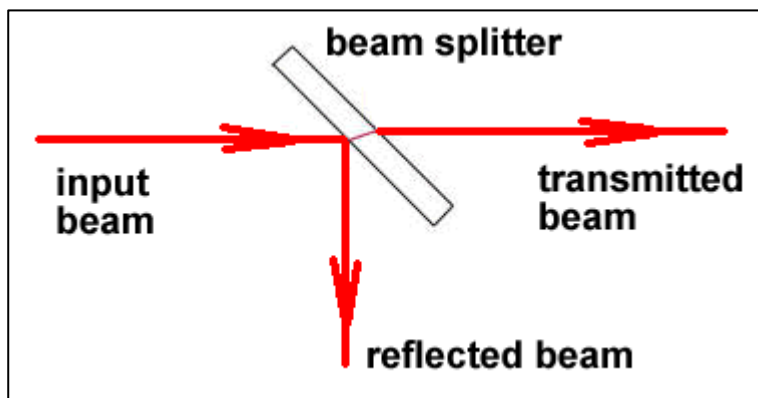


## Beam Splitters

Beam splitters allow a beam to be split into two beams of differing power, however, the most popular power split is 50:50 at a 45° incidence angle. The polarization needs to be considered when specifying a beam splitter otherwise the reflected and transmitted beams will not have the correct power. We have developed a special 'polarization insensitive' coating which eliminates this problem for the 50:50 case.

- Advanced in-house design
- Up to 500W/cm<sup>2</sup> power handling
- High quality laser grade material

The following standard beam splitter are available.



Model	Material	Diameter mm	ET mm	Transmission %	Reflectance %	Coating
BS-10.6-10PIB3-45	ZnSe	25.4	3	50	50	AR/50%-PIB
BS-10.6-10ZPF3-50-P	ZnSe	25.4	3	50	50	AR/50%-45P
BS-10.6-10ZPF3-50-R	ZnSe	25.4	3	50	50	AR/50%-45R
BS-10.6-10ZPF3-50-S	ZnSe	25.4	3	50	50	AR/50%-45S
BS-10.6-10ZPF4-99-R	ZnSe	25.4	3	1	99	AR/99%-45R
BS-10.6-15PIB3-45	ZnSe	38.05	3	50	50	AR/50%-PIB
BS-10.6-15PIB4-45	ZnSe	38.05	4	50	50	AR/50%-PIB
BS-10.6-15ZPF3-10-R	ZnSe	38.05	3	90	10	AR/10%-45R
BS-10.6-15ZPF3-1-R	ZnSe	38.05	3	99	1	AR/1%-45R
BS-10.6-15ZPF3-50-P	ZnSe	38.05	3	50	50	AR/50%-45P
BS-10.6-15ZPF3-50-R	ZnSe	38.05	3	50	50	AR/50%-45R
BS-10.6-15ZPF3-50-S	ZnSe	38.05	3	50	50	AR/50%-45S
BS-10.6-15ZPF3-5-R	ZnSe	38.05	3	95	5	AR/5%-45R
BS-10.6-15ZPF4-50-R	ZnSe	38.05	4	50	50	AR/50%-45R
BS-10.6-15ZPF5-50-R	ZnSe	38.05	5	50	50	AR/50%-45R
BS-10.6-20PIB5-45	ZnSe	50.8	5	50	50	AR/50%-PIB

Remark:

- 1) The above items are flat/flat;
- 2) The angle of incidence is 45 degree;
- 3) The above items are polarisation-insensitive.

Model Number	Diameter	Thickness	Reflectance	Polarization
BS-10.6-BSZ-1012-50-P	1.000"	0.120"	50% ±3%	P
BS-10.6-BSZ-1012-50-S	1.000"	0.120"	50% ±3%	S
BS-10.6-BSZ-1012-50-U	1.000"	0.120"	50% ±3%	U
BS-10.6-BSZ-1516-50-P	1.500"	0.160"	50% ±3%	U
BS-10.6-BSZ-1516-50-S	1.500"	0.160"	50% ±3%	S
BS-10.6-BSZ-1516-50-U	1.500"	0.160"	50% ±3%	U
BS-10.6-BSZ-2020-50-P	2.000"	0.200"	50% ±3%	P
BS-10.6-BSZ-2020-50-S	2.000"	0.200"	50% ±3%	S
BS-10.6-BSZ-2020-50-U	2.000"	0.200"	50% ±3%	U

Note: For "U" polarization: This is an unpolarized beamsplitter. It is not a polarization-insensitive beamsplitter.

## ZnSe Laser Windows

ZnSe windows can be fabricated in dimensions from 4.0mm to 300mm diameter, and in thicknesses from 1.0mm up to 50mm. The windows are AR coated at 10.6um. Many standard sizes are manufactured and held in stock.



- Hi-tech manufacturing methods
- Latest ultra-low absorption coatings
- High quality laser grade material

The following standard windows are available.

Part No	Material	Diameter mm	ET mm	Incidence deg	T %	R %	Coating
WIN-10.6-4.9ZWA20	ZnSe	12.5	2	0	99.4	0.1	AR/AR
WIN-10.6-5.0ZWA30	ZnSe	12.7	3	0	99.4	0.1	AR/AR
WIN-10.6-5.9ZWA10	ZnSe	15	1	0	99.4	0.1	AR/AR
WIN-10.6-5.9ZWA60UU	ZnSe	15	6	0	71	14.5	Uncoated ZnSe
WIN-10.6-6.3ZWA30	ZnSe	16	3	0	99.4	0.1	AR/AR
WIN-10.6-10ZWA20	ZnSe	25.4	2	0	99.4	0.1	AR/AR
WIN-10.6-10ZWA30	ZnSe	25.4	3	0	99.4	0.1	AR/AR
WIN-10.6-10ZWA30UU	ZnSe	25.4	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-10ZWA40	ZnSe	25.4	4	0	99.4	0.1	AR/AR
WIN-10.6-11ZWA30	ZnSe	28	3	0	99.4	0.1	AR/AR
WIN-10.6-11ZWA40	ZnSe	28	4	0	99.4	0.1	AR/AR
WIN-10.6-11ZWA50	ZnSe	28	5	0	99.4	0.1	AR/AR
WIN-10.6-11.8ZWA30UU	ZnSe	30	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-15ZWA30	ZnSe	38.05	3	0	99.4	0.1	AR/AR
WIN-10.6-15ZWA30-P30	ZnSe	38.05	3	0	99.4	0.1	AR/AR
WIN-10.6-15ZWA40	ZnSe	38.05	4	0	99.4	0.1	AR/AR
WIN-10.6-15ZWA50	ZnSe	38.05	5	0	99.4	0.1	AR/AR
WIN-10.6-15ZWA60	ZnSe	38.05	6	0	99.4	0.1	AR/AR
WIN-10.6-17.5ZWA80	ZnSe	44.5	8	0	99.4	0.1	AR/AR
WIN-10.6-19.7ZWA30	ZnSe	50	3	0	99.4	0.1	AR/AR
WIN-10.6-19.7ZWA40	ZnSe	50	4	0	99.4	0.1	AR/AR
WIN-10.6-19.7ZWA50	ZnSe	50	5	0	99.4	0.1	AR/AR
WIN-10.6-19.7ZWW50-99	ZnSe	50	5	0	1	99	AR/99%
WIN-10.6-20ZWA30UU	ZnSe	50.8	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-20ZWA40	ZnSe	50.8	4	0	99.4	0.1	AR/AR
WIN-10.6-20ZWA50	ZnSe	50.8	5	0	99.4	0.1	AR/AR
WIN-10.6-20ZWA50UU	ZnSe	50.8	5	0	71	14.5	Uncoated ZnSe
WIN-10.6-20ZWA60	ZnSe	50.8	6	0	99.4	0.1	AR/AR
WIN-10.6-25ZWA30	ZnSe	63.5	3	0	99.4	0.1	AR/AR
WIN-10.6-30ZWA30	ZnSe	76.2	3	0	99.4	0.1	AR/AR

The following series of ZnSe Laser Windows are manufactured especially for CO<sub>2</sub> Laser applications. They are offered in both coated with an anti-reflectance thin-film coating applied to both surface, or uncoated which can be used for a variety of applications as they are. We can custom coat these for any wavelength or spectral performance you may require. In addition to the sizes listed below we generally have metric size diameters available such as 25mm, 50mm etc. Other diameters and thicknesses along with coating for other wavelengths can be custom manufactured quickly in our fabrication shop to your specific requirement. Although these are made extremely parallel the two surfaces to each other, they can be manufactured these with specific wedge angles from 10 minutes up to several degrees or arc. Please contact us for these or other custom parts.

Specifications:

Material: Zinc Selenide (ZnSe) Laser Grade

Diameter Tolerances. +.000", -.005" for parts up to 2.000"Ø  
 +.000", -.010" for parts from 2.50" to 6.000"Ø

Thickness: ±.010"

Parallelism: < 30 seconds of arc

Surface Quality: < 40/20 scratch – dig Laser Finish

Spectral Performance:

Standard high efficiency low loss anti-reflectance

thin film coating applied to both sides.

Reflectance per surface @ 10.6µm for normal incidence <0.20%

Total finish part Absorption < .25%

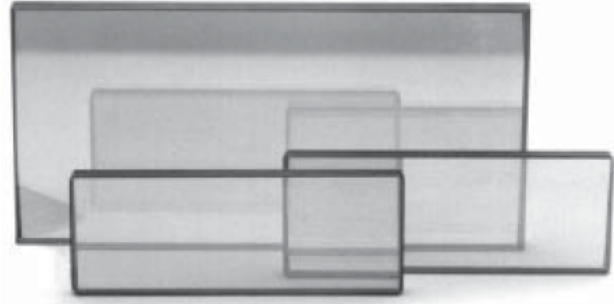
Transmission > 99.0% typically

Part Number Coated	Diameter	Thickness	Part Number Uncoated
WIN-10.6-WZ-0508-AR	0.500"	0.080"	WIN-10.6-WZ-0508-UC
WIN-10.6-WZ-0512-AR	0.500"	0.120"	WIN-10.6-WZ-0512-UC
WIN-10.6-WZ-0516-AR	0.500"	0.160"	WIN-10.6-WZ-0516-UC
WIN-10.6-WZ-0708-AR	0.750"	0.080"	WIN-10.6-WZ-0708-UC
WIN-10.6-WZ-0712-AR	0.750"	0.120"	WIN-10.6-WZ-0712-UC
WIN-10.6-WZ-1008-AR	1.000"	0.080"	WIN-10.6-WZ-1008-UC
WIN-10.6-WZ-1012-AR	1.000"	0.120"	WIN-10.6-WZ-1012-UC
WIN-10.6-WZ-1016-AR	1.000"	0.160"	WIN-10.6-WZ-1016-UC
WIN-10.6-WZ-1112-AR	1.100"	0.120"	WIN-10.6-WZ-1112-UC
WIN-10.6-WZ-1512-AR	1.500"	0.120"	WIN-10.6-WZ-1512-UC
WIN-10.6-WZ-1516-AR	1.500"	0.160"	WIN-10.6-WZ-1516-UC
WIN-10.6-WZ-1525-AR	1.500"	0.250"	WIN-10.6-WZ-1525-UC
WIN-10.6-WZ-2012-AR	2.000"	0.120"	WIN-10.6-WZ-2012-UC
WIN-10.6-WZ-2020-AR	2.000"	0.200"	WIN-10.6-WZ-2020-UC
WIN-10.6-WZ-2025-AR	2.000"	0.250"	WIN-10.6-WZ-2025-UC
WIN-10.6-WZ-2038-AR	2.000"	0.375"	WIN-10.6-WZ-2038-UC
WIN-10.6-WZ-2525-AR	2.500"	0.250"	WIN-10.6-WZ-2525-UC
WIN-10.6-WZ-3012-AR	3.000"	0.125"	WIN-10.6-WZ-3012-UC
WIN-10.6-WZ-3025-AR	3.000"	0.250"	WIN-10.6-WZ-3025-UC
WIN-10.6-WZ-3038-AR	3.000"	0.375"	WIN-10.6-WZ-3038-UC
WIN-10.6-WZ-3025-AR	3.500"	0.250"	WIN-10.6-WZ-3025-UC
WIN-10.6-WZ-3538-AR	3.500"	0.375"	WIN-10.6-WZ-3538-UC
WIN-10.6-WZ-4025-AR	4.000"	0.250"	WIN-10.6-WZ-4025-UC
WIN-10.6-WZ-4038-AR	4.000"	0.375"	WIN-10.6-WZ-4038-UC
WIN-10.6-WZ-6050-AR	6.000"	0.500"	WIN-10.6-WZ-6050-UC

## ZnSe Brewster Windows

Brewster windows operate at an angle of incidence equal to the 'Brewster angle' which is 67.4 for ZnSe at 10.6µm. In order to present a square profile to the incident beam, they are about 2.5 times longer than their width. They fully transmit linearly polarized light in the P-plane and reflect about 50% of the S-plane component. Consequently, they can be used to enhance ('clean-up') the polarization or by rotating it about the beam axis, they can be used as an attenuator. Coated versions enhance the reflectance of the S-component but at the expense of restricting the power. Usually, Brewster windows are used in pairs.

- Wedged to between 1 and 3 arcminutes in order to overcome multiple interference
- Coated or uncoated versions and many sizes available
- High quality laser grade material



### Sizes/tolerances

Custom-made Brewster plates may be made in sizes up to 200mm length as long as the specified thickness is appropriate to the size. Design tolerances for standard plates are:

Length	: +0 / -0.1mm
Width	: +0 / -0.1mm
Thickness	: ± 0.1mm
Flatness	: Better than $\lambda/80$ over any 25mm dia test area.
Parallelism	: Wedged 2.0 ± 1.0 minutes of arc.
Surface roughness	: Better than 15Å RMS.
LIDT cw	: >6000W/mm (>6kW per mm of beam dia. 1/e <sup>2</sup> )

The following standard Brewster windows are available.

Model	Material	Diameter mm	ET mm	Incidence deg	T %	R %	Coating
WIN-10.6-BWZ2510	ZnSe	25	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZ3315	ZnSe	33	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZE4015	ZnSe	40	3	67.4	98% P-Pol	99.5S-Pol	AR/U-EB
WIN-10.6-BWZ4218	ZnSe	42	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZ5018	ZnSe	50	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZE5018	ZnSe	50	3	67.4	98% P-Pol	99.5S-Pol	AR/U-EB
WIN-10.6-BWZ5320	ZnSe	53	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZ6122	ZnSe	61	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZ6323	ZnSe	63	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZ6625	ZnSe	66	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZE6625	ZnSe	66	3	67.4	98% P-Pol	99.5S-Pol	AR/U-EB
WIN-10.6-BWZ10038	ZnSe	100	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZ11542	ZnSe	115	3	0	71	14.5	Uncoated ZnSe
WIN-10.6-BWZ13248	ZnSe	132	3	0	71	14.5	Uncoated ZnSe

### The Brewster Angle

The Brewster angle for a material is determined by the index of refraction for the wavelength concerned. Where the refractive index is 'n' the Brewster angle of incidence ' $\theta_b$ ' is given by:

$$\theta_b = \text{TAN}^{-1}(n)$$

In the case of ZnSe at 10.6µm,  $n = 2.4028$ , and  $\theta_b = 67.24^\circ$ .

When specifying Brewster windows having some required value for optical clear aperture, it is necessary to make appropriate allowances on the width and length of the plate for the mechanical mounting arrangement.

## **Applications**

### **Polarization-forcing**

ZnSe Brewster windows may be used within a laser resonator so as to force the laser to emit linearly polarized radiation.

### **Polarizers/analysers**

Outside a laser cavity, plates may be used singly or in 'stacks' to perform the role of polarizers or analysers.

### **Isolators**

A particularly useful function of Brewster plates occurs in the laser-processing of highly reflective metals, where Brewster-based 'isolator' assemblies and phase-retarder units may be used to prevent back-reflected radiation from re-entering the laser resonator.

### **Wedge Angle**

If the level of parallelism of the Brewster window is high, then multiple interference between beams reflected from the two surfaces can affect the intended function of the plate. Our Brewster plates are deliberately wedged to between 1 and 3 arcminutes in order to overcome this problem.

### **Enhanced Brewsters**

Plates with special coatings to enhance the polarizing function are available.

## Beam Combiner

Beam Combiners are ideal for applications where diode lasers are being used for system alignment. Designed for used at 45 degree, they transmit the long wavelength beam and align it with the 90 degree reflected diode beam.

### 1. Beam Combiner for CO<sub>2</sub> Laser (wavelength 10.6um)

Average transmission > 99%@10.6um, Average reflection > 85%@650nm (or 633nm)

Diameter Tolerance: +0/-0.13mm

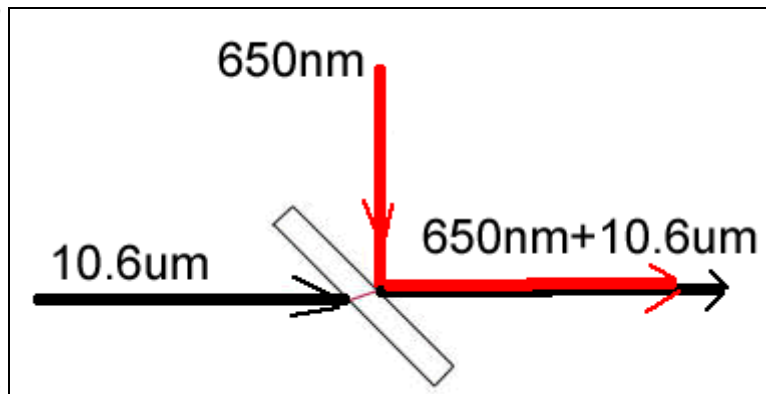
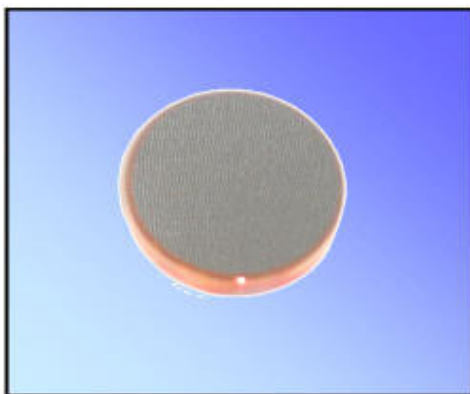
Thickness: ±0.25mm

Side1: T>99%@10.6um, 45AOI

Side2: T>99%@10.6um R>85%@650nm or 633nm 45AOI

Flatness: λ/20 @10.6um

Part No.	Material	Diameter (inch)	Thickness (mm)	Remark
BCZ-0.5-2-650	ZnSe	0.5	2	MaxT10.6μm/MaxR650nm
BCZ-0.75-2-650	ZnSe	0.75	2	MaxT10.6μm/MaxR650nm
BCZ-1.0-3-650	ZnSe	1.0	3	MaxT10.6μm/MaxR650nm
BCZ-1.1-3-650	ZnSe	1.1	3	MaxT10.6μm/MaxR650nm
BCZ-1.5-3-650	ZnSe	1.5	3	MaxT10.6μm/MaxR650nm
BCZ-1-3-9.4-650	ZnSe	1.0	3	MaxT9.5μm/MaxR650nm
BCZ-20-2-650	ZnSe	20mm	2	MaxT10.6μm/MaxR650nm
BCZ-0.5-2-633	ZnSe	0.5	2	MaxT10.6μm/MaxR633nm
BCZ-0.75-2-633	ZnSe	0.75	2	MaxT10.6μm/MaxR633nm
BCZ-1-3-633	ZnSe	1	3	MaxT10.6μm/MaxR633nm
BCZ-1.5-3-633	ZnSe	1.5	3	MaxT10.6μm/MaxR633nm



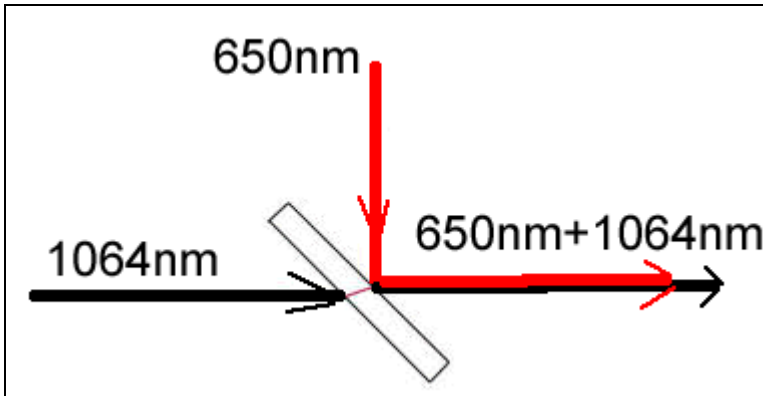
Model Number	Diameter	Thickness	Reflectance/Wavelength	Wedge
BCZ-0508-AR	1.000"	0.120"	90% @ 0.633μm	< 3 minutes
BCZ-0512-AR	1.000"	0.120"	90% @ 0.633μm	< 3 minutes
BCZ-0708-AR	1.000"	0.120"	90% @ 0.633μm	< 3 minutes
BCZ-0712-AR	1.500"	0.160"	90% @ 0.633μm	< 3 minutes
BCZ-1012-AR	1.500"	0.160"	90% @ 0.633μm	< 3 minutes
BCWZ-1012-AR	1.500"	0.160"	90% @ 0.633μm	12 minutes ±2 minutes
BCPZ-1012-AR	2.000"	0.200"	90% @ 0.633μm	< 10 seconds
BCZ-1112-AR	2.000"	0.200"	90% @ 0.633μm	< 3 minutes
BCZ-1512-AR	2.000"	0.200"	90% @ 0.633μm	< 3 minutes
BCZ-2012-AR	2.000"	0.200"	90% @ 0.633μm	< 3 minutes
BCZ-2520-AR	2.000"	0.200"	90% @ 0.633μm	< 3 minutes

Note:

- Transmission: > 99.1% average @ 10.6μm with reflectance > 90% average @ 633nm (RED)
- For 45° Angle of Incidence operation
- Other red diode wavelengths available in most sizes above from stock. Specify 650nm, 670nm, or 680nm

## 2. Beam Combiner for Nd:YAG Laser (wavelength 1064nm)

Average transmission > 99%@1064nm, Average reflection > 85%@650nm



Diameter Tolerance: +0/-0.13mm

Thickness: ±0.25mm

Side1: T>99%@1064nm, 45AOI

Side2: T>99%@1064nm, R>85%@650nm, 45AOI

Flatness:  $\lambda/2$  @1064nm per 25mm dia

Part No.	Material	Diameter (inch)	Thickness (mm)
BCBK-0.5-2	BK7	0.5	2
BCBK-0.75-2	BK7	0.75	2
BCBK-0.75-3	BK7	0.75	3
BCBK-1.0-3	BK7	1.0	3
BCBK-1.0-3.4	BK7	1.0	3.4
BCBK-1.1-3	BK7	1.1	3
BCBK-1.5-3	BK7	1.5	3

## 3. Beam Combiner for Green Laser (532nm)

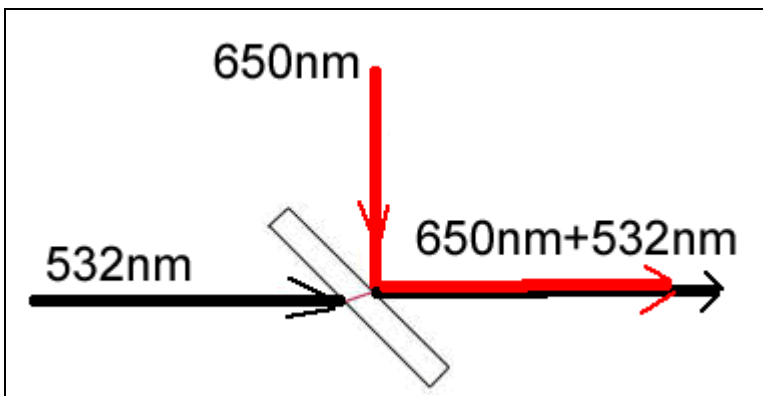
Diameter Tolerance: +0/-0.13mm

Thickness: ±0.25mm

Side1: T>99%@532nm, 45AOI

Side2: T>99%@532nm, R>85%@650nm, 45AOI

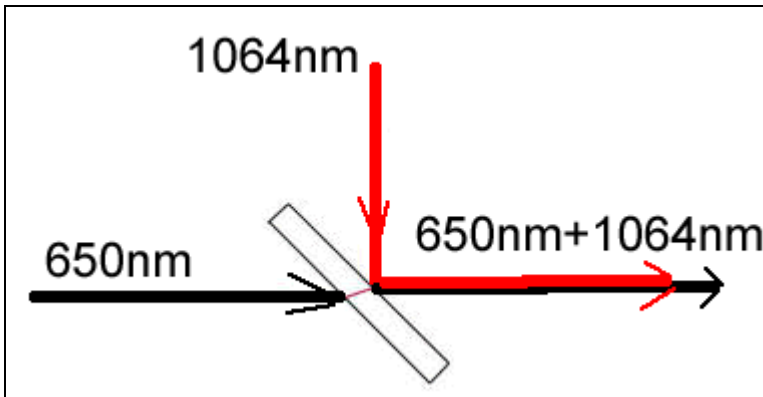
Flatness:  $\lambda/2$  @560nm per 25mm dia



Part No.	Material	Diameter (inch)	Thickness (mm)
BCBK-1-3-532T650R	BK7	1	3

#### 4. Reverse Beam Combiner

Reverse YAG Beam Combiner refers to an optic component used to transmit a short wavelength beam (eg. 650nm) at an angle of incidence of 45° while reflecting a long wavelength 1064nm.



Diameter Tolerance: +0/-0.13mm

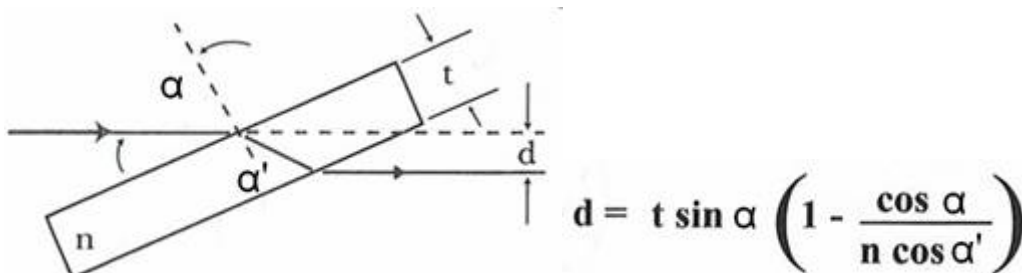
Thickness: ±0.25mm

Side1: T>99%@650nm, 45AOI

Side2: T>99%@650nm R>99%@1064nm, 45AOI

Flatness: λ/2 @1064nm per 25mm dia

Part No.	Material	Diameter (inch)	Thickness (mm)
BCBK-1-3.5-1064R	BK7	1	3.5
BCBK-1-7-1064R	BK7	1	7
BCBK-2-6.35-1064R	BK7	2	6.35



Where,

- α is angle of incidence
- n is index of refraction
- t is thickness
- d is displacement of the material

For example: BCZ-1-3, d=1mm; BCBK-1-3, d=0.8mm