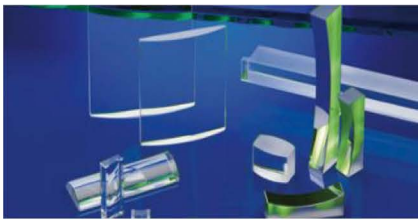
Cylindrical Lens



A cylinder also called cylindrical lens is a lens which focuses light which pass through on to a line instead of on to a point, as a spherical lens would.
The curved face or faces of a cylindrical lens are sections of a cylinder, and focus the image passing through it onto a line parallel to the intersection of the surface of the lens and a plane tangent to it.

Capability of Cylindrical Lens

Attribute	Commercial Quality	Precision Quality	ManufacturingLimit
Material	Optical Glass/Fused Silica CaF2/MgF2/Silicon/Germanium/ZnSe/ZnS, etc.		
Dimension	[Round] Dia.1.5mm – Dia.300mm [Rectangle] 1×1mm – 350×350mm		
Diameter	±0.200mm	±0.050 mm	±0.010 mm
Center Thickness	±0.200mm	±0.050mm	±0.010mm
Radius Tolerance	±1%	±0.5%	±0.1%
Surface Quality	S/D 60-40	S/D 40-20	S/D 10-5
Irregularity (Plano Surface)	1/4 Lambda or 0.5FR	1/8 Lambda or 0.25FR	<1/15 Lambda or 0.15FR
Irregularity (Cylindrical Surface)	1/2 Lambda or 1FR	1/4 Lambda or 0.5FR	<1/8 Lambda or 0.25FR
Centration	±8′	±3′	±0.5′
Roughness	2nm	1nm	0.5-0.6nm

[Note] *Banner Union could process optical material with easy-erosion.*
The data of Irregularity in above table based on the per inch in dimension.
The data of Centration in above table base on each 20mm in dimension.

Inspection of Cylindrical Lens

Banner Union's Quality Control Laboratory is equipped with a range of high-precision measurement equipments to perform a wide variety of tests of cylindrical lenses, include optical and geometrical parameters such as focal length, radius of curvature, centering error and so on.

Equipment	Precision	Set
4" ZYGO GPI XP/D	4" Flat Transmission 1/20 WAVE 4" Sphere Transmission F/3.3,F/1.5, F/0.75 1/20 WAVE 4" CGH F/3, F/1.5, 1/20 WAVE	1 set
Cylindrical Radius Measure Equipment-PC	0.01-0.3%	1 set
Cylindrical Centration Measure Equipment-PC Based, square cylinder	0.1′	1 set
Cylindrical Centration Measure Equipment-PC Based, round cylinder	0.1′	1 set

Equipment	Precision	Set
Goniometer	15"	2 set
5 second Parallelism and Perpendicularity Measure Equipment	<5"	1 set
Olympus 200X	200X	1 set
Olympus KIF-202L Laser Interferometer	R2 – R300 Dimension 60 △N≤0.1	1 set
Spherometer	0.01-0.3%	1 set
Digital Measure Projector	0.001mm	1 set

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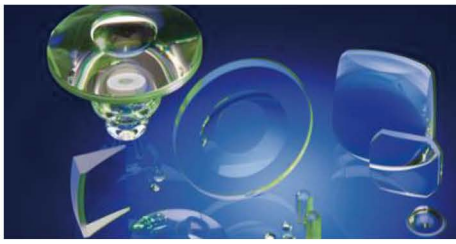
Spherical Lens



A transparent optical component consisting of one or more pieces of optical glass with spherical surfaces that they serve to converge or diverge the transmitted rays from an object, thus forming a real or virtual image of that object. Banner Union provides these lenses with the material of BK7,fused silica, ZnSe, ZnS, CaF2 and MgF2 as standard. Other materials lenses are available.

Capability of Spherical Lens

Attribute	Specification			
Material	Optical Glass/Fused Silica CaF2/MgF2/Silicon/Germanium/ZnSe/ZnS,etc.			
Dimension Range	[Round] Dia.1.5mm-Dia.300mm [Rectangle] 1×1mm – 350×350mm			
Dimension Tolerance	Dia.1.5- Dia.20mm	Dia.21-Dia.40mm	Dia.40- Dia.80mm	Dia.80-Dia.300mm
Center Thickness	2.5mm – ∞			
Radius Tolerance	R±2.5 – R±50	R±5 – R±50	R±50 – R ∞	R±100 – R ∞
Diameter	±0.01mm	±0.01mm	±0.02 mm	±0.05~±0.1 mm
Center Thickness	±0.03mm	±0.05mm	±0.05mm	±0.08~±0.1 mm
Surface Quality	S/D10-5 – S/D20-10	S/D 40-20	S/D 40-20	S/D 40-20 – S/D 60-40
Irregularity	N<3,△N<0.5	N<5,△N<1	N<5,△N<1	N<8,△N<2
Centration	<2′	<3′	<3′	<3′

Inspection of Spherical Lens

Banner Union's Quality Control Laboratory is equipped with a range of high-precision measurement equipments to perform a wide variety of tests of spherical lenses, include optical and geometrical parameters such as focal length, radius of curvature, centering error and so on.

Equipment	Measurement Range
4" ZYGO GPI XP/D	4" Flat Transmission 1/20 WAVE 4" Sphere Transmission F/3.3,F/1.5, F/0.75 1/20 WAVE 4" CGH F/3, F/1.5, 1/20 WAVE
Olympus Microscope	200X
Spherical Centration Measurement Equipment	R5 – R400, Tolerance 1%
Radius Measurement Equipment	R5 – R400, Tolerance 0.3%
Spherometer	R6 – R12000,Tolerance 0.03%~0.06%
OLYMPUS Laser Interferometer KIF-202L	R2 – R300, Dimension 60, △N≤0.1

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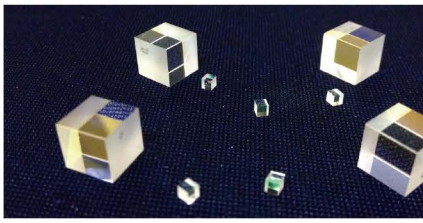
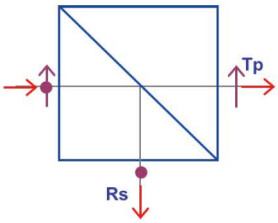
Polarizing Beamsplitter



Polarizing Beamsplitters split randomly polarized beams into two orthogonal, linearly, polarized components S-polarized light is reflected at a 90 degree angle while P-polarized light is transmitted. Each beamsplitter consists of a pair of high precision right angle prisms cemented together with a dielectric coating on the hypotenuse of one of RAP.

Banner Union has own technology in providing two types of high precision polarizing beamsplitter cube. One is by using cemented method for PBS (standard PBS) another one is using optical bonding method for PBS (as high power PBS).

The comparison specification of two PBS



Attribute	Standard PBS	High Power PBS
Bond Method	Optical Adhesive	Optical Bonding
Damaged Threshold@1064nm	0.2-1J/cm^2	>15J/cm^2
Flatness	Lambda/4	Lambda/8
Transmission@1064nm	>95%	>96%
Surface Quality	S/D 60-40	S/D 40-20 or S/D 20-10
Extinction Ratio	300:1-500:1	>1000:1

Capability of High Power PBS (Single Wavelength)

Attribute	High Power PBS (Single Wavelength)
Damage Threshold	~10J/cm^2@1064nm 20ns,20Hz
Bond Method	Optical Bonding
Extinction Ratio	Better than 30dB @ 1064nm
Transmission	>96%@Central Wavelength
Surface Quality	S/D 40-20
Wavelength Range	1064nm ±30nm (Material BK7) 1550nm ±35nm (Material BK7) 532nm ±20nm (Material BK7) 355nm±10nm (Material Fused Silica)

Capability of High Power PBS (Broadband Wavelength)

Attribute	High Power PBS (Broadband Wavelength)
Damage Threshold	3-5J/cm^2@1064nm 20ns,20Hz
Bond Method	Optical Bonding
Extinction Ratio	Better than 30dB
Transmission	>92%
Surface Quality	S/D 40-20 or S/D 20-10
Wavelength Range	450-650nm 650-900nm 900-1200nm 1200-1600nm

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Polarizing Beamsplitter

Polarizing Beamsplitters split randomly polarized beams into two orthogonal, linearly, polarized components S-polarized light is reflected at a 90 degree angle while P-polarized light is transmitted.

Capability of Standard PBS (Single Wavelength)

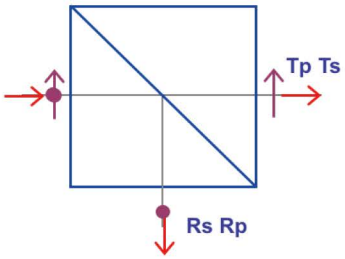
Attribute	Standard PBS (Single Wavelength)
Dimension Tolerance	±0.2mm
Bond Method	Optical Adhesive
Flatness	Lambda/4 per 1inch @632.8nm
Surface Quality	40-20
Extinction Ratio	>500:1
Beam Deviation	<3′
Principal Transmittance	Tp>95% and Ts<0.2%
Principal Reflectance	Rs>99%, Rp<5%
Coating	AR coating on all input and output surfaces Polarizing Beamsplitter coating on hypotenuse Standard Wavelength 488/532/632.8/808/980/1064/1310/1550nm

Capability of Standard PBS (Broadband Wavelength)

Attribute	Standard PBS (Broadband Wavelength)
Dimension Tolerance	±0.2mm
Bond Method	Optical Adhesive
Flatness	Lambda/4 per 1inch @632.8nm
Surface Quality	40-20
Extinction Ratio	>500:1
Beam Deviation	<3′
Principal Transmittance	Tp>95% and Ts<0.2%
Principal Reflectance	Rs>99%, Rp<5%
Coating	AR coating on all input and output surfaces Polarizing Beamsplitter coating on hypotenuse Standard Wavelength 488/532/632.8/808/980/1064/1310/1550nm

Non-Polarizing Beamsplitter

Non-Polarizing Cube Beamsplitters consist of a pair of high precision Right Angle Prisms cemented together with a metallic dielectric coating on the hypotenuse of one of the prisms.
The low polarization dependence of the metallic dielectric hybrid coating allows the transmission and reflection of S-polarization and P-polarization states to be within 6% of each other. These beamsplitters are spectrally flat across their specified wavelength ranges, reducing effects caused by changes in the angle of incidence or converging/diverging beams.



Capability of NPBS (Single Wavelength)

Attribute	NPBS (Single Wavelength)
Dimension Tolerance	±0.2mm
Flatness	Lambda/4 per 1inch @632.8nm
Surface Quality	40-20
Beam Deviation	<3′
Principal Transmittance	Tp=Ts=50%±5%
Principal Reflectance	Rs=Rp=50%±5%
Coating	AR coating on all input and output surfaces Non-Polarizing Beamsplitter coating on hypotenuse Standard Wavelength 532/632.8/1064/1550nm

Capability of NPBS (Broadband Wavelength)

Attribute	NPBS (Single Wavelength)
Dimension Tolerance	±0.2mm
Flatness	Lambda/4 per 1inch @632.8nm
Surface Quality	40-20
Beam Deviation	<3′
Principal Transmittance	Tp=Ts=50%±5%
Principal Reflectance	Rs=Rp=50%±5%
Coating	AR coating on all input and output surfaces Non-Polarizing Beamsplitter coating on hypotenuse Standard Wavelength 400-700/700-1000nm

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Extremely Low Expansion Glass (LAS)

LAS Material Characteristics

Banner Union's Extremely Low Expansion Glass (Banner Union Material Code LAS is a very good substitutable material of Schott Zerodur. High precision flat mirrors from LAS are widely used in high technology applications such as high precision measurement, astronomy, for all demanding applications in which geometrical shape and distance changes must be minimized as much as possible during shifts in temperature.
Banner Union has offered LAS Mirror Substrate for many years. The flatness of the mirror could be lambda/20.

Diameter 320mm LAS Mirror

Material Code	LAS
Density	2.53g/cm^3
Transmittance	≥90% (0.6μm - 2.5μm)
Refractive index	N=1.541 (632.8nm)
Coefficient of Thermal Expansion	<8×10-8/ °C
Stress Birefringence	<4nm/cm
Flexural Strength	173MPa
Long-time Usage Temperature	600°C

Capability of LAS Substrate

Attribute	Commercial Quality	Precision Quality
Diameter	+0/-0.1mm	+0/-0.02
Length & Width	±0.1mm	±0.05
Thickness	±0.1mm	±0.005
Clear Aperture	>90%	>90%
Parallelism	<1′	<1″
Attribute	Commercial Quality	Precision Quality
Reflected Flatness (λ=633nm)	Lambda /4	Lambda /20 (Diameter less than 4″)
Surface Quality (Scratch-Dig)	S/D 40-20	S/D 10-5

Capability of Metallic Coating

Coating Type	Reflectivity
Protected Aluminum	Ravg>87%@400-1200nm
Enhanced Aluminum	Ravg>91%@450-650nm
UV Enhanced Aluminum	Ravg>85%@250-700nm
Protective Silver	Ravg>96%@450-12000nm
Protective Gold	Ravg>98%@2000-20000nm

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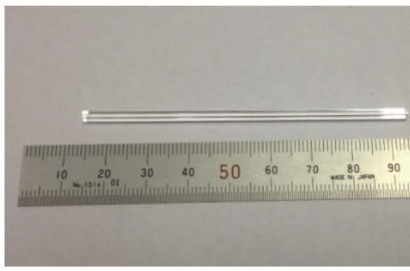
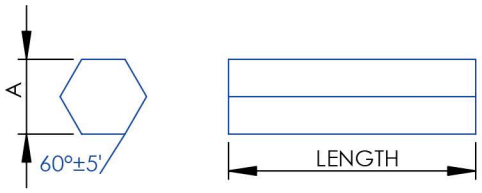
Light Pipe Homogenizing Rods

Light pipe homogenizing rods utilize total internal reflection to homogenize non-uniform light sources regardless of their spectral characteristics. Their hexagonal configurations provide 35% less light loss than a comparable square configuration. Low Numerical Aperture (NA) sources require longer pipes to uniformly homogenize light while shorter pipes will sufficiently homogenize the output from high NA sources.

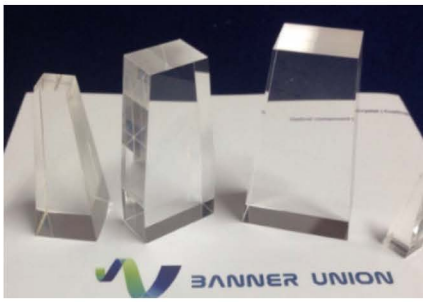


Attribute	Specification
Minimum Aperture Dimension	2mm
Dimension Tolerance	±0.1mm
Length Tolerance	±0.3mm
Clear Aperture	>90%
Parallelism	<1′
Flatness (λ=633nm)	1 Lambda
Surface Quality (Scratch-Dig)	S/D 60-40

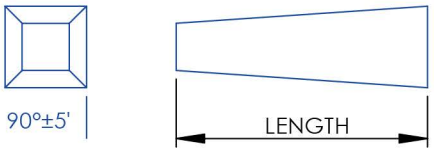


Tapered Light Pipe Homogenizing Rods

Tapered Light Pipe Homogenizing Rods are available in both 2X and 3X magnifications. The Numerical Aperture (NA) of the light output is reduced proportionally to the magnification, allowing significant reduction in NA of the output light.

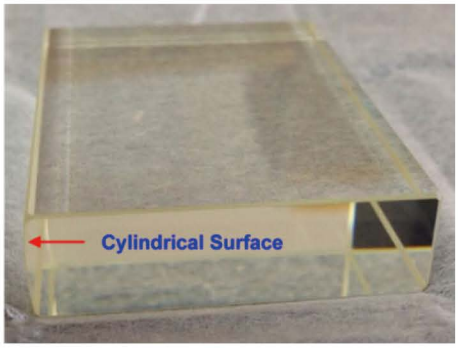


Attribute	Specification
Minimum Aperture Dimension	2mm
Dimension Tolerance	±0.1mm
Length Tolerance	±0.3mm
Clear Aperture	>90%
Parallelism	<1′
Flatness (λ=633nm)	1 Lambda
Surface Quality (Scratch-Dig)	S/D 60-40



Special Shape Light Pipe

Dodecagon Light Pipe for Rotary Laser System Inspection Machine



Light Pipe with one cylindrical surface for IPL Instrument

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$LaBr_3$:Ce Scintillators

$LaBr_3$:Ce Scintillators are the main components of nuclear radiation detector. $LaBr_3$:Ce Scintillation detector can be used to detect the ionizing radiation just like X-rays and Gamma rays, etc.

Basic Properties

Density	5.2g/cm^3
Refractive Index	1.9
Light Yield	63 Photons/KeV
Nonlinear Energy	≤6% @ (30keV-1.3MeV)
Peak luminous wavelength	380nm
The decay time of principal components	≤30ns
Energy Resolution	3%-3.9% @ 662keV

Application

The high light yield, good energy resolution, short decay time and small nonlinear response of LaBr3:Ce make it widely used in the international terrorism, nuclear material control, Security Check, Energy, Nuclear medicine, industrial metrology, oil well logging and other fields.

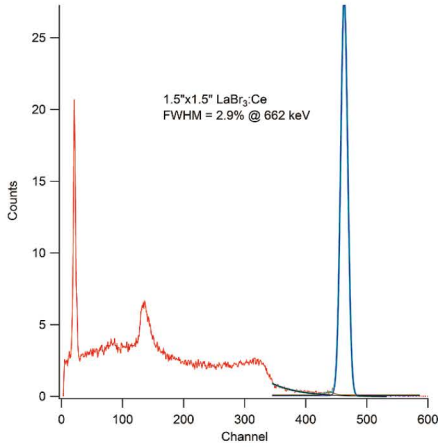
Energy Resolution

Energy Resolution result from Lawrence Livermore National Laboratory.

Test Date: Feb.15,2015

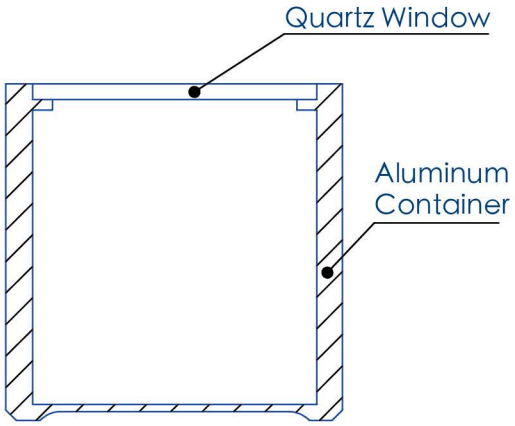
Part Number SLBR1515 (Dia.1.5″X 1.5″)

Test Result: FWHM=3.0%@662 keV



Mounted Method

LaBr3:Ce Scintillators are sealed in the aluminum containers with quartz windows.



Standard Products

Banner Union has many years' experience in process LaBr3:Ce Scintillators, Customer's designs are acceptable for us.

Part Number	Dimension
SLBR0505	Dia.0.5″X 0.5″
SLBR1010	Dia.1.0″X 1.0″
SLBR1515	Dia.1.5″X 1.5″
SLBR2020	Dia.2.0″X 2.0″
SLBR3030	Dia.3.0″X 3.0″
SLBRA005	$LaBr_3$:Ce Scintillators Array 5mm X 5mm

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BANNER UNION

$LaBr_3$:Ce Scintillators

The scintillation probe of LaBR series are made up of $LaBr_3$:Ce Scintillators , fast-response photomultiplier, voltage division circuit, fast-response charge sensitive preamplifier and the metal case. Because the optimal design of direct coupling, the probe has many advantages like the high energy resolution, good energy linear and the fast response. It widely used in nuclear detection technology.

Basic Properties

Attribute	Specification
Dimension	Diameter 25-75mm Height 10-200mm
Photon Conversion Efficiency	62000 photon/MeV
Energy Resolution	3%-3.9% @ 662keV
Nonlinear Energy	≤6% @ (30keV-1.3MeV)
Output Amplitude	0.5-1V/MeV photon
Energy Signal Output Waveform	Positive pulse index. Rise time is 12ns. back porch is 2μs. Amplitude depends on the high pressure
Output Impedance	50 ohm
Temperature Coefficient of Output Signals	≤±0.1% /℃ (-10 to +50℃)

Power Supply Requirement

(1)LV: ±12V DC stabilized power supply

Current consumption: Less than 20 mA

(2)HVDC

①Positive or negative polarity

②500-1000V

③Current consumption≤0.4mA

④Output Ripple Voltage≤2mV(peak value)

Product Description

Type LaBR-A, Double-Signal $LaBr_3$:Ce Scintillation Probe

LaBR -A is one of the $LaBr_3$:Ce scintillation probe which is special designed for energy with time-of-flight mass spectrometer. LaBR -A could provide not only the fast time signal, but also they photon energy signal. The probe is the best choice in energy and time measurement with best energy resolution and short decay time. The probe can be also used as the γ-spectrometer probe and γ-time measuring probe.

Type LaBR-B, Portable γ-spectrometer $LaBr_3$:Ce Scintillation Probe

LaBR-B is one of the $LaBr_3$:Ce scintillation probe which is special designed for portable γ-spectrometer. $LaBr_3$:Ce, photomultiplier tube and pre amplifier integrated packed so the structure is compact. The probe is the first choice of the high precision portable γ-spectrometer Dimension:

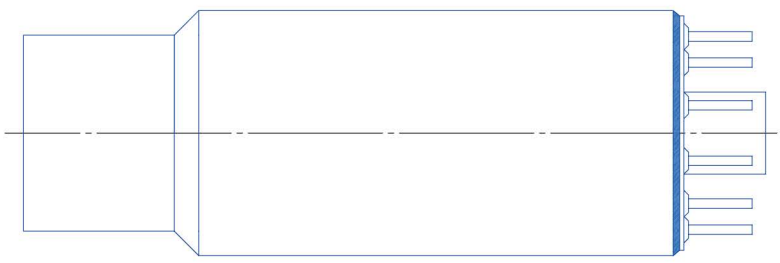
Type LaBR-C, General type (economical) $LaBr_3$:Ce Scintillation Probe

LaBR -C is one of the general type $Labr_3$:Ce scintillation probe. During the design process, we considered the NaI scintillation probe user's interest and we realize the probe technology upgrading with the minimum cost. When the user add the LaBR-C probe to the spectrometer, it will be a new one and the performance improve greatly. The NaI probe can be used as a spare part.

Type LaBR-D, Radioactive logging (high temperature)$LaBr_3$:Ce Scintillation Probe

LaBR-D is one of the $LaBr_3$:Ce scintillation probe which is special designed for the oil industry of radioactive logging. The temperature stability of $LaBr_3$:Ce is excellent, so the probe has good temperature stability in the nuclear logging of oil field.$LaBr_3$:Ce Scintillators coupling with the special photomultiplier tube will achieve a high detection deficiency and excellent energy resolution. Further more, it can be ensure the reliability and stability of the probe in the industrial fi eld.

Probe Structure



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Cesium Lithium Borate (CLBO)

Cesium Lithium Borate (CLBO) is a newly developed nonlinear optical crystal It is a scarce crystal which generate fourth harmonic and fifth harmonics of the Nd:YAG laser output. Due to high damage threshold it can be application in solid-state UV laser. Besides CLBO possesses small walk-off angle large acceptable angular spectral and temperature bandwidth.

Basic Properties

Transparent Range	180-2750 nm
Nonlinear Susceptibility	d_{36} = 1.01 pm/V (λ=532nm) d_{36} = 1.16 pm/V (λ=484nm)
Cell Parameters	a = 10.494Å, b = 8.939Å
Density	2.45g/cm^3
Principal refractive indices	n_o=1.4852, n_e=1.4355 (λ=1064nm) n_o=1.4985, n_e=1.4462 (λ=532nm)
Optical damage threshold	26 GW/cm^2 (λ=1064nm)
Cut-off SHG wavelength	471nm
Walk-off angles	1.83°(λ=532nm) 0.98°(λ=488nm)
Angular bandwidth	1.7mrad·cm (λ=1064nm)
Spectrum bandwidth	0.84nm·cm (λ=532nm)
Conversion Efficiency	45% (532nm→266nm)·

Capability of CLBO

Attribute	Specification
Dimension Tolerance	±0.1mm
Orientation Accuracy of Cut Angle	<30′
Flatness	≤Lambda/4 @ 633nm
Surface Quality (Scratch-Dig)	S/D 20-10
Parallelism	<30″
Perpendicularity	<5′
Damage threshold	>25GW/cm^2 @ 1064 nm

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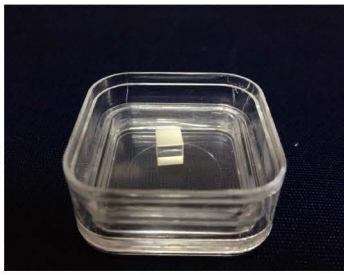
KDP/DKDP



Potassium Dihydrogen Phosphate (KDP) and Potassium Dideuterium Phosphate (KD*P) are among the most widely-used commercial NLO materials, characterized by good UV transmission, high damage threshold, and high birefringence, though their NLO coefficients are relatively low. They are usually used for doubling, tripling and quadrupling of a Nd:YAG laser at the room temperature. In addition, they are also excellent electro-optic crystals with high electro-optic coefficients, widely used as electro-optical modulators, such as Q-switches, Pocket Cells, etc.

Capability of KDP/DKDP

	KDP	DKDP
Chemical Formula	KH_2PO_4	KH_2PO_4
Transparency Range	200-1500nm	200-1600nm
Nonlinear Coefficients	d_{36}=0.44pm/V	d_{36}=0.40pm/V
Refractive Index (at 1064nm)	n_o=1.4938, n_e=1.4599	N_o=1.4948, n_e=1.4554
Electro-optical Coefficients	r_{41}=8.8pm/V r_{63}=10.3pm/V	r_{41}=8.8pm/V r_{63}=25pm/V
Longitudinal Half-wave Voltage	V_π=7.65KV(λ=546nm)	V_π=2.98KV(λ=546nm)
Absorption	0.07/cm	0.006/cm
Optical Damage Threshold	>5GW/cm²	>3GW/cm²
Extinction Ratio		30dB
Sellmeier Equations of KDP		
$n_0^2=2.259276+0.01008956 / (\lambda^2-0.012942626)+13.00522\lambda^2/(\lambda^2-400)$ $n_e^2=2.132668+0.008637494 / (\lambda^2-0.01281043)+3.2279924\lambda^2/(\lambda^2-400)$		
Sellmeier Equations of DKDP		
$n_0^2=1.9575544+0.2901391\lambda^2 / (\lambda^2-0.0281399)-0.02824391\lambda^2+0.004977826\lambda^4$ $n_e^2=1.5005779+0.6276034\lambda^2/ (\lambda^2-0.0131558)-0.01054063\lambda^2+0.002243821\lambda^4$		

Capability of KDP/DKDP

Transmitted Wavefront Distortion	Less than Lambda/8@633nm
Dimension Tolerance (mm)	±0.1
Flatness	Lambda/8@633nm
Parallelism	<20″
Perpendicularity	<10′
Angle Tolerance	<10′
Surface Quality (Scratch-Dig)	S/D 20-10
Clear Aperture	> 90% Central Area
Working Temperature	25˚C

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Banner Union's waveplate, including octadic-wave(λ/8), quarter-wave(λ/4), half-wave(λ/2) and full wave(λ) plates, are widely used in synthesis and analysis of light in various states of polarization. The standard wavelengths of waveplates are listed below for your reference.

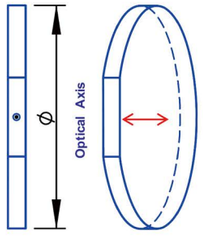
Standard Wavelengths (nm) Other wavelength in 200-2300nm is also available

248	266	355	400	488	514	532	632.8
780	800	810	850	1064	1310	1480	1550

Attribute	Commercial Quality	Precision Quality
Material	Crystal Quartz/MgF_2	
Dimension Tolerance (mm)	+0/-0.1	±0.02
Wavefront Distortion	Lambda/8@632.8nm	Lambda/20@632.8nm
Retardation Tolerance@23˚C	Lambda/150@632.8nm	Lambda/500@632.8nm
Wavelength Range	240-2100nm	240-2100nm
Parallelism	<3″	<0.5″
Surface Quality (Scratch-Dig)	S/D 20-10	S/D 10-5
AR/AR Coating	R<0.2%@ central wavelength	R<0.1%@ central wavelength

Low Order Waveplate

- Thickness: 0.20-0.50mm
- High Damage Threshold
- Better Temperature Bandwidth
- Low Cost



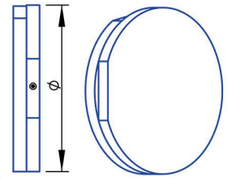
Capability of Low Order Waveplates

Attribute	Commercial Quality	Precision Quality
Material	Crystal Quartz/MgF_2	
Dimension Tolerance (mm)	+0/-0.1	±0.02
Wavefront Distortion	Lambda/8@632.8nm	Lambda/20@632.8nm
Retardation Tolerance@23˚C	Lambda/120@632.8nm	Lambda/500@632.8nm
Wavelength Range	240-2100nm	240-2100nm
Parallelism	<3″	<0.5″
Surface Quality (Scratch-Dig)	S/D 20-10	S/D 10-5
AR/AR Coating	R<0.2%@ central wavelength	R<0.1%@ central wavelength

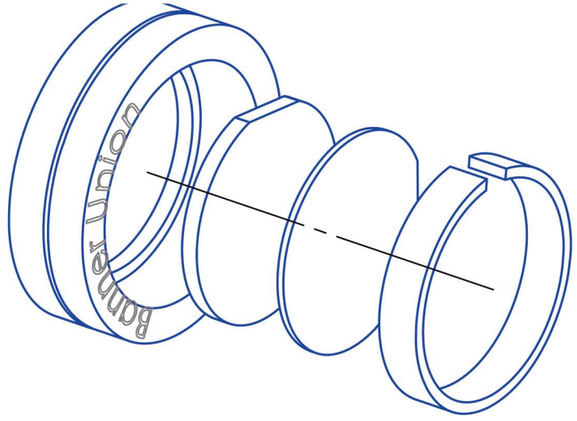
Zero-Order Waveplates

Cemented and Optically Contacted Zero-Order Waveplates

- Double Plates
- Broad Spectral Bandwidth
- Wide Temperature Bandwidth
- AR Coated



Cemented and Optically Contacted Zero-Order Waveplat



- Double Retardation Plates
- High Damage Threshold
- Broad Spectral Bandwidth
- Wide Temperature Bandwidth
- AR Coated and Mouted

Capability of Zero-Order Waveplates

Attribute	**Commercial Quality**	**Precision Quality**
Material	Crystal Quartz/MgF_2	
Dimension Tolerance (mm)	+0/-0.1	±0.05
Wavefront Distortion	Lambda/8@632.8nm	Lambda/10@632.8nm
Retardation Tolerance@23˚C	Lambda/120@632.8nm	Lambda/500@632.8nm
Wavelength Range	240-2100nm	240-2100nm
Parallelism	<3″	<0.5″
Surface Quality (Scratch-Dig)	S/D 20-10	S/D 10-5
AR/AR Coating	R<0.2%@ central wavelength	R<0.1%@ central wavelength

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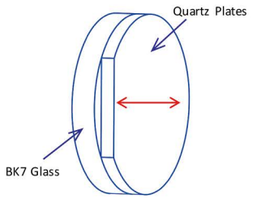
True Zero-Order Waveplates

Cemented True Zero-Order Waveplates

- Broad Spectral Bandwidth
- Wide Temperature Bandwidth
- Wide Angle Bandwidth
- Cemented by Epoxy

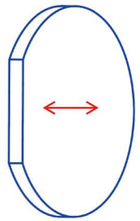


Capability of Cemented True Zero-Order Waveplates

Attribute	Commercial Quality	Precision Quality
Material	Crystal Quartz/MgF_2	
Dimension Tolerance (mm)	+0/-0.1	±0.02
Wavefront Distortion	Lambda/8@632.8nm	Lambda/20@632.8nm
Retardation Tolerance@23˚C	Lambda/240@632.8nm	Lambda/500@632.8nm
Wavelength Range	240-2100nm	240-2100nm
Parallelism	<3″	<1″
Surface Quality (Scratch-Dig)	S/D 20-10	S/D 10-5
AR/AR Coating	R<0.2%@ central wavelength	R<0.1%@ central wavelength

Single Plate True Zero-Order Waveplates

- Broad Spectral Bandwidth
- Wide Temperature Bandwidth
- Wide Angle Bandwidth
- High Damage Threshold
- Standard Wavelength 1310nm,1550nm
- λ/2 Waveplate
- Thickness down to 0.028mm



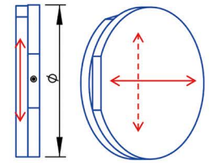
Attribute	Commercial Quality	Precision Quality
Material	Crystal Quartz/MgF_2	
Dimension Tolerance (mm)	+0/-0.1	±0.02
Wavefront Distortion	Lambda/8@632.8nm	Lambda/20@632.8nm
Retardation Tolerance@23˚C	Lambda/240@632.8nm	Lambda/500@632.8nm
Wavelength Range	240-2100nm	240-2100nm
Parallelism	<3″	<1″
Surface Quality (Scratch-Dig)	S/D 20-10	S/D10-5
AR/AR Coating	R<0.2%@ central wavelength	R<0.1%@ central wavelength

Achromatic Waveplates

Achromatic waveplates are similar to zero-order except that the two plates are made from different material, such as crystal quartz and magnesium fluoride. Since the dispersion of the birefringence can be difference for the two material, it is possible to specify the retardation value at a wavelength range. Hence, the retardation of the resulting waveplate can be made to low sensitivity to wavelength change. Based on the contact methods of the two plates, achromatic waveplates are classified into two types: air-spaced and cemented

Standard Wavelength

VIS	465nm-610nm
NIR	700nm-1000nm



Capability of Achromatic Waveplates

Attribute	Commercial Quality	Precision Quality
Material	Crystal Quartz/MgF_2	
Dimension Tolerance (mm)	+0/-0.1	±0.02
Wavefront Distortion	Lambda/8@632.8nm	Lambda/20@632.8nm
Retardation Tolerance@23˚C	Lambda/240@632.8nm	Lambda/500@632.8nm
Wavelength Range	240-2100nm	240-2100nm
Parallelism	<3″	<1″
Surface Quality (Scratch-Dig)	S/D 20-10	S/D 10-5
AR/AR Coating	R<0.2%@ central wavelength	R<0.1%@ central wavelength

Dual Wavelength Waveplates

Attribute	Specification
Material	Crystal Quartz
Dimension Tolerance (mm)	+0/-0.2
Wavefront Distortion	<λ/8@633nm
Surface Quality (Scratch-Dig)	S/D 20-10
Parallelism	<1″

- BPrecise Polarization control for dual wavelength sources
- Multiple-order Waveplates for Narrow Bandwidth applications
- Other Wavelength and Retardation Combinations available
- Rotary Mounts Available
- Optional Ring Mount Prevents Breakage and Fits easily into lens or Mirror Mount

λ1(nm)	λ1 Retardation	λ2(nm)	λ2 Retardation
532	Lambda/2	355	Lambda
532	Lambda/2	1064	Lambda
1064	Lambda/2	355	Lambda
1064	Lambda/2	532	Lambda

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