-4.17
Moisture	No	A Little	A Little	No	No	No	Yes	No	No
Thermal cond. W/m/K	13	⊥c:1.2 //c:1.6	3.5	k1=1.8 k2=1.9 k3=2.1		38 at 25°C	1.9⊥z 2.1//z	1.5⊥c 1.4//c	
Therm-optic coef. (10^{-6}/°C)	X:11 Y:13 Z:16	o:-9.3 e:-16.6	X:-1.8 Y:-13.6 Z:-6.3-2.1 l			o:-0.874 e:39.073			

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NLO Crystals Optical Properties

Crystals	KTP	BBO	LBO	KTA	BIBO	$LiNbO_3$	KD*P	$AgGaS_2$	RTP
T range	350nm-4500nm	189-nm 3500nm	155nm-3200nm	350nm-5300nm	286nm-2500nm	420nm-5200nm	200nm-1600nm	0.5μm-12μm	350nm-4500nm
SHG range	1000nm-1800nm	409nm-3400nm	554nm-2600nm	1075nm-1134nm	574nm-2480nm	1060nm-3700nm	532nm-1498nm	1800nm-11.3μm	1038nm-3100nm
Deff. (pm/V)	$d_{31}=6.5$ $d_{32}=5$ $d_{33}=13.7$ $d_{24}=7.6$ $d_{15}=6.1$	$d_{11}=2.2$ $d_{31}=0.08$ $d_{22}<0.05xd_{11}$	$d_{31}=1.05$ $d_{32}=-0.98$ $d_{33}=0.05$	$d_{15}=2.3$ $d_{24}=3.2$ $d_{31}=2.8$ $d_{32}=4.2$ $d_{33}=16.2$	$d_{12}=d_{14}=2.3$ $d_{25}=d_{36}=2.4$ $d_{11}=2.53$ $d_{13}=-1.3$ $d_{35}=-0.9$ $d_{26}=2.8$	$d_{33}=34.4$ $d_{31}=d_{15}=5.95$ $d_{22}=3.07$	$d_{36}=0.40$	$d_{36}=13$	$d_{15}=2.0$ $d_{24}=3.6$ $d_{33}=8.3$
E-O coeff. (pm/V)	$\gamma_{13}=9.5$ $\gamma_{23}=15.7$ $\gamma_{33}=36.3$ $\gamma_{42}=7.3$ $\gamma_{51}=9.3$	$\gamma_{11}=2.7$ $\gamma_{22}, \gamma_{31}<0.1\gamma_{11}$		$\gamma_{13}=11.5$ $\gamma_{23}=15.4$ $\gamma_{33}=37.5$		$\gamma^{T}_{33}=32$ $\gamma^{T}_{31}=10$ $\gamma^{S}_{31}=8.6$ $\gamma^{T}_{22}=6.8$ $\gamma^{S}_{22}=3.4$	$\gamma_{41}=8.8p$ $\gamma_{63}=25p$		$\gamma_{13}=10.6$ $\gamma_{23}=12.5$ $\gamma_{33}=38.5$
Ab.coef. @1064	α<50ppm	α<1000ppm	α<50ppm	α<1000ppm	α<1000ppm	α<1000ppm	α<1000ppm	<0.09/cm	α<500ppm
n 1064nm	$n_x=1.7377$ $n_y=1.7453$ $n_z=1.8297$	$n_e=1.5425$ $n_o=1.6551$	$n_x=1.5656$ $n_y=1.5905$ $n_z=1.6055$	$n_x=1.782$ $n_y=1.790$ $n_z=1.868$	$n_1=1.9166$ $n_1=1.9166$ $n_3=1.7835$	$n_e=2.156$ $n_o=2.232$	$n_o=1.4948$ $n_e=1.4554$	$n_o=2.4508$ $n_e=2.3966$	$n_x=1.7424$ $n_y=1.8211$ $n_z=1.7905$
DT (10ns)	$8J/cm^2$ 1064nm	$13J/cm^2$ 1064nm	$25J/cm^2$ 1064nm	$8J/cm^2$ 1064nm	$3J/cm^2$ 1064nm	$2J/cm^2$ 1064nm	$10J/cm^2$ 1064nm	$5J/cm^2$ @10.6μm	$8J/cm^2$ 1064nm

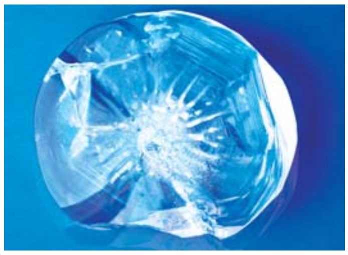
Effective nonlinearity expressions

KTP	$d_{eff}(II)\approx(d_{24}-d_{15})\sin2\varphi\sin2\theta-(d_{15}\sin^2\varphi+d_{24}\cos^2\varphi)\sin\theta$	BBO	$d_{ooe}=d_{31}\sin\theta+(d_{11}\cos3\varphi-d_{22}\sin3\varphi)\cos\theta$ $d_{eoe}=(d_{11}\sin3\varphi+d_{22}\cos3\varphi)\cos^2\theta$
LBO	$d_{ooe}=d_{32}\cos f$ (in XY plane) $d_{oeo}=d_{31}\cos q$ (in YZ plane)	KTA	$d_{eff}(II)\approx(d_{24}-d_{15})\sin2\varphi\sin2\theta-(d_{15}\sin2\varphi+d_{24}\cos^2\varphi)\sin\theta$
$LiNbO_3$	$d_{ooe}=d_{31}\sin\theta-d_{22}\cos\theta$ $d_{eoe}=d_{22}\cos3\varphi\cos^2\theta$	KD*P	$d_{ooe}=d_{36}\sin\theta\sin2\varphi$ $d_{eoe}=d_{36}\sin2\theta\cos2\varphi$
$AgGaS_2$	$d_{ooe}=d_{36}\sin\theta\sin2\varphi$ $d_{eoe}=d_{36}\sin2\theta\cos2\varphi$	RTP	$d_{eff}(II)\approx(d_{24}-d_{15})\sin2\varphi\sin2\theta-(d_{15}\sin^2\varphi+d_{24}\cos^2\varphi)\sin\theta$

BBO

Beta-barium borate (BBO) is grown with the flux method. It is a negative uniaxial crystal, with ordinary refractive-index (n_o) larger than extraordinary refractive-index (n_e). BBO has the following exceptional properties that make it a very important nonlinear crystal.

- SHG phase-matching range from 410nm to 2100nm
- Large effective nonlinear coefficient
- High damage threshold ;
- Wide temperature-bandwidth of about 55°C.



The Sellmeier equations (λ in μm):

$n_o^2=2.7359+0.01878/(\lambda^2-0.01822)-0.01354\lambda^2$

$n_e^2=2.3753+0.01224/(\lambda^2-0.01667)-0.01516\lambda^2$

Application

BBO is of particular importance in the visible and far UV. A wide variety of phase-matching applications are possible, including the following:

- Second, third, fourth and fifth harmonic generation of Nd doping lasers
- Frequency-doubling, -tripling and -mixing of Dye lasers
- Second, third and fourth harmonic generation of Ti:Sapphire lasers
- Optical parametric amplifier (OPA) and optical parametric oscillators (OPO)

BBO Specifications:

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	P-Coating

Note:

1. BBO has a low susceptibility to the moisture. The user is advised to provide dry conditions for both the use and preservation of BBO.
2. BBO is relatively soft and therefore requires precautions to protect its polished surfaces.
3. When angle adjusting is necessary, keep in mind that the acceptance angle of BBO is small.

Standard Product

Dimension	Application	Coating	Type
3x3x5mm	S(T)HG@1064nm	AR coating	I
4x4x10mm	S(T)HG@1064nm	AR coating	I
5x5x1mm	S(T)HG@800nm	P-Coating	I
5x5x0.1mm	S(T)HG@800nm	P-coating	I
8x6x15mm	OPO	P-coating@355	I

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LBO

LBO is grown with the flux method. It is a negative biaxial crystal, with the principal axes X, Y, and Z (nz>ny>nx) parallel to the crystallographic axes a, c, and b, respectively.

Lithium triborate (LiB3O5 or LBO) has the following exceptional properties that make it a very important nonlinear crystal:

- Broad transparency range from 160nm to 2600nm;
- Reatively large effective SHG coefficient ;
- high damage threshold;
- wide acceptance angle and small walk-off;
- type I and type II non-critical phase matching (NCPM) in a wide wavelength range;

The Sellmeier equations (λ in μm):

$$n^2_x=2.454140+0.011249/(\lambda^2-0.011350)-0.014591\lambda^2-6.60\times10^{-5}\lambda^4$$
$$n^2_y=2.539070+0.012711/(\lambda^2-0.012523)-0.018540\lambda^2+2.00\times10^{-4}\lambda^4$$
$$n^2_z=2.586179+0.013099/(\lambda^2-0.011893)-0.017968\lambda^2-2.26\times10^{-4}\lambda^4$$

LBO has the highest damage threshold in all the commonly-used inorganic NLO crystals. Therefore, it is the best candidate for high average power SHG and other nonlinear optical processes.

Damage Threshold at 1053nm

Crystals	Energy Density (J/cm^2)	Power Density (GW/cm^2)	Ratio
KTP	6.0	4.6	1.00
KDP	10.9	8.4	1.83
BBO	12.9	9.9	2.15
LBO	24.6	19.9	4.10

Application:

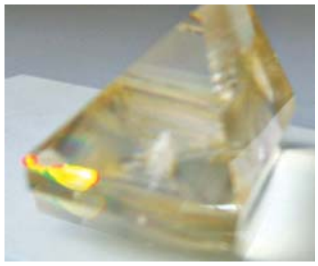
- SHG and THG for middle and high power Nd: lasers at 1064nm
- NCPM SHG over a broad wavelength range from 900nm-1700nm was measured.
- Optical Parametric Amplifiers (OPA) and Oscillators (OPO) application
- Other wavelength Laser SHG application

LBO's Specification:

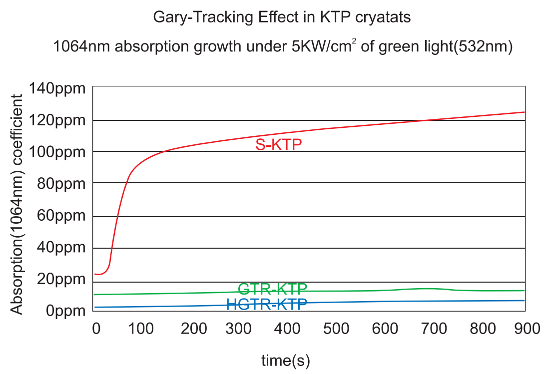
Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	AR@1064nm(R<0.1%)&532nm(R<0.4%)

GTR—KTP

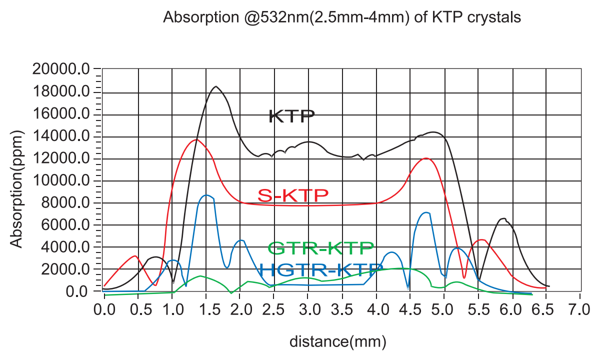
Gray Track Resistance Potassium Titanyl Phosphate (GTR-KTP) is the improved KTP. It has following advance compare with normal KTP crystals.



- High damage threshold
- Without gary-track in high power cw intracavity application
- Lower absorption in 532nm
- Better inside Quality



GTR test



532nm Absorption

Application:

GTR KTP is specially developed for high power cw green laser application. It has not appear the gray track for higher power cw green laser than normal KTP crystals. It is ideal for high power of 1W-5W cw green laser application.

GTR-KTP Specifications:

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	R<0.1% at 1064nm and R<0.4% at 532nm
Optical damage threshold	5W, cw, 532nm, Dia.0.2mm, Intracavity

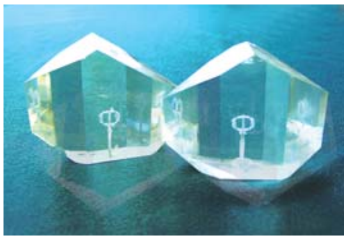
Standard Products

Crystals	Dimension	Application	Coating	Type
GTRKTP	3x3x5mm	SHG@1064nm	DBAR-coating	II
GTRKTP	4x4x5mm	SHG@1064nm	DBAR-coating	II
GTRKTP	3x3x10mm	SHG@1064nm	DBAR-coating	II
GTRKTP	5x5x7mm	SHG@1064nm	DBAR-coating	II

S—KTP

Super Potassium Titanyl Phosphate (S-KTP) is a positive biaxial crystal, with the principal axes X, Y, and Z ($n_z>n_y>n_x$) parallel to the crystallographic axes a, b, and c, respectively.

- Large nonlinear optical coefficient
- Wide angular bandwidth and small walk-off angle
- Broad temperature and spectral bandwidth
- High thermal conductivity



The Sellmeier equations (λ in μm):

$n_x^2=3.0065+0.03901/(\lambda^2-0.04251)-0.01327\lambda^2$

$n_y^2=3.0333+0.04154/(\lambda^2-0.04547)-0.01408\lambda^2$

$n_z^2=3.0065+0.05694/(\lambda^2-0.05658)-0.01682\lambda^2$

KTP for SHG of Nd:lasers

KTP is the most commonly used material for frequency doubling of Nd:YAG lasers and other Nd-doped lasers, particularly at the low or medium power density.

KTP for OPO

As an efficient OPO crystal pumped by the fundamental and second harmonics of a Nd:YAG or Nd:YLF laser, KTP plays an important role in parametric sources for tunable output from visible (0.6μm) to mid-IR (4.5μm). NCPM KTP OPO pumped by 1064nm, the signal output is around eye safe wavelength, find applications in eye-safe devices. The NCPM KTP OPO keeps the KTP crystal fixed in X-axis and tunes the pumping wavelength. If 1064nm pumping source, the output will be at 1.57μm (signal) and 3.3 μm (idler).

GTR-KTP Specifications:

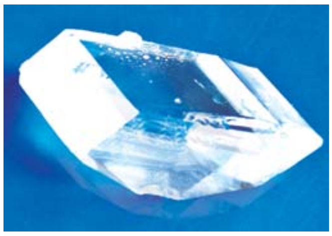
Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	R<0.1% at 1064nm and R<0.4% at 532nm
Optical damage threshold	500MW/cm^2 (@1.064μm, 10ns, 10Hz)

Standard Products

Crystals	Dimension	Application	Coating	Type
S-KTP	3x3x5mm	SHG@1064nm	DBAR-coating	II
S-KTP	3x3x10mm	SHG@1064nm	DBAR-coating	II
S-KTP	7x7x7mm	SHG@1064nm	DBAR-coating	II
S-KTP	8x8x8mm	SHG@1064nm	DBAR-coating	II
S-KTP	4x4x25mm	OPO for 1064-->1570nm	AR coating	II
S-KTP	8x8x20mm	OPO for 1064-->1570nm	AR coating	II

BIBO

BIBO (BiB_3O_6) is a newly developed Nonlinear Optical Crystal. It has advanced characteristic for the NLO application, compare with BBO and LBO crystals, the high reflection coating is available, it make the BIBO crystals can be used for more compact laser application.



- large effective SHG coefficient
- Wide SHG wavelength range 574-2480nm
- Inertness with respect to moisture

The Sellmeier equations(λ in μm):

$n_1^2=3.6545+0.0511/(\lambda^2-0.0371)-0.0226\lambda^2$

$n_2^2=3.0740+0.0323/(\lambda^2-0.0316)-0.01337\lambda^2$

$n_3^2=3.1685+0.0373/(\lambda^2-0.0346)-0.01750\lambda^2$

BIBO's applications:

- SHG for middle and high power Nd: lasers at 1064nm
- SHG for the Nd: Lasers at 914nm & 946nm for blue laser
- Optical Parametric Amplifiers (OPA) and Oscillators (OPO) application

Nonlinear Optical Properties Compare (SHG@946nm)

Crystals	Length (mm)	D_{eff} (pm/V)	Walk-off (mrad)	Output Power (W)	Co. Eff.
BIBO	10.4	3.3	40.7	2.8	63%
LBO	10	0.81	11.3	1.52	33%
BBO	8	2.0	60.3	2.1	47%

BIBO's Specification:

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	AR@1064nm(R<0.1%)&532nm(R<0.4%)

LiNbO3

Lithium niobate is a ferroelectric material suitable for a variety of applications. Its versatility is made possible by the excellent electro-optic, nonlinear, and piezoelectric properties of the intrinsic material.

- Laser Dimension
- Broad spectral transmission ranges from 0.4μm to 5.0μm with an OH-absorption at 2.87μm
- No moisture

Application:

Optical parametric oscillation, difference frequency mixing to generate tunable infrared wavelengths, and second harmonic generation..

Lithium niobate is particularly effective for second harmonic generation of low power laser diodes in the 1.3 to 1.55μm range.,

For infrared generation by difference frequency mixing, the peak power limit is considerably lower than for 1.064μm, being about $40MW/cm^2$

The Sellmeier equations (λ in μm):

$n_o^2=4.9048+0.11768/(\lambda^2-0.04750)-0.027169\lambda^2$

$n_e^2=4.5820+0.099169/(\lambda^2-0.04443)-0.021950\lambda^2$

The Fe:$LiNbO_3$ and MgO:$LiNbO_3$ crystals is available too. The MgO: $LiNbO_3$ has similar effective nonlinear coefficients to pure $LiNbO_3$. Its Sellmeier equations (for MgO dopant 7 mol%) are:

$n_o^2=4.8762+0.11554/(\lambda^2-0.04674)-0.033119\lambda^2$

$n_e^2=4.5469+0.094779/(\lambda^2-0.04439)-0.026721\lambda^2$

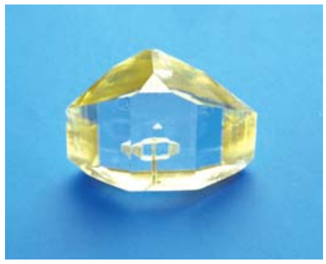
$LiNbO_3$'s Specifications:

Material	Laser grade $LiNbO_3$
Orientation	±0.5°
Dimensional Tolerance	±0.1mm
Surface quality	20/10 Scratch/Dig per MIL-O-13830B
Flatness	λ/8 at 633nm
Perpendicularity	5 arc min
Parallelism	better than 20 arc sec
Clear Aperture	>Central 90%
AR Coating	AR coating with R<0.2% at center wavelength

KTA

KTA crystal is an excellent nonlinear optical crystal for Optical Parametric Oscillation (OPO) application. KTA's OPO devices are reliable, solid state sources of tunable laser radiation exhibiting energy conversion efficiencies above 50%.

In comparison to KTP, KTA crystals feature large non-linear optical coefficient and electro-optical coefficient and have significantly reduced absorption in the 2.0-5.0μm range.



- Large nonlinear optical and electro-optical coefficients
- Broad temperature and spectral bandwidth
- Low dielectric constants, loss tangent and ionic conductivities
- High damage threshold
- Lower absorption and high transmission in the 3-4μm than KTP

The Sellmeier equations (λ in μm):

$n_x^2=1.90713+1.23522\lambda^2/(\lambda^2-0.19692^2)-0.01025\lambda^2$

$n_y^2=2.15912+1.00099\lambda^2/(\lambda^2-0.21844^2)-0.01096\lambda^2$

$n_z^2=2.14768+1.29559\lambda^2/(\lambda^2-0.22719^2)-0.01436\lambda^2$

Application:

- An excellent NLO crystal developed mainly for Optical Parametric Oscillation (OPO)
- Frequency Doubling (SHG @1083nm-3789nm)
- Sum and Difference Frequency Generation (SFG)/(DFG)
- NCPM cut 1064--->1533+3475 (type I Theta=90deg., phi=0deg.)

KTA's Specification

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	AR@1064nm

DKDP

Potassium Dideuterium Phosphate (KD*P)and Potassium Dihydrogen Phosphate (KDP) are among the most widely-used commercial NLO materials. They are commonly used for doubling, tripling and quadrupling of Nd:YAG laser at the room temperature.

- Good UV transmission
- High optical damage threshold
- High birefringence

The Sellmeier equations (λ in μm):

$n_o^2=1.9575544+0.2901391/(\lambda^2-0.0281399)-0.02824391\lambda^2$

$n_e^2=1.5005779+0.6276034/(\lambda^2-0.0131558)-0.01054063\lambda^2$

Application:

- Second, third, and fourth harmonic generation of Nd:lasers
- Frequency doubling of dyer laser
- High power laser frequency conversion materials

KD*P Single Crystals Application			
Designation	Operation	Input	Output
53.7°	SHG (II)	1064nm	532nm
59.5°	THG (II)	1064nm+532nm	355nm
86°	FHG (I) angle tune	532nm	266nm
90°	FHG (I) temp. tune	532nm	266nm

KD*P Specifications

Wavefront distortion	less than λ/8 @633nm
Dimension tolerance	0.1mm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
Scratch/Dig code	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	5 arc minutes
Angle tolerance	Δθ<±0.3°, ΔΦ<±0.3°

Note:

KDP, KD*P is highly hygroscopic and the coating can not be available. Please keep it in a dry environment, and sealed housing is recommended.

$AgGaS_2$

$AgGaSe_2$, $AgGaS_2$ are nonlinear optical crystals, which have gained tremendous interest for the middle and deep infrared applications due to their unique features. The crystals have large effective optical nonlinearity, wide spectral and angular acceptance, broad transparency range, noncritical requirements for temperature stabilization and vibration control, are well mechanically processed. AgGaSe's useful transmission ranges lying within 0.9-16μm and wide phase matchability provides excellent potential for OPO applications when pumped by variety of currently available lasers. $AgGaS_2$ high short wavelength transparency edging at 550nm has been used in OPO_s pumped by Nd:YAG laser; in numerous difference frequency mixing experiments using diode, Ti:Sapphire, Nd:YAG and IR dye lasers covering 3-12μm range; direct infrared countermeasure systems, and SHG of CO_2 laser.

Basic Properties:

		$AgGaSe_2$	$AgGaS_2$			$AgGaSe_2$	$AgGaS_2$
Crystal Symmetry		Tetragonal	Tetragonal	Optical transmission, μm		0.73-18	0.5-12
Point Group		42m	42m	Indices of refraction at			
Lattice Constants	a	5.9901	5.757	1.06μm	n_o	2.7005	2.4508
	c	10.8823	10.305		n_e	2.6759	2.3966
Density:g/cm^3		5.71	4.56	5.3μm	n_o	2.6140	2.5823
Laser damage threshold					n_e	2.5823	2.3421
25MW/cm^2 at 50ns 2.05μm		25MW/cm^2 at 20ns 1.06μm		10.6μm	n_o	2.5915	2.5915
					n_e	2.5915	2.5915
Nonlinearity pm/V		43	31				
SHG at 10.6μm		55°	67°	Absorption Coefficient cm^{-1} at	1.06μm	<0.02[9]	<0.02
Walk-off angle at 5.3μm		0.67°	0.85°		2.5μm	<0.01	0.01
Melting point °C		851	998		5.0μm	<0.01	0.01
Thermal Expansion Coe. 10^{-6}/°K	⊥	23.4	12.5		7.5μm	-//-	0.02
	II	23.4	-13.2		10.0μm	-//-	<0.6

Sellmeier equations	
$AgGaSe_2$	$n_o^2=6.8507+0.4297/(\lambda^2-0.15840)-0.00125\lambda^2$
	$n_e^2= 6.6792+0.4598/(\lambda^2-0.21220)-0.00126\lambda^2$
$AgGaS_2$	$n_o^2=3.3970+2.3982/(1-0.09311/\lambda^2)+2.1640/(1-950.0/\lambda^2)$
	$n_e^2=3.5873+1.9533/(1-0.11066/\lambda^2)+2.3391/(1-1030.7/\lambda^2)$

Specification:

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	AR@1064nm

Cr:YAG

Cr^{4+}:YAG ($Y_3Al_5O_{12}$) is an ideal material for passive Q-switching of Nd:YAG and other Nd or Yb doped lasers in the wavelength range of 0.8 to 1.2μm. One of the remarkable features of Cr4+:YAG is high damage threshold of 500-1000MW/cm^2. Passive Q-Switching is preferred for simplicity of manufacturing and operation, low cost and reduced system size and weight.

The preliminary experiments of Cr:YAG showed that the pulse width of passively Q-switched lasers could be as short as 9 ns for diode pumped Nd:YAG lasers and repetition as high as 10kHz for diode pumped Nd:YVO_4 lasers. Furthermore, an efficient green output @ 532nm, and UV output @ 355nm and 266nm were generated, after a subsequent intracavity SHG in KTP or LBO, THG and 4HG in LBO and BBO for diode pumped and passive Q-switched Nd:YAG and Nd:YVO_4 lasers.

Specifications:

Orientation	<100>or<111>crystalline direction
Wavefront distortion	λ/8 per inch @633nm
Surface quality	10/5 Scratch / Digper MIL-O-1380A
Parallelism	<10 arc seconds
Perpendicularity	<5 arc minutes
Clear Aperture	>90%
Transmission Tolerance	±3%
Flatness	<λ/10 @633nm
Anti-Reflection Coating	R<0.20% @1064nm per surface

Standard Products

Dia.	T	Coating
6mm	T=10-90%	AR/AR@1064nm
8mm	T=10-90%	AR/AR@1064nm
10mm	T=10-90%	AR/AR@1064nm
12mm	T=10-90%	AR/AR@1064nm

Note:
When ordering Cr^{4+}:YAG crystal, please specify the aperture, initial transmission(To) and coatings.

Electric-Optical Crystals Structural and Physical Properties

Crystals	KD*P	BBO	$LiNbO_3$	RTP
Crystal structure	Tetragonal	Trigonal	Trigonal	Orthorhombic
space group	42m	$R3c$	$R3c$	$Pna2_1$
point group			3m	Mm2
Cell parameters		a=b=12.532Å c=12.717Å Z=6	a=5.148Å c=13.863Å	a=12.96Å b=10.56Å c=6.49Å
Melting point		1095±5°C	1253°C	~1000°C
Curie point		925±5°C	1140°C	~810°C
Hardness	2.5	4	≈5	~5
Density	2.355g/cm^3	3.85g/cm^3	4.64g/cm^3	3.6g/cm^3
Thermal expansion coef. (10^{-6}/K)	⊥z:19 //z:44	a:4 c:36	//a:2.0 //c:16.7	a_1=10.1 a_2=13.7 a_3=-4.17
Hygroscopic susceptibility	Yes	A Little	NO	NO
Thermal cond. W/m/K	⊥z:1.9 //z:2.1	⊥c:1.2 //c:1.6	38 at 25°C	
Therm-optic coef. (10^{-6}/k)		dn_o/dT=-9.3 dn_e/dT=-16.6	dn_o/dT=-0.87 dn_e/dT=39.07	

Electric-Optical Crystals Optical Properties

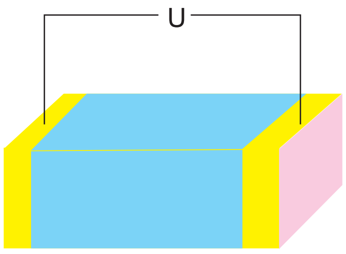
Crystals	KD*P	BBO	$LiNbO_3$	RTP
V_π4x4x20mm	~3400V	~4800V	~950V	~1400V
Contrast Ratio	30dB	40dB	25dB	20dB
Capacitance	7~10pF	<2pF	20pF	6pF
Electrical Resistivity	10^9-10^{10}W.cm	10^{12}-10^{13}W.cm	10^9-10^{10}W.cm	10^{11}-10^{12}W.cm
Transmitting range	200nm-1600nm	189nm-3500nm	420nm-5200nm	350nm-4500nm
Electro-optic coefficients	γ_{41}=8.8pm/V γ_{63}=25pm/V	γ_{11}=2.7pm/V γ_{22}, γ_{31}<0.1γ_{11}	γ^T_{33}=32pm/V γ^S_{33}=31pm/V γ^T_{31}=10pm/V γ^S_{31}=8.6pm/V γ^T_{22}=6.8pm/V γ^S_{22}=3.4pm/V	γ_{13}=10.6pm/V γ_{23}=12.5pm/V γ_{33}=38.5pm/V
Ab.coef. @1064nm	α<1000ppm	α<1000ppm	α<1000ppm	α<500ppm
Index @1064nm	n_o=1.4948 n_e=1.4554	n_e=1.5425 n_o=1.6551	n_e=2.156 n_o=2.232	n_x=1.7424 n_y=1.8211 n_z=1.7905
DT (10ns):1064nm	10J/cm^2	13J/cm^2	2J/cm^2	8J/cm^2

Electric-Optical Crystals

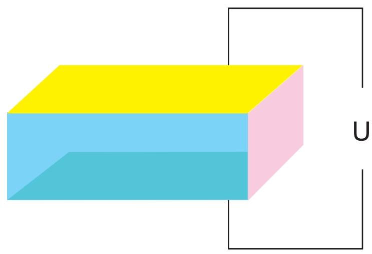
Electro-optic Pockels cells are used in applications that require fast switching of the polarization direction of a beam of light. These uses include Q-switching of laser cavities, coupling light into and out from regenerative amplifiers, and, when used in conjunction with a pair of polarizers, light intensity modulation. Pockels cells are characterized by fast response, since the Pockels Effect is largely an electronic effect that produces a linear change in refractive index when an electric field is applied, and are much faster in response than devices based on acoustic changes in a material, for example.

When an electric field (E) is applied to an electro-optic (E-O) crystal, the refractive index of E-O crystal will change linearly to electric field. The phenomenon is called linear electro-optic effect. For KD*P crystal, for example, the change of the refractive index (Δn) is $\Delta n=0.5n^3_o r_{63}E$ if both the directions of light propagation and electric field are along the z-axis, where n_o is refractive index without electric field and r_{63} is electro-optic coefficient of KD*P.

If a linearly polarized light passes through an E-O crystal, the phase retardation (Γ) will be induced by Δn to $\Gamma=2\pi\Delta nL$ where L is crystal length, for KD*P, again as an example, $\Gamma=\pi Ln^3_o r_{63}E/\lambda$. It is clear that the phase of light will change together with electric field (E). This is called electro-optic phase modulation. If two crossed polarizers are placed at input and output ends of E-O crystal separately, the output intensity of light will be $I=I_o\sin^2(\Gamma/2)$, where I_o is input intensity. That means the intensity or amplitude of light can also be modulated by electric field. This is called amplitude modulation.



longitudinal E-O modulation



transverse E-O modulation

There are two kinds of E-O modulations. One is longitudinal E-O modulation if the directions of electric field and light propagation are the same. The KDP isomorphic crystals are normally used in this scheme. If the directions of electric field and light propagation are perpendicular, it is called transverse E-O modulation. The $LiNbO_3$, BBO and KTP crystals are usually employed in this scheme.

The half-wave voltage (V_π) is defined as the voltage at $\Gamma=\pi$, for example, $V_\pi=\lambda/(2n_o^3 r_{63})$ for KD*P and $V_\pi=\lambda d/(2n_o^3 r_{22}L)$ for $LiNbO_3$, where λ is light wavelength and d is the distance between the electrodes.

BBO

BBO is the electro-optic material of choice for high average power Pockels cell applications at the wavelength range from 200nm to 2500nm. BBO has a high damage threshold and a low dielectric constant and is useful in high repetition rate, high average power (up to 150W) diode pumped solid state lasers (DPSS lasers). BBO has significant advantages over other materials in terms of laser power handling abilities, temperature stability, and substantial freedom from piezoelectric ringing. Because it relies on the electro optic effect, switching time — aided by the low capacitance of the Pockels cell — is very fast. The wide transparency range of BBO allows it to be used in diverse applications.

Because of crystal symmetry and the desire for the light beam to experience no birefringence in the absence of an electric field, BBO Pockels cells are transverse-field devices. It has electro-optic coefficients γ_{11}=2.7pm/V and γ_{22}, γ_{31}<0.1γ_{11}. It can be used for Q-Switching a cw diode pumped Nd:YAG laser with average power>50W.

- Applications at high repetition rate
- High Damage Threshold
- High Extinction and Contrast Ratio

The Sellmeier equations(λ in μm):

$n_o^2=2.7359+0.01878/(\lambda^2-0.01822)-0.01354\lambda^2$

$n_e^2=2.3753+0.01224/(\lambda^2-0.01617)-0.01354\lambda^2$

BBO Specifications:

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	AR@1064nm and Au coating in sides

Standard Products

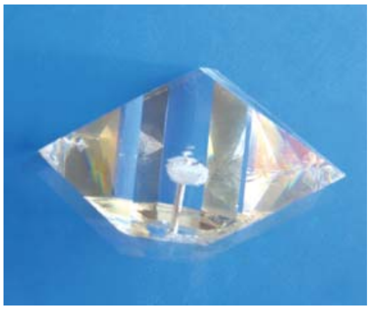
Crystals	Cut	Application	Dimension	Coating	X-Side coating
BBO	Z-Cut	Pockel Cell	3x3x20mm	AR@1064nm	Au coating
BBO	Z-cut	Pockel Cell	4x4x20mm	AR@1064nm	Au coating
BBO	Z-cut	Pockel Cell	4x4x25mm	AR@1064nm	Au coating
BBO	Z-cut	Pockel Cell	6x6x20mm	AR@1064nm	Au coating

RTP

The RTP is an isomorph of KTP. However, it has higher damage threshold, higher resistivity, and no sign of electro- chromism. These are biaxial crystals and natural birefringence needs to be compensated by use of two crystal rods specially oriented so that beam passes along the X-direction. The Q-switch is built using two RTP elements in a temperature compensating design. Input beam is polarized along the diagonal of the input face and Z and Y axis are perpendicular to the two side faces. Y and Z faces are rotated by 90° in the second crystal for thermal compensation. The 'o' ray in the first crystal becomes the 'e' ray in the second crystal and vice versa, so that the thermal birefringence is compensated. Matched pairs (equal lengths polished together) are required for effective compensation.

The effective E-O constant r_{c1} (light propagating along the Y axis) is 23.6pm/V and E-O constant r_{c2} (light propagating along the X axis) is 20.3pm/V. The contrast ratio is better for r_{c2} constant. At repetition rates of 50KHz, the noise due to piezo-electric ringing is less than 3% while that in BBO it is 10% when operated at 30KHz.

- Applications at high repetition rate
- High Damage Threshold
- No Piezoelectric Ringing
- Thermal Compensating Design
- Non-hygroscopic
- Not induce piezo-electric effect



The Sellmeier equations (λ in μm):

$n_x^2=2.15559+70339.0\lambda^2/(\lambda^2-0.209942)-0.01452\lambda^2$

$n_y^2=2.38494+0.73603\lambda^2/(\lambda^2-0.238912)-0.01583\lambda^2$

$n_z^2=2.27723+1.11030\lambda^2/(\lambda^2-0.234542)-0.01995\lambda^2$

RTP Specifications:

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	AR@1064nm and Au coating in sides

Standard Products

Crystals	Cut	Application	Dimension	Coating	Z-Side coating
RTP	Y-cut	Pockel Cell	3x3x10mm (pairs)	AR@1064nm	Au coating
RTP	Y-cut	Pockel Cell	4x4x12mm (pairs)	AR@1064nm	Au coating
RTP	Y-cut	Pockel Cell	4x4x20mm (pairs)	AR@1064nm	Au coating
RTP	Y-cut	Pockel Cell	6x6x20mm (pairs)	AR@1064nm	Au coating

DKDP

KD*P crystal is widely applied for electro-optic application as Q-switch and Pockels cells. KD*P is routinely used for Q-switching applications from the uv out to about 1.1μm where absorption limits its use in active cavities, although it can be useful at longer wavelengths when a few percent of absorption can be tolerated. KD*P has high optical uniformity and is useful for large aperture applications.

The device of longitudinal Pockels' cell using crystal of >98% deuterated DKDP is normally used for Q-switch of laser radiation. These Pockels' cells are manufactured from the crystals that have been specially selected for their low optical loss and strain free property. The crystal is in the form of a cylinder and two silver ring electrodes are used to produce the longitudinal electric field.

- High Damage Threshold
- High Extinction and Contrast Ratio
- Low cost

The Sellmeier equations (λ in μm):

$n_o^2=1.9575544+0.2901391/(\lambda^2-0.0281399)-0.02824391\lambda^2$

$n_e^2=1.5005779+0.6276034/(\lambda^2-0.0131558)-0.01054063\lambda^2$

Standard Specifications:

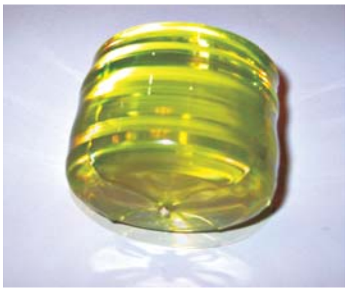
Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	Uncoated

Standard Products

Crystals	Cut	Application	Dimension	Coating
DKDP	Z-cut	Pockel Cell	10x10x20mm	Uncoated
DKDP	Z-cut	Pockel Cell	13x13x20mm	Uncoated
DKDP	Z-cut	Pockel Cell	17x17x20mm	Uncoated
DKDP	Z-cut	Pockel Cell	20x20x30mm	Uncoated

$LiNbO_3$

Crystal Lithium Niobate ($LiNbO_3$) has higher transmission, and high contrast ratio at average powers in the KW range. Applications that utilize the large electro-optic coefficients of lithium niobate are optical modulation and Q-switching of infrared wavelengths. Because the crystal is nonhygroscopic and has a low half-wave voltage, it is often the material of choice for Q-switches in military applications. The crystal can be operated in a Q-switch configuration with zero residual birefringence and with an electric field that is transverse to the direction of light propagation. Because piezoelectric ringing can be severe, piezo-electrically damped designs can be very useful. The light propagates in z-axis and electric field applies to x-axis, the refractive retardation will be $\Gamma=\pi L n r_{22} \lambda d$.



- Low cost
- Low Half-Voltage
- High Extinction and Contrast Ratio

The Sellmeier equations (λ in μm):

$n_o^2=4.9048+0.11768/(\lambda^2-0.04750)-0.027169\lambda^2$

$n_e^2=4.5820+0.099169/(\lambda^2-0.04443)-0.027169\lambda^2$

$LiNbO_3$ Specifications:

Dimension tolerance	±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
S/D	10/5 to MIL-O-13830A
Parallelism	better than 20 arc seconds
Perpendicularity	12 arc minutes
Angle tolerance	Δθ<±0.2°, Δφ<±0.2°
AR coating	AR@1064nm and Au coating in sides

Standard Products

Crystals	Cut	Application	Dimension	Coating	X-Side coating
$LiNbO_3$	Z-Cut	Pockel Cell	9x9x25mm	AR@1064nm	Au coating

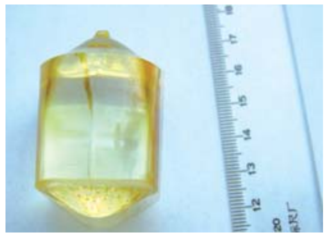
Q-Switch Crystals

Optical Crystals Structural and Physical Properties

Crystals	YVO_4	α-BBO	Calcite	$LiNbO_3$	YAG	Sapphire	MgF_2	CaF_2
Crystal structure	Zircon Tetragonal	Trigonal	Rhombihedral	Trigonal	Cubic	Hexagonal		
space group	D_{4h}-I4/amd	R_{3c}		R_{3c}	12.01			
Cell Para. (Å)	a=b=7.1193 c=6.2892	a=b=12.532 c=12.717 Z=6		a=5.148 c=13.863		a=4.785 c=12.991	a=4.621 c=3.053	
Melting point	1825	1095±5°C		1253°C	1970°C	2042°C	1255°C	1418°C
Hardness	4-5	4	3	≈5	8.5	9	6	840
Density	4.22g/cm³	3.85g/cm³	2.7g/cm³	4.64g/cm³	4.5g/cm³	3.98g/cm³	3.18g/cm³	3.18g/cm³
Thermal Exp. coe. (10^{-6}/K)	a:4.43 c:11.37	a:4 c:36	a:24.39 c:5.68	//a:2.0 //c:16.7	7.8	5.8	a:13.7 c:8.48	16.2
Thermal cond. W/m/K	//c:5.23 ⊥c:5.10	⊥c:1.2 //c:1.6		38 at 25°C	15	25.12 (@100°C)	7.5	9.17
Therm-optcoe. (10^{-6}/K)	dn_e/dT=2.9	dn_o/dT =-9.3 dn_e/dT=-16.6		dn_o/dT=-0.87 $dn_e dT$=39.0	7.3	13		
Transparency Range	400nm-5000nm	189nm-3500nm	350nm-2300nm	420nm-5200nm	250nm-5000nm	150nm-5500nm	120nm-8500nm	150nm-9μm

YVO_4

The yttrium orthvanadate (YVO_4) is a positive uniaxial crystal grown with Czochralski method. It has good temperature stability and physical and mechanical properties, wide transparency and large birefringence, so it is also ideal for optical components such as fiber optical isolators and circulators, beam displaces and other polarizing optics, etc.



Sellmeier Equation (λ in mm):

$n_o^2=3.77834+0.069736/(\lambda^2-0.04724)-0.0108133\lambda^2$

$n_e^2=4.59905+0.110534/(\lambda^2-0.04813)-0.0122676\lambda^2$

		0.6341μm	1.30μm	1.55μm
Refractive Indices	n_o	1. 9929	1.950	1.9447
	n_e	2.2154	2.1554	2.1486
Birefringence ($\Delta n=n_e-n_o$)		0.2225	0.2054	0.2039
Walk-off Angle at 45° (ρ)		6.04° at	5.72°	5.69°

Applications of YVO_4 Crystals:

- Fiber Optic Isolator (YVO_4 Wedges)
- Beam Displacers
- Circulators
- Interleaver

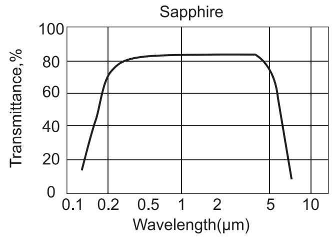
Specifications:

Dimension tolerance	(W±0.1mm) x (H±0.1mm) x L (0.05mm)
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
Scratch/Dig code	10/5 to MIL-O-13830A
Parallelism	better than 10 arc seconds
Perpendicularity	5 arc minutes
Angle tolerance	Δθ<±0.5°, Δφ<±0.5°
AR coating	R<0.2% at 1550nm
Wedge Angle tolerance	0.1°(wedges)

Sapphire

CLASER's Sapphire is grown by TGT and CZ method Due to the hardest of the oxide crystals, Sapphire has a combination of optical and physical properties that makes it the best choice for a variety of demanding applications. Sapphire maintains its strength even at high temperatures. It has good thermal properties, excellent electrical and dielectric properties and is resistant to chemical attack. These properties encourage the use of Sapphire in aggressive environments where reliability, optical transmission or strength is required.

We supply high quality and low cost sapphire. Careful selection of raw materials and strict quality control ensure Our sapphire has the best quality. Large size Sapphire crystals up to 5" in boule is available.



Transmission (2mm think sample)

Application:

UV and IR Optics, Windows for Temperature and Pressure, Corrosion Resistance, Abrasion Resistance, Heat sinkers and Thermocouples, Semiconductor Wafer Carriers, Electrical Insulators, Thin film Deposition, Transparent Electronic Substrate, Silicon on Sapphire Wafers, Superconductor Substrate.

Window:

- Windows
- Used in very high-pressure applications in NMR
- Surgical tips
- Endoscope lenses
- Sapphire light guides
- lenses, prisms and other laser and infrared optic

Standard Specifications of Sapphire Windows

Diameter	Less than 180mm
Thickness	Less than 50mm
Flatness	better than λ/4 per inch(@633nm)
Parallelism	better than 1'
Perpendicularity	better than 5'
Scratch-Dig	60/40 per MIL-O-13830A
Wavefront Distortion	Less than λ/2 per inch (λ@1064nm)

Note: Other high-precision sapphire widows, AR- or HR-coatings are available upon request. and cut Sapphire blocks and φ2", φ3"x0.65/0.7mm as cut black is also available.

MgF_2

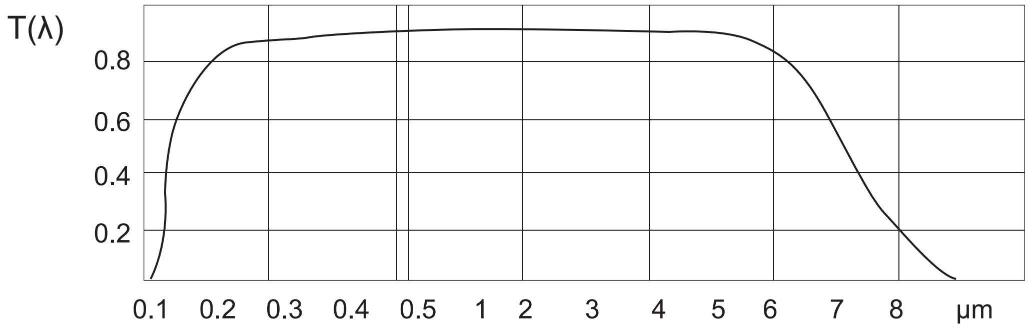
Magnesium Fluoride (MgF_2 crystals) is used for optical elements where extreme ruggedness and durability is required. Its useful transmission range is 0.12μm-8.5μm. Irradiation does not lead to color centers. It is a rugged, hard material which is resistant to thermal and mechanical shock and can be worked to the highest standards. MgF_2 crystal is slightly birefringent and usually applied with the optic axis cut perpendicular to the window faces.

MgF_2 crystals has the following exceptional properties that make it a very important optics crystal:

(1) High optical transmittance from the vacuum ultraviolet to the infrared spectrum region (0.12～8.5μm).
(2) Resistant to mechanical and thermal shock, to radiation,.
(3) Chemically stable.

CLASER's MgF_2 crystals are high transmittance in DUV for large size single domain, and especially suitable for Excimer or DUV windows.

MgF_2 crystals: High transmittance



5% @120nm, 78% @140nm, 90% @200nm, 93% @300-5000nm.

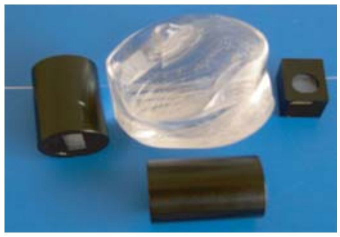
We can provide UV Blank, UV Windows, UV Lenses, UV Cylindrical Lenses, UV Prisms, UV Wedges and customers' design products.

Specifications of MgF_2:

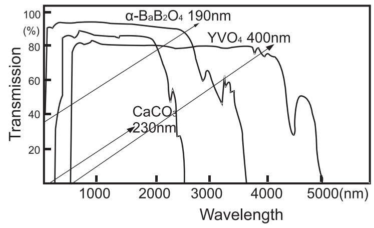
Material	DUV grade MgF_2
Orientation	Perpendicular to C-axis ±0.5°
Dimension tolerance	W±0.1mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
Scratch/Dig code	20/10 to MIL-O-13830A
Parallelism	1 arc minutes
Perpendicularity	30 arc minutes
AR coating	R<0.2% at 1064nm

α-BBO

High Temperature form BBO (α-BaB_2O_4) is a negative uniaxial crystal. It has large birefringence over the broad transparent range from 189nm to 3500nm. The physical, chemical, thermal and optical properties of α-BBO crystal are similar to those of α-BBO. However, the nonlinear optical properties of α-BBO crystal are vanished due to the centric symmetry with its crystal structure. It is not recommended to use for NLO processes.



α-BBO is an excellent crystal to replace Calcite, TiO_2, and $LiNbO_3$, etc. in Glan-Taylor and Glan-Thompson polarizers as well as walk-off beam splitters, especially for high power and UV polarizer, due to its unique UV transparency, good mechanical properties and high damage threshold. CLASER manufactures and supplies Glan-Laser, Glan-Taylor, Glan-Thompson Polarizers and other beam displacers from high quality α-BBO crystals to replace Calcite in many applications, especially in UV and high power operations.(Please view 38-43 for α-BBO polarizer details)



Transmission curve of three birefringent crystals.

Sellmeier equations: (λ in μm) :

$n_o^2=2.7359+0.01878/(\lambda^2-0.01822)-0.01354\lambda^2$

$n_e^2=2.3753+0.01224/(\lambda^2-0.01667)-0.01516\lambda^2$

Refractive Indices, Birefringence ($Dn=n_e-n_o$) and Walk-off Angle at 45°(ρ):

at 1.0642μm n_e=1.5379, n_o=1.6579 Dn=-0.073282 ρ=-4.9532°

at 0.5321μm n_e=1.5534, n_o=1.6776 Dn=-0.075491 ρ=-5.0407°

at 0.2660μm n_e=1.6114, n_o=1.7617 Dn=-0.089805 ρ=-5.6926°

Specifications of α-BBO

Dimension tolerance	W±0.2mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
Scratch/Dig code	10/5 to MIL-O-13830A
Parallelism	better than 30 arc seconds
Perpendicularity	5 arc minutes
Angle tolerance	Δθ<±0.5°, Δφ<±0.5°
AR coating	R<0.2% at 1064nm

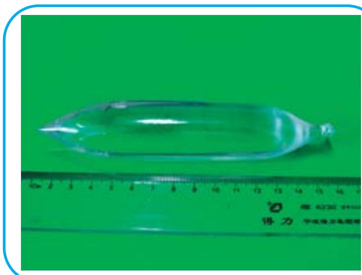
YAG

Undoped YAG is a new substrate and window material that can be used for both UV and IR optics. It is particularly useful for high temperature and high-energy applications. YAG shows no trace absorption in the 2-3μm region where glasses tend to be highly absorbent due to the strong H_2O band. Sapphire is also slightly birefringence. The mechanical and chemical stability of YAG is similar to Sapphire, but YAG is not birefringence and is available with high optical homogeneity.

Based on the patented new growth technique of Temperature Gradient Technique (TGT), CLASER has successfully produced large size of φ50x150mm and high quality undoped YAG.

Advanced:

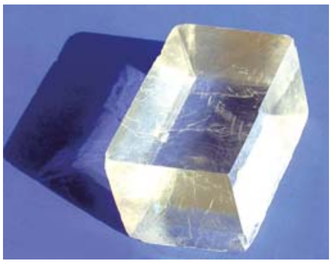
- Wide Transmission Rang: from 250nm to 5000nm
- No absorption in the 2-3μm
- High thermal conductivity, 10 times better than glasses
- Extremely hard and durable
- Non-birefringence
- Stable mechanical and chemical properties
- High index of refraction, facilitating low aberration lens design



Calcite

Calcite is a negative uniaxial crystal that has high birefringence, wide spectral transmission and availability in reasonably sized rhombs. Although is a fairly soft crystal and is easily scratched, it is ideal material used as visible and near IR polarizers, such as Glan Taylor, Glan Thompson and Glan laser.

Carefully select the raw calcite crystals by inspecting them with a cw green laser beam. We have perfected a number of proprietary processes for cutting, grinding and polishing good quality optical surfaces for calcite prism. These skills are evident in the high quality of the finished components, and enable polarizers to be used with very high peak power lasers.



Sellmeier Equation (λ in μm):

$n_o^2=2.69705+0.0192064/(\lambda^2-0.01820)-0.0151624\lambda^2$

$n_e^2=2.18438+0.0087309/(\lambda^2-0.01018)-0.0024411\lambda^2$

Specifications:

Dimension tolerance	W±0.2mm
Wavefront distortion	λ/4 @633nm
Clear aperture	> 90% central area
Flatness	λ/4 @633nm
Scratch/Dig code	40/20 to MIL-O-13830A
Parallelism	better than 30 arc seconds
Perpendicularity	5 arc minutes
AR coating	R<0.2% at 1550nm
Wedge Angle tolerance	0.1°(wedges)

TGG

The magneto-optical crystal TGG is an optimum material for Faraday devices (Rotator and Isolator) in the range from 400nm-1100nm, excluding 470-500nm.The Faraday rotator consists of a TGG rod contained inside a special designed magnet. The rotation sense of the polarization of a light beam passing through the rotator only depends on the direction of the magnetic field and not on the direction of propagation of the light beam. The optical isolator is a Faraday rotator set between two suitably aligned polarizers which allows a light beam to pass through in one direction only. TGG has a combination of excellent properties such as large Verdet constant, low light loss, high thermal conductance and high light damage threshold which makes it a unique material for Faraday devices particularly suitable for YAG lasers and Ti: sapphire tunable lasers, ring lasers and seed injected lasers.

Crystal Parameters:

Chemical Formula	$Tb_3Ga_5O_{12}$
Lattice Parameter	a=12.355Å
Growth Method	Czocralski
Density	7.13g/cm^3
Mohs Hardness	8.0
Melting Point	1725°C
Refractive Index	1.954@1064nm
Thermal Conductivity	9.4x10^{-6}°C^{-1}
Verdet Constant	0.12min/Oe.cm at 1064nm

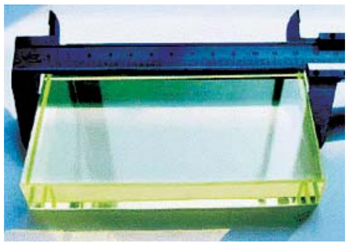
Specifications:

Orientation	[111] within 5 degrees
Extinction Ratio	>30dB
Dimension tolerance	D±0.1mm, L±0.2mm
Wavefront distortion	λ/8 @633nm
Clear aperture	>90% central area
Flatness	λ/8 @633nm
Scratch/Dig code	40/20 to MIL-O-13830A
Parallelism	better than 30 arc seconds
Perpendicularity	30 arc minutes
AR coating	R<0.2% at 1550nm

Faraday Rotator Glass

Faraday rotator glass has been used for magneto-optical isolator, switch, modulator and sensor.

TGP20 is characterized by a high Verdet constant and a lower nonlinear refractive index n_2 to avoid self-focusing in high power laser system.

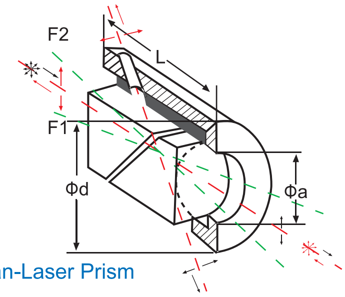


The Properties of Faraday Rotator Glasses

	TG20	TGP20
Verdet constant V (min/Oe.cm)		
632.8nm	-0.258	-0.149
1064nm	-0.075	-0.05
Refractive Index nd	1.6888	1.5588
Abbe Number	53.14	62.92
Nonlinear refractive index (10^{-13} e.s.u.)	2.46	1.34
Thermal coefficient of refractive index (10^{-7}/°C)	74	6.9
Thermal coefficient of optical path (10^{-7}/°C)	105	46
Transmission window (nm)	520-1400	520-1400
Coefficient of thermal expansion (10^{-7}/°C)	51.3	70
Transition temperature (°C)	760	566
Sag temperature (°C)	800	596
Density (g/cm^3)	4.32	3.32
Young's modulus GPa	108	65.2
Poisson's ratio	0.22	0.24
Knoop hardness (Kgf/cm^2)	760	515
Chemical durability	Excellent	Excellent

Glan-Laser

1.Air-Spaced.
2. Suits for high power application.
3. Wide Wavelength Range.
4. High Polarezation Purity.



Glan-Laser Prism

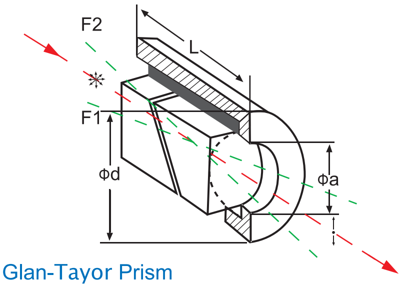
Part No.	Material	Wavelength Range (nm)	Extinction Ratio	Angular Field	Clear Aperture (mm)	Outside Φ (mm)	L (mm)
PGL1306	α -BBO	220-350	$<5x10^{-6}$	6.0°	Φ6	15.0	29.0
PGL1308					Φ8	25.4	31.0
PGL1310					Φ10	25.4	31.0
PGL1315		300-1200			Φ15	30.0	38.6
PGL2306					Φ6	15.0	29.0
PGL2308					Φ8	25.4	31.0
PGL2310					Φ10	25.4	31.0
PGL2315					Φ15	30.0	38.6
PGL3306		700-3000	$<5x10^{-6}$		Φ6	15.0	29.0
PGL3308					Φ8	25.4	31.0
PGL3310					Φ10	25.4	31.0
PGL3315					Φ15	30.0	38.6
PGL1406	Calcite	350-2000	$<1x10^{-5}$	7.7°	Φ6	15.0	15..0
PGL1408					Φ8	25.4	17.0
PGL1410					Φ10	25.4	19.0
PGL1415					Φ15	30.0	23.0
PGL1506	YVO_4	500-4000	$<5x10^{-6}$	6.6°	Φ6	15.0	15.0
PGL1508					Φ8	25.4	17.0
PGL1510					Φ10	25.4	19.0
PGL1515					Φ15	30.0	23.0

Specification

Material	α-BBO, Calcite, YVO_4
Surface Quality	20-10 scratch and dig
Dimensions Tolerance	±0.1mm
Wavefront Distortion	λ/4 @632.8nm
Beam Deviation	<3 arc minutes
Coating	Single layer MgF_2
Housing	Black Anodized Aluminum

Glan-Tayor

1. Air-spaced
2. The extraordinary ray passes through straightly with little deviation.
3. Sealed mount without escape windows is suitable for low to medium power application where the rejected beam is not required.

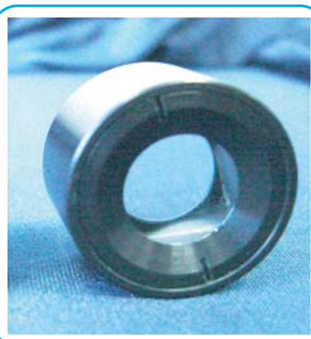


Glan-Tayor Prism

Part No.	Material	Wavelength Range (nm)	Extinction Ratio	Angular Field	Clear Aperture (mm)	Outside Φ(mm)	T (mm)
PGT1306	α -BBO	200-300	$<5x10^{-6}$	6.0°	6	15.0	15.0
PGT1308					8	25.4	17.0
PGT1310					10	25.4	19.0
PGT1315		300-1200			15	30.0	23.0
PGT2306					6	15.0	15.0
PGT2308					8	25.4	17.0
PGT2310					10	25.4	19.0
PGT2315					15	30.0	23.0
PGT3306		700-3000	$<5x10^{-6}$		6	15.0	15.0
PGT3308					8	25.4	17.0
PGT3310					10	25.4	19.0
PGT3315					15	30.0	23.0
PGT1406	Calcite	350-2000	$<1x10^{-5}$	7.7°	6	15.0	15.0
PGT1408					8	25.4	17.0
PGT1410					10	25.4	19.0
PGT1415					15	30.0	23.0
PGT1506	YVO_4	500-4000	$<5x10^{-6}$	6.6°	6	15.0	12.0
PGT1508					8	25.4	15.0
PGT1510					10	25.4	17.0
PGT1515					15	30.0	20.0

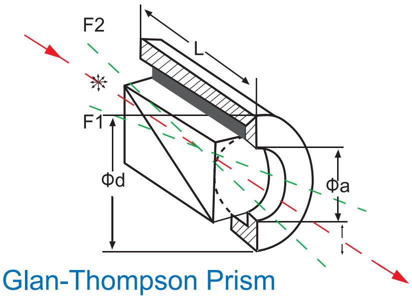
Specification

Material	Calcite, YVO_4, α-BBO
Transmission	>95%
Surface Quality	20-10 scratch and dig
Dimensions Tolerance	±0.1mm
Wavefront Distortion	<λ/4 @632.8nm
Beam Deviation	<3 arc minutes
Coating	Single layer MgF_2
Housing	Black Anodized Aluminum



Glan-Thompson

1.Large Acceptance Angle.
2.High Polarization Purity.
3.Low Power Application.

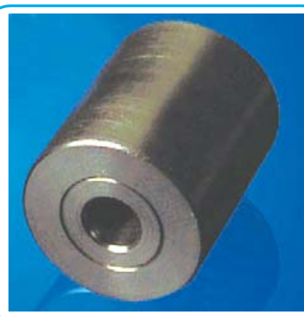


Glan-Thompson Prism

Part No.	Material	L/A	Extinction Ratio	Angular Field	Clear Aperture (mm)	Outside φ(mm)	L (mm)
PGM1406	Calcite	2.5	$<1x10^{-5}$	14°-16°	Φ6	15.0	23
PGM1408					Φ8	25.4	28
PGM1410					Φ10	25.4	33
PGM1415					Φ15	30.0	45
PGM2406		3.0	$<1x10^{-5}$	25°-28°	Φ6	15.0	26
PGM2408					Φ8	25.4	32
PGM2410					Φ10	25.4	38
PGM2415					Φ15	30.0	53
PGM1506	YVO_4	2.5	$<5x10^{-6}$	12°-13°	Φ6	15.0	23
PGM1508					Φ8	25.4	28
PGM1510					Φ10	25.4	33
PGM2506		3.0	$<5x10^{-6}$	20°-23°	Φ6	15.0	26
PGM2508					Φ8	25.4	32
PGM2510					Φ10	25.4	38

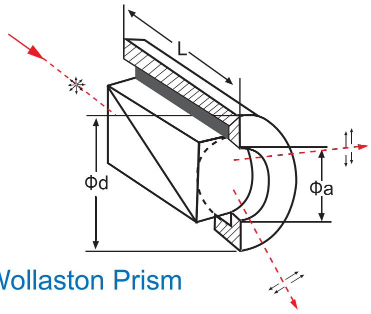
Specification

Material	Calcite, YVO_4
Surface Quality	40-20 scratch and dig
Dimensions Tolerance	±0.1mm
Wavefront Distortion	<λ/4 @632.8nm
Beam Deviation	<3 arc minutes
Coating	Single layer MgF_2
Housing	Black Anodized Aluminum



Wollaston

1. Cemented.
2. Both ordinary and extraordinary beams are deviated.
3. Suits for low power application and where the large deviation is required.

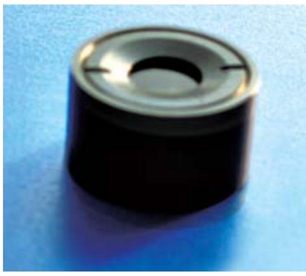


Wollaston Prism

Part No.	Material	Extinction Ratio	Angular Field	Clear Aperture (mm)	Outside Φ(mm)	L (mm)
PWT1306	α -BBO	$<5x10^{-6}$	15°-25°	Φ6	15.0	14.0
PWT1308				Φ8	25.4	16.0
PWT1310				Φ10	25.4	18.0
PWT1315				Φ15	30.0	23.0
PWT1320				Φ20	38.0	28.0
PWT1406	Calcite	$<1x10^{-5}$	15°-20°	Φ6	15.0	14.0
PWT1408				Φ8	25.4	16.0
PWT1410				Φ10	25.4	28.0
PWT1415				Φ15	30.0	23.0
PWT1420				Φ20	38.0	28.0
PWT1506	YVO_4	$<5x10^{-6}$	10°-23°	Φ6	15.0	14.0
PWT1508				Φ8	25.4	16.0
PWT1510				Φ10	25.4	18.0
PWT1515				Φ15	30.0	23.0
PWT1520				Φ20	38.0	28.0

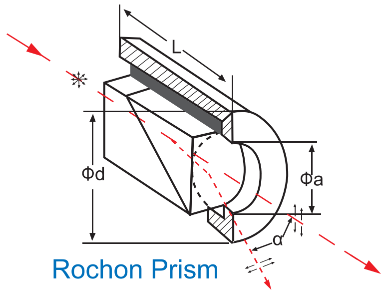
Specification

Material	Calcite, YVO_4, α-BBO
Surface Quality	40-20 scratch and dig
Dimensions Tolerance	±0.1mm
Wavefront Distortion	<λ/4 @632.8nm
Beam Deviation	<3 arc minutes
Coating	Single layer MgF_2
Housing	Black Anodized Aluminum



Rochon

1. Wide Wavelength Range
2. High UV Transmission
3. High Extinction Ratio
4. Large Field Angle

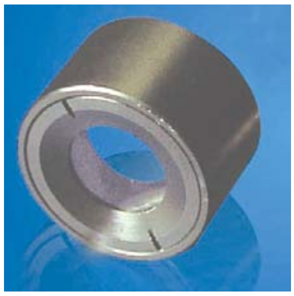


Rochon Prism

Part No.	Material	Wavelength Range(nm)	Extinction Ratio	Separation Angle	Clear Aperture (mm)	Outside Φ(mm)	L (mm)
PRH1306	α-BBO	200-3000	$<1 \times 10^{-6}$	8.0° -14° 8°@1064nm	Φ 6	15.0	14
PRH1308					Φ 8	25.4	16
PRH1310					Φ 10	25.4	18
PRH1315					Φ 15	30.0	23
PRH1506	YVO_4	450-5000	$<5 \times 10^{-6}$	9.8° -13.0° 10°@1064nm	Φ 6	15.0	14
PRH1508					Φ 8	25.4	16
PRH1510					Φ 10	25.4	16
PRH1515					Φ 15	30.0	20

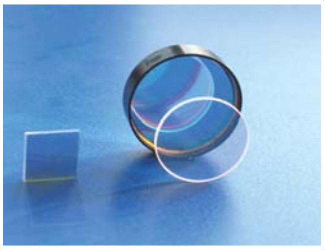
Specification

Material	α-BBO, YVO_4
Surface Quality	20-10 scratch and dig
Dimensions Tolerance	±0.1mm
Wavefront Distortion	<λ/4 @632.8nm
Beam Deviation	<3 arc minutes
Coating	Single layer MgF_2
Housing	Black Anodized Aluminum



CLASER INC.

Waveplates



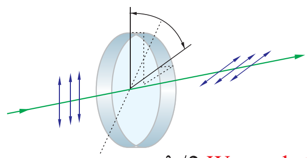
Waveplates are made from materials which exhibit birefringence. The velocities of the extraordinary and ordinary rays through the birefringent materials vary inversely with their refractive indices. The difference in velocities gives rise to a phase difference when the two beams recombine. In the case of an incident linearly polarized beam this is given by $\alpha=2\pi xd(n_e-n_o)$ λ(α-phase difference; d-thickness of waveplate; n_e, n_o-refractive indices of extraordinary and ordinary rays; λ-wavelength). At any specific wavelength the phase difference is governed by the thickness of the retarder.

Transmission range:330nm-2100nm
Thermal Expansion Coefficient:$7.5x10^{-6}$/K.
Density:2.51g/cm^3

Half Waveplate

The thickness of a half waveplate is such that the phase difference is λ/2-wavelength (true-zero order) or some multiple of λ/2-wavelength (multiple order).

A linearly polarized beam incident on a half waveplate emerges as a linearly polarized beam but rotates such that its angle to the optical axis is twice that of the incident beam. Therefore, half waveplates can be used as continuously adjustable polarization rotators. Half waveplates are used in rotating the plane of polarization, electro-optic modulation and as a variable ratio beamsplitter when used in conjunction with a polarization cube.

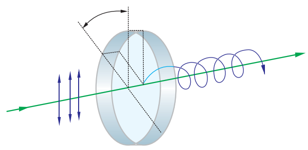


λ/2 Waveplate

Quarter Waveplate

The thickness of the quarter waveplate is such that the phase difference is λ/4 wavelength (true-zero order) or some multiple of λ/4 wavelength (multiple order).

If the angle θ (between the electric field vector of the incident linearly polarized beam and the retarder principal plane) of the quarter waveplate is 45º, the emergent beam is circularly polarized. When a quarter waveplate is double passed, i.e. by mirror reflection, it acts as a half waveplate and rotates the plane of polarization to a certain angle. Quarter waveplates are used in creating circular polarization from linear or linear polarization from circular, ellipsometry, optical pumping, suppressing unwanted reflection and optical isolation.



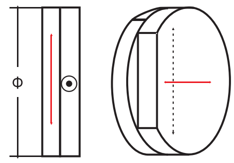
λ/4 Waveplate

Order Information: Part No.+Retardance+Wavlength
Sample: WPL1101+λ/2+1064nm

Zero Order

Optically Contacted Zero-Order

- Optically Contacted
- Thickness 1.5~2mm
- Double Retardation Plates
- Broad Spectral Bandwidth
- Wide Temp. bandwidth



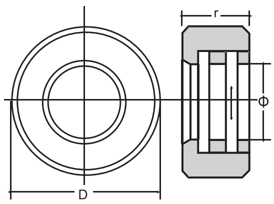
Diameter	Φ10.0	Φ12.7	Φ15.0	Φ20.0	Φ25.4
Part No.	WPZ1610	WPZ1612	WPZ1615	WPZ1620	WPZ1625

Specifications

Material	Optical grade Crystal Quartz
Dimension Tolerance	+0.0,-0.2mm
Wavefront Distortion	<λ/8@633nm
Retardation Tolerance	<λ/500
Surface Quality	20/10 Scratch and Dig
AR Coating	R<0.2% at center wavelength
Standard wavelength	532nm, 800nm, 850nm,1064nm

Air Spaced Zero-Order Waveplate

- Double Retardation Plates
- AR Coated, R<0.2% and Mounted
- High Damage Threshold
- Better Temperature Bandwidth
- Wide Wavelength Bandwidth



Diameter	Φ10.0	Φ 12.7	Φ15.0	Φ20.0	Φ25.4
Part No.	WPZ2610	WPZ2612	WPZ2615	WPZ2620	WPZ2625

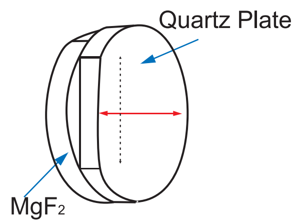
Specifications

Material	Optical grade Crystal Quartz
Dimension Tolerance	+0.0,-0.2mm
Wavefront Distortion	<λ/8@633nm
Retardation Tolerance	<λ/300
Surface Quality	20/10 Scratch and Dig
AR Coating	R<0.2% at center wavelength
Standard wavelength	355nm, 532nm, 800nm, 1064nm

Note: The true Zero order waveplate is available too.

Cemented Achromatic

Achromatic waveplate is similar to Zero-order waveplate except that the two plates are made from different materials, such as crystal quartz and magnesium fluoride. Since the dispersion of the birefringence can be different for the two materials, it is possible to specify the retardation values at a wavelength range.



Diameter	Φ10.0	Φ12.7	Φ15.0
Part No.	WPA1610	WPA1612	WPA1615

Specifications

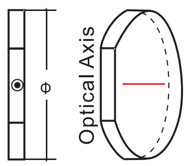
Material	Optical grade Crystal Quartz and MgF_2
Dimension Tolerance	+0.0,-0.2mm
Wavefront Distortion	<λ/8@633nm
Retardation Tolerance	<λ/100
Surface Quality	20/10 Scratch and Dig
AR Coating	R<0.2% at center wavelength
Standard wavelength	VIS:465-610nm, NIR:700-1000nm, IR:1200-1650nm

Low Order

Thickness: 0.2-0.5 mm

High Damage Threshold

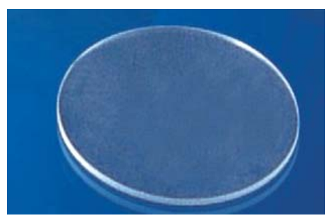
Low Cost



Diameter	Φ10.0	Φ12.7	Φ15.0	Φ20.0	Φ25.4
Part No.	WPL2610	WPL2612	WPL2615	WPL2620	WPL2625

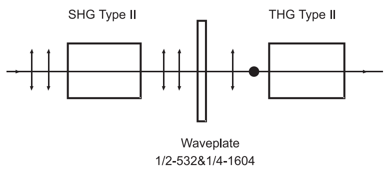
Specifications

Material	Optical grade Crystal Quartz
Dimension Tolerance	+0.0,-0.2mm
Wavefront Distortion	<λ/8@633nm
Retardation Tolerance	<λ/300
Surface Quality	20/10 Scratch and Dig
AR Coating	R<0.2% at center wavelength
Standard wavelength	266nm, 355nm, 532nm, 800nm, 1064nm



Dual Wavelength Waveplate

Dual wavelength waveplate is widely used on Third Harmonic Generation (THG) system. When you need a NLO crystal for type II SHG (o+e→e), and a NLO crystal for type II THG (o+e→e), the out put polarization from SHG can not be used for THG. So you must to turn the polarization to get two perpendicular polarization for type II THG. Dual wavelength waveplate works like a polarizing rotator, it can rotate the polarization of one beam and remain another beam's polarization. Also the dual wavelength waveplate can be applied to following systems:



Specifications

Material	Crystal Quartz
Diameter tolerance	+0.0/-0.15mm
Parallelism	< 1 arc second
Surface quality	20-10 S/D
Wavefront distortion	<λ/10@ 633nm
Retardation tolerance	<λ/100
Coating	DBAR Coating

Items	Diameter (mm)			
	10.0	12.7	15.0	20.0
λ-1064nm; λ/2-532nm	WPD1610	WPD1612	WPD1615	WPD1620
λ/2-1064nm; λ-532nm	WPD2610	WPD2612	WPD2615	WPD2620
λ/2-1064nm; λ/4-532nm	WPD3610	WPD3612	WPD3615	WPD3620
λ/4-1064nm; λ/2-532nm	WPD4610	WPD4612	WPD4615	WPD4620

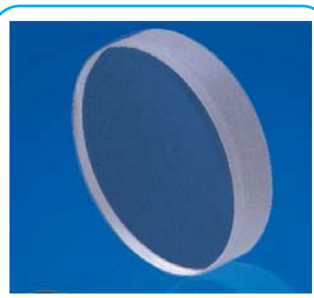
Note: Other size and specifications are available upon requirement.

Polarization Rotator

A plane of linear polarization light will be rotated by Quartz crystal due to the optical activity. ATOM supplies our Quartz polarization rotators for widely polarization application.

Specifications

Material	Crystal Quartz
Diameter tolerance	+0.0/-0.15mm
Parallelism	< 10 arc second
Surface quality	20-10 S/D
Wavefront distortion	<λ/10@ 633nm
Rotation tolerance	<0.5°
AR coating	R<0.25%



Standard wavelength (nm): 355, 488, 532, 633, 800, 850, 1064

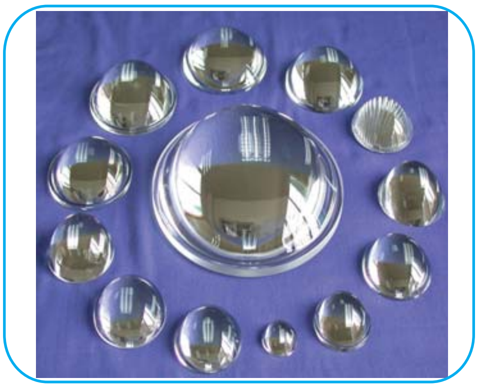
Rotation Angle: 45°, 90°

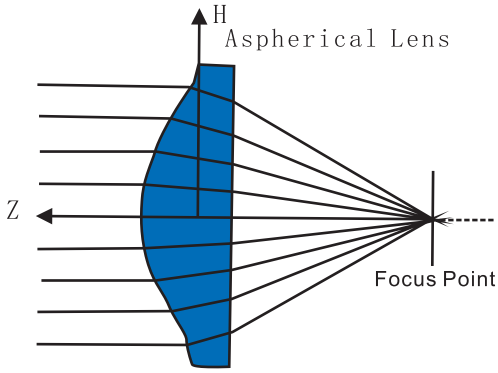
CLASER INC.

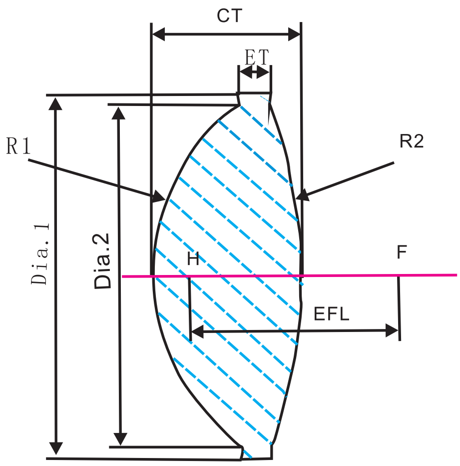
Aspherical Lenses

Aspherical lenses can be used to reduce the total number of lens elements required in a lens assembly while maintaining high optical performance

Our aspherical lenses offer advantages in the molding with high melting point glass and lower depreciation expense, both of which are necessary for rapid technological innovation. Various shapes of lenses are available including bi-convex, bi-concave and meniscus







Specifications

Material	B270 (Nd=1.523), Pyrex(Nd=1.474)
Diameter tolerance	+0.0/-0.5mm
Thickness tolerance :	±0.4mm
Surface quality	80-50 S/D
Paraxial Focal Length:	±5%
Clear Aperture	>80%
AR coating	Single layer MgF2 or BBAR 420-680nm

Windows

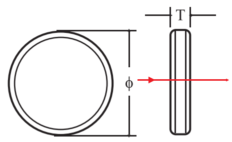
Windows are widely used on optical systems, which are applied to isolate optical system and environment while allowing the light to pass. The material of windows must be considered first, for different material with different transmission range. Also other specifications must be considered with certain environment.

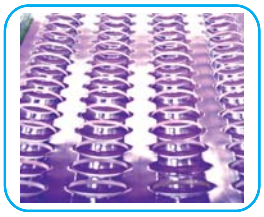
CLASER supply large of windows with different materials, including BK7 glass, other specific glass, Fused Silica, Sapphire, CaF_2, etc..

High Precision Windows		Standard Windows	
Specifications		Specifications	
Material	BK7 grade A glass OR UVFS	Material	BK7 grade A glass or UVFS
Diameter Tolerance	+0.0/-0.15mm	Diameter Tolerance	+0.0/-0.15mm
Thickness Tolerance	±0.2mm	Thickness Tolerance	±0.2mm
Clear Aperture	90% Diameter	Clear Aperture	90% Diameter
Parallelism	< 30 arc seconds or better	Parallelism	< 3 arc minutes
Surface Quality	20-10 scratch and digs	Surface Quality	60-40 scratch and digs
Flatness	λ/8@ 633nm	Flatness	λ/2@ 633nm
Wavefront Distortion	λ/8 per 25mm	Wavefront Distortion	λ per 25mm

CaF_2 Windows

Specifications

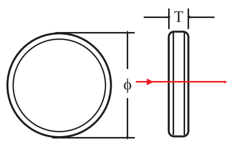


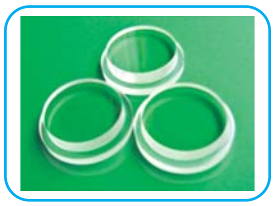


Material	Calcium Fluoride Single Crystal
Transmission Range	0.17-7.8 μm
Diameter Tolerance	+0.0/-0.15mm
Thickness Tolerance	±0.2mm
Clear Aperture	90% Diameter
Parallelism	< 3 arc minutes
Surface Quality	60-40 scratch and digs
Flatness	λ/2@ 633nm

Sapphire Windows

Specifications

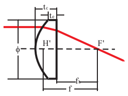
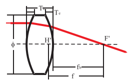
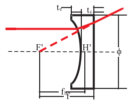
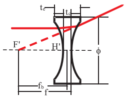
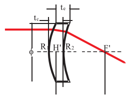
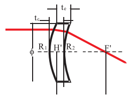




Material	Optical Grade Sapphire Crystal
Transmission Range	0.185-4.5 μm
Diameter Tolerance	+0.0/-0.15mm
Thickness Tolerance	±0.2mm
Clear Aperture	90% Diameter
Parallelism	< 3 arc minutes
Surface Quality	60-40 scratch and digs
Flatness	λ per 25mm@ 633nm

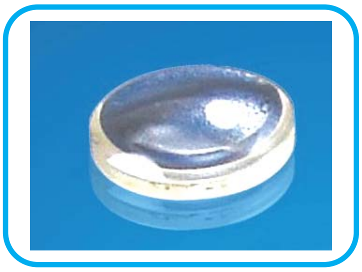
Singlet Lenses

Type: Plano-Convex, Double-Convex, Plano-Concave, Double-Concave, Meniscus

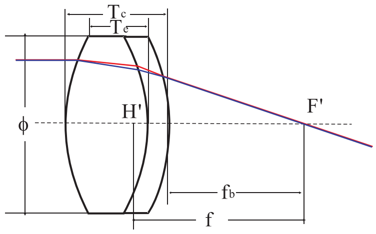
Plano-convex	Double-convex	Plano-concave
		
Double-concave	**Positive Meniscus**	**Negative Meniscus**
		

Specifications

Material	BK7, Fused Silica, ZnSe, ZnS, Si, Ge, etc..
Dimension Tolerance	+0/-0.1mm
Center Thickness	±0.2mm
Focal Length Tolerance	±1%
Surface Quality	20/10
Surface Figure	up to λ/6@ 633nm
Clear Aperture	>90%
Centration	<3 arc minutes



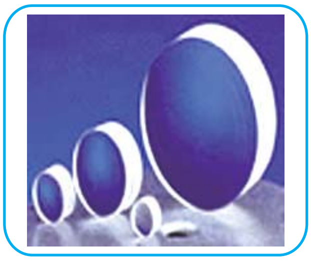
Achromatic Lenses



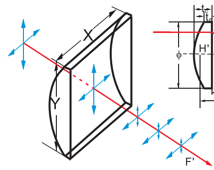
- OEM design or Sinocera design
- UV glue cemented doublet
- Broadband AR coating
- Mounting is available required
- Minimal chromatic aberration

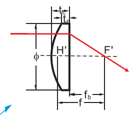
Specifications

Material	Design by optimal design
Diameter	from 2mm to 200mm
Focal length tolerance	±2%
Clear Aperture	>80%
Surface Figure	λ/4
Surface Quality	from 60-40 up to 20-10
Bevel	0.25mm x 45°



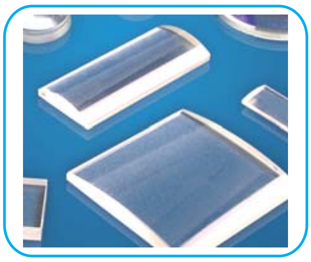
Cylindrical Lenses





Specifications

Material	BK7 or other optical material
Dimension Tolerance	+0.0, 0.1mm
Center Thickness	±0.2mm
Focal Length Tolerance	±1%
Surface Quality	60-40
Surface Figure	λ/2@ 633nm on plano side
Clear Aperture	>90%
Bevel	0.25mm x 45°



Note: Other size and specifications are available upon requirement.

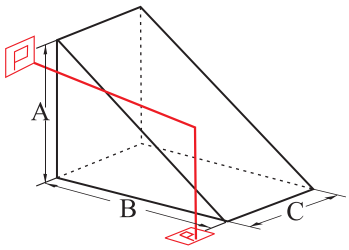
Optical Components

Right Angle Prism

Specifications

Material	BK7 grade A
Dimension Tolerances	±0.1mm
Clear Aperture	>80%
Surface Quality	20-10
Surface Flatness	λ/4@ 633nm
Angle Tolerance	<1 arc min
Bevel	0.3mm±0.1mm

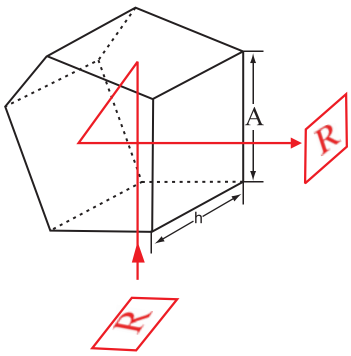
- Fused Silica material is available
- High precision for laser system
- Other material is available to require
- Coating available by requirement



Penta Prism

Specifications

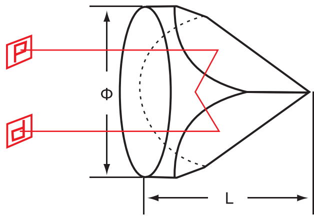
Material	BK7 grade A
Dimension Tolerances	±0.1mm
Clear Aperture	>80% Dimension
Surface Quality	60-40
Surface Flatness	λ/4@ 633nm
Angle Tolerance	up to 10 sec
Coasting	Aluminized and black paint overcoat
Bevel	0.3mm±0.1mm



RETROREFLECTOR

Specifications:

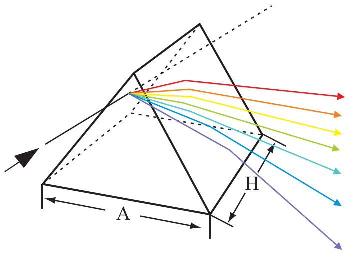
Material	BK7 grade A
Dimension Tolerances	±0.1mm
Clear Aperture	>80% Dimension
Surface Quality	60-40
Surface Flatness	λ/4@ 633nm for big surface λ/4@ 633nm for other surface
Angle Tolerance	180° ±5 arc sec
Coating	Aluminized and black paint on small surfaces
Bevel	0.3mm±0.1mm

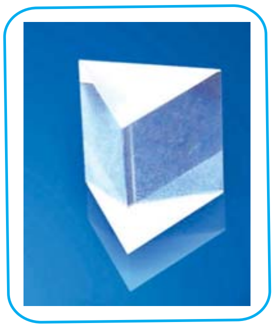


Dispersion Prism

Specifications:

Material	BK7 grade A
Dimension Tolerances	±0.1mm
Clear Aperture	>80% Dimension
Surface Quality	60-40
Surface Flatness	λ/4@ 633nm
Angle Tolerance	60° ±3 arc min
Bevel	0.3mm±0.1mm

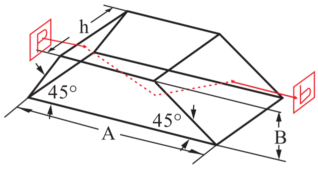




Dove Prism

Specifications:

Material	BK7 grade A
Dimension Tolerances	±0.1mm
Clear Aperture	>80% Dimension
Surface Quality	60-40
Surface Flatness	λ/4@ 633nm
Angle Tolerance	±3 arc min
Bevel	0.3mm±0.1mm

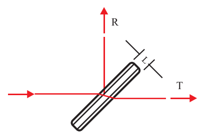


High Power Beamsplitter Plate

Specifications

Material	Optical grade BK7 or UVFS
Dimension Tolerance	+0.0,-0.2mm
Wavefront Distortion	<λ/10 @633nm
Parallelism	<1'
Clear Aperture	>85%
Surface Quality	10/5 Scratch and Dig
Incidence	45 °
AR	R<0.25% @45 ° P, R<1.3% @ 45 ° S
Major Coating	50% ± 3%
Damage Threshold	10J/cm^2 @10ns, 15KW/cm^2 cw 1064nm
Wavelength	473, 488, 532, 650, 800, 850, 980,

1.High Power application.
2.Without adhesive
3.45º incidence
4.Transmitted beam is displaced

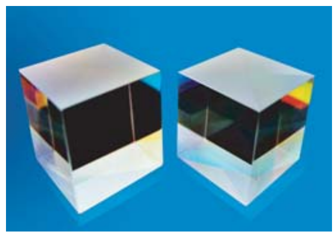


Part No.	Material	Dimension
FBS0110	UVFS	Φ10x3.0
FBS0112	UVFS	Φ12.7x3.0
FBS0125	UVFS	Φ25.4X6.35

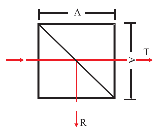
Beamsplitter Cube

Specifications

Material	Optical grade BK7
Dimension Tolerance	+0.0,-0.2mm
Wavefront Distortion	<λ/6 @633nm
Beam Deviation	<1'
Surface Quality	40/20 Scratch and Dig
T/R	50/50±5%, for natrual light T=(Ts+Tp)/2, R=(Rs+Rp)/2
Standard Wavelength	488, 532, 650, 800, 850, 1064, 1310, 1550 nm
Broaden Wavelength	450-650, 650-900, 900-1200, 1200-1550nm



1.Identical path lengths for both the reflected and the transmitted beams
2.Transmitted beam is neither displaced nor deflected
3.Low power application



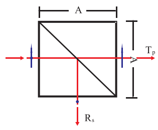
Part No.	Dimension
CBS0110	10.0x10.0x10.0
CBS0112	12.7x12.7x12.7
CBS0120	20.0x20.0x20.0
CBS0125	25.4x25.4x25.4

Polzrizer Beamsplitter Cube

Specifications

Material	BK7, SF2, SF57HHT
Dimension Tolerance	+0.2,-0.2mm
Wavefront Distortion	<λ/6 @633nm
Beam Deviation	<2'
Surface Quality	60/40 Scratch and Dig
Extinction Ratio	>500:1
Principal Transmittance	Tp>99% and Ts<0.2%
Principal Reflectance	Rs>99.8% and Rp<1%
Standard Wavelength	488, 532, 650, 800, 1064, 1310, 1550 nm
Broaden Wavelength	450-650, 650-900, 900-1200, 1200-1500nm

1.Low power application.
2.High Extinction Ratio
3.Transmitted beam is neither displaced nor deflected



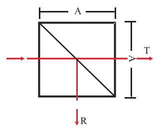
Part No.	Dimension
PBS0103	3.2x3.2x3.2
PBS0110	10.0x10.0x10.0
PBS0112	12.7x12.7x12.7
PBS0115	15.0x15.0x15.0
PBS0125	25.4x25.4x25.4

Non-polarized Beamsplitter Cube

Specifications

Material	Optical grade BK7
Dimension Tolerance	+0.2,-0.2mm
Wavefront Distortion	<λ/6 @633nm
Beam Deviation	<2'
Surface Quality	60/40 Scratch and Dig
Transmittance	45%±5%
Absorption	<10%
Polarization	6%
Standard Wavelength	488, 532, 632.8, 650, 808,1064, 1310, 1550 nm

1.low polarization dependence
2.Low power application.
3.Not change the state of polarization of the incident beam.

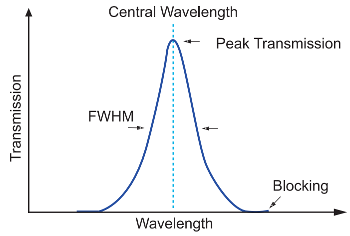


Part No.	Dimension
NPBS0110	10.0x10.0x10.0
NPBS0112	12.7x12.7x12.7
NPBS0115	15.0x15.0x15.0

Interference Filters

Specifications

Material	BK7 or Fused Silica
Diameter	Φ25.4mm+0/-0.2mm
Thickness	3.0mm±0.2mm
Clear Aperture	>90%
FWHM	±5 nm
Peak Transmission	>80%
Block	0.01% (±20nm from the peak)



Standard wavelength: 355, 405, 488, 514, 532, 633, 780, 850, 1064

Bandpass Filters

Bandpass filter has a transmission band surrounded by two blocking bands that allow only a portion of the spectrum to pass. These filters have broad spectral bandwidths in either the ultraviolet, visible, or infrared spectrums. IR filters are often used in nightvision and IR sensing systems

Specifications

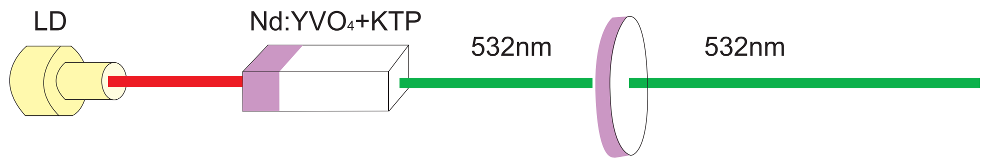
Dimensions :	10mm, 12.7mm ±0.15mm
Clear Apeature:	>80%
Operating Temp. Range	-50°C to +75°C
Blocking	<=0.1%, X-ray to 1.2μ
CWL	±15nm
FWHM	±25nm
Peak Transmittance (min.)	60%
Thickness Tolerance	±0.5mm
Angle Sensitivity	Intended for collimated input

Note: Other size and specifications are available upon requirement.

Green Laser Core

$Nd:YVO_4$+KTP for high power Green Laser Module(100mW)

Claser develop the high power (100mw) green laser core, it can solve the thermal conductivity and warrantee the green laser core stability and long life. time. It will make the green laser more compact and reduce the cost of laser. It has widely been used in display and laser show.



The most outstanding advantage of DPSS laser is its compact package, especially for Green Laser Pointer. Claser supply which combine $Nd:YVO_4$ crystal with KTP crystal, resulting in efficient, ultra-compact, diode pumped laser devices emitting the green laser. It greatly reduces your material cost and enhances assembling efficiency.

Now the large quantity green laser core can be available from Claser with competitive price and stable output quality.

Diode pumped $Nd:YVO_4$+KTP green laser core

$Nd:YVO_4$ (mm^3)	KTP (mm^3)	Pump Power	Output
0.8x0.8x0.5	0.8x0.8x2	160mW	>1mW
2x2x1	2x2x5	1 W	>100mW

Coating: S1: R>99.8% @1064nm&532nm, R<5% @80nm;
S2: R>99.8% @1064nm, R<5% @532nm

Standard Products

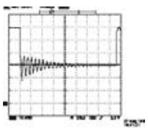
Part No.	$Nd:YVO_4$	KTP	Holder
GLC01	0.8x0.8x0.5mm	0.8x0.8x2mm	Dia.8mm
GLC02	2x2x1mm	2x2x5mm	Dia.8mm

BBO Pockel Cell

BBO is the electro-optic material of choice for high average power Pockels cell applications. BBO has significant advantages over other materials in terms of laser power handling abilities, temperature stability, and substantial freedom from piezoelectric ringing. Because it relies on the electro optic effect, switching time — aided by the low capacitance of the Pockels cell — is very fast. The wide transparency range of BBO allows it to be used in diverse applications.

Because of crystal symmetry and the desire for the light beam to experience no birefringence in the absence of an electric field, BBO Pockels cells are transverse-field devices. The quarter-wave voltage $\lambda/4$ is $d/(4r^{22}n_o^{31})$

Piezoelectric ringing in BBO is small, as evidenced by comparison to KD*P and $LiNbO_3$ Pockels cells. Transmission of a test laser beam at 633nm, with the Pockels cell placed between parallel polarizers, is shown in the following oscilloscope traces. Application of the quarter-wave voltage for each cell caused the transmitted light intensity to decrease to one-half. Operation at the quarter-wave voltage accentuates indicates ground or zero→appearance of acoustic ringing. In the traces, the light intensity. Plots are shown using KD*P, $LiNbO_3$, and BBO as the Pockels cell material.

		
KD*P	BBO	$LiNbO_3$

Advanced:

- High Repetition Rate
- Low Acoustic Noise
- Damage Resistant Ceramic Apertures
- High Average Power Applications
- Compact Design
- Suitable for Q-switch and Regen-amp Applications

CLASER INC.

KD*P Pockel Cell

KD*P is routinely used for Q-switching applications from the uv out to about 1.1 µm where absorption limits its use in active cavities, although it can be useful at longer wavelengths when a few percent of absorption can be tolerated

Advanced:

- Massive Production to support industrial and Commercial Applications
- AR-Coating, Mounting and Re-polishing Service
- Strict Quality Control
- Competitive Price and Huge OEM Discount
- Fast Delivery

KD*P Pockel cell Standard Specifications:

Deuteration Level:	>98%
Repetition Ratio	<100HZ
Aperture Diameter	9.5 mm
Quarter-Wave Voltage	<3.6KV @1064nm
Intrinsic Contrast @1064nm	>1000:1
Optical Transmission	>96% T
Damage Threshold* (Nanosecond Pulses)	>1GW/cm^2
Damage Threshold* (cw Power)	>5kW/cm^2
Wavefront Distortion @1064nm	<λ/4
Electrical Contacts	two, electrically floating, miniature banana plugs
Typical Capacitance	7~10pF @ 1kHz
Outline Dimensions	1" Diameter x 2" Long Cylinder

Note: Quality Warranty Period: 1000 hours under proper use

$LiNbO_3$ Pockel Cell

Electro-optic Pockel cells are used in applications that require fast switching of the polarization direction of a beam of light. These use include Q-switching of laser cavities, coupling light into and out from regenerative amplifiers, and, when used in conjunction with a pair of polarizers, light intensity modulation. Pockels cells are characterized by fast response, since the Pockels Effect is largely an electronic effect that produces a linear change in refractive index when an electric field is applied, and are much faster in response than devices based on acoustic changes in a material.

Selection of the best crystalline material to use as the Pockels cell medium is determined by the wavelength of operation and the specific performance requirements such as damage threshold, average power handling ability, contrast ratio, extinction ratio, and repetition rate.

$LiNbO_3$ Pockels cells use a configuration in which the electric field is applied transverse to the direction of light propagation. This configuration allows lower voltages to be used for a given retardance through the use of thinner and longer crystals. Hard, damage resistant, anti-reflective coatings are deposited directly on the polished crystal faces in order to reduce reflective losses.

This capacitive Pockels cell uses standard 9mmx9mmx25mm crystals that have found widespread use in military and medical laser systems. Standard AR coatings at 1064nm make this a versatile unit. Transmission of the 1064nm

$LiNbO_3$ Pockels Cell Specifications:

Aperture Diameter	8.5mm
Quarter-Wave Voltage	1.65Kv
Intrinsic Contrast @1064nm	>300:1
Optical Transmission	>98% T
Repetition Ratio	<1000Hz
Damage Threshold (Nanosecond Pulses)	>200MW/cm^2
Damage Threshold (cw Power)	>1kW/cm^2
Wavefront Distortion @1064nm	<λ/4
Electrical Contacts	two, electrically floating, miniature banana plugs
Typical Capacitance	20pF
Outline Dimensions	1" Diameter x 2" Long Cylinder

Standard Laser Kits

CLASER develop the standard Laser kits in stock for different laser application. The lower price and quick delivery is available for these kits.

Green Laser Kits

Product	Doping	Dimension	S1	S2
$Nd:YVO_4$	2%	3x3x1mm	HR@1064&532,HT@808	AR@1064&532nm
$Nd:YVO_4$	0.5%(1%)	3x3x5mm	HR@1064&532,HT@808	AR@1064&532nm
Nd:YAG	1.1%	3x3x8mm	HR@1064&532,HT@808	AR@1064&532nm
Nd:YAG	1.0%	Dia.6x110mm	AR@1064nm	AR@1064nm
GTRKTP	type II	3x3x5mm	AR@1064&532nm	AR@1064&532nm
S-KTP	type II	5x5x5mm	AR@1064&532nm	AR@1064&532nm
S-KTP	type II	9x9x7mm	AR@1064&532nm	AR@1064&532nm
Lenses	R=-50mm	Dia.10x2mm	HR@1064&HT532nm	AR@532nm
Lenses	R=-100mm	Dia.10x2mm	HR@1064&HT532nm	AR@532nm

Blue Laser Kits

Product	Spec.	Dimension	S1	S2
Nd:YAG	1%	3x3x8mm	HR@946&473,HT@808&1064nm	AR@946&473nm
Nd:YAG	1%	3x3x2mm	HR@946&473,HT@808&1064nm	AR@946&473nm
LBO	type I	2x2x10 mm	AR@946&473nm	AR@946&473nm
LBO	type I	2x2x14mm	AR@946&473nm	AR@946&473nm
Lenses	R=-50mm	Dia.10x2mm	HR@946,HT473nm	AR@473nm
Lenses	R=-100mm	Dia.10x2mm	HR@946,HT473nm	AR@473nm

Other Laser Kits

Product	Spec.	Dimension	S1	S2
S-KTP	x-cut	4x4x20mm	AR@1064&1570&3300	same S1
S-KTP	x-cut	8x8x25mm	AR@1064&1570&3300	same S1
BBO	OPO355nm	6x6x15mm	P-Coating	P-Coating
BBO	SHG@800	5x5x1mm	P-Coating	P-Coating
BBO	THG@800	5x5x0.5mm	P-Coating	P-Coating

Coating

Coating Type		Properties and Application
Anti- Reflection	Single Layer MgF_2	Applied to materials with refractive indices from 1.45 to 2.4. The most popular antireflection coating for visible. They are insensitive to change in incidence angles.
	Multilayer “V”	Used to provide lowest reflectance with narrow wave band for most laser application. Minimum reflection less than 0.1%
	Broadband Multilayer	They have excellent performance in broadband. Coating performance is sensitive to angle of incidence.
	Dual Wavelength Band	Offer very low reflectance at two widely spaced wavelengths, such as Nd:YAG Laser (1064) and its second harmonic (532) .
Partial Reflection	Single Wavelength Band	Provide 50% reflection and transmission at 45° angle of incidence in single wavelength. Perfect for beamsplitters application.
	Broadband	In wide bandwidth provide 50% reflection and transmission. Claser can also partial coating with different R/T ratios at any angle of incident.
Beam -splitter	Laser Line Polarization Beamsplitter	High reflection to s-polarized and antireflection to p-polarized for laser application.
	Broadband Polarization Beamsplitter	In wide wavelength bandwidth provide high reflection to s-polarized and anti-reflection to p-polarized.
	Dichroic Beamsplitters Mirrors	These coatings can separate the laser fundamental and the pump wavelength, or the fundamental and the second harmonic. They specifically applied to laser mirror.
High Reflection	Dielectric High Reflective Coatings	Provide high reflectance over a broad bandwidth, it is ideal for tunable laser and white light application.
	Metallic High Reflective Coatings	Metallic coatings have low peak reflectance, mechanical durability and damage threshold, but they have extremely broadband and low cost, specially they are insensitivity to angle of incident light and polarization.

Order Information

Purchase order can be placed by e-mail, fax or mail.

Quotation are valid for 60 days from the date of the quotation.

Please send all purchase orders, materials and inquiry to:
Sale Dept.
CLASER Inc.
No.512, Huocheng road,
Jiading, Shanghai, 201821
CHINA
Tel:+86 21 39108798
Fax:+86 21 39108098
E-mail: sales@claserinc.com

Prices for catalog stock items are listed in our current price list. Customer orders will be quoted per provided specifications. Listed and quoted prices are in U.S. Dollars (or EUR) and are subject to change without notice.

Discounts are available for volume purchases. Please contact our salesman for further information.

Shipping is F.O.B. shipping Point. All shipping charges will be prepaid and added to the invoice unless otherwise specified.

Terms of Payment for all invoices are net 30 days by T/T or Advanced payment by T/T, upon establishment of open account.

Warranty period is for sixty days from date of shipment. CLASER guarantee that all products will meet agreed upon specifications. Should a discrepancy occur, a returning material authorization number (RMA#) must be obtained prior to return of product. This warranty extends to the purchase value only, and material found defective will be repaired or replaced at free charge. Customer furnished material for fabrication and/or coating is warranted for the value of the work performed only. There is no liability assumed for the value of the material furnished.

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