

## CLBO - Cesium Lithium Borate ( $\text{CsLiB}_6\text{O}_{10}$ )

### Introduction

Cesium Lithium Borate ( $\text{CsLiB}_6\text{O}_{10}$  or CLBO) is a newly developed crystal with excellent UV nonlinear feature, and widely used for high-power lasers, micro processing, optical communications, bio-medical, UV-LiDAR, etc. Compared to BBO, it has larger spectral and temperature acceptance, larger angle tolerance and smaller walk-off angle (see Table 1). These advantages make CLBO obtain larger SHG conversion efficiency than BBO. Moreover, it is suitable for FOHG and FIHG of high-power Nd:YAG laser.

### CASTECH'S CLBO is featured by

- Cut-off wavelength up to 180 nm
- Maximum FOHG and FIHG conversion efficiencies of Nd doped laser
- Relatively large effective NLO coefficient (about two times that of KDP)
- Wide acceptance angle and small walk-off angle
- The VUV output at 193 nm is available by phase matching
- No saturation for high-power generation
- Short grow cycle and large size

### CASTECH offers

- Strict quality control
- Cutting angle and dimension upon request
- Sealed-housing or AR-coating/P-coating to prevent deliquescence
- AR-coating for fourth or fifth harmonic generations of 1064 nm
- Reworking services
- Fast delivery (15 working days for polished only, 20 working days for AR-coated)

### Basic Properties

Table 1. Nonlinear Optical Properties of CLBO and BBO Crystal

Wavelength (nm)	NLO Crystal	Phase Matching Angle (deg)	Deff (pm/V)	Angle Tolerance (mrad·cm)	Walk-off Angle (deg)	Spectral Acceptance (nm·cm)	Temperature Acceptance (°C·cm)
532+532=266	CLBO	61.70	0.84	0.49	1.83	0.13	8.30
	BBO	47.70	1.32	0.17	4.80	0.07	4.50
1064+266=213	CLBO	68.40	0.87	0.42	1.69	0.16	4.60
	BBO	51.10	1.26	0.11	5.34	0.08	3.10

Table 2. Chemical and Structural Properties

Crystal Structure	Tetragonal, Space group $I\bar{4}2m$
Lattice Parameter	$a = b = 10.494 \text{ \AA}$ , $c = 8.939 \text{ \AA}$
Symmetry	$Z = 4$
Melting Point	About $844.5 \text{ }^\circ\text{C}$

Table 3. Optical and Nonlinear Optical Properties

Transparency Range	180-2750 nm
Angle Acceptance	1.02 mrad·cm at 1064 nm, 0.49 mrad·cm at 532 nm, 0.84 mrad·cm at 488 nm.
Temperature Acceptance	$9.4^\circ\text{C}\cdot\text{cm}$
Spectral Acceptance	7.03 nm·cm at 1064 nm, 0.13 nm·cm at 532 nm, 0.09 nm·cm at 488 nm
Walk-off Angle	$1.78^\circ$ at 1064 nm, $1.83^\circ$ at 532 nm, $0.98^\circ$ at 488 nm
Effective NLO Coefficients	1.01 pm/V at 532 nm, 1.16 pm/V at 488 nm, 0.95 pm/V at 1064 nm
NLO Coefficients	$d_{\text{eff}}(\text{I}) = d_{36} \sin\theta_m \sin(2\Phi)$ $d_{\text{eff}}(\text{II}) = d_{36} \sin(2\theta_m) \sin(2\Phi)$
Sellmeier Equations ( $\lambda$ in $\mu\text{m}$ )	CLBO at $20^\circ\text{C}$ $n_o^2 = 2.2104 + 0.01018 / (\lambda^2 - 0.01424) - 0.01258 \lambda^2$ $n_e^2 = 2.0588 + 0.00838 / (\lambda^2 - 0.01363) - 0.00607 \lambda^2$ ( $0.1914 \mu\text{m} < \lambda < 2.09 \mu\text{m}$ )

## CLBO's Parameters

Table 4. Specifications

Dimension Tolerance	$(W \pm 0.1 \text{ mm}) \times (H \pm 0.1 \text{ mm}) \times (L + 0.5/-0.1 \text{ mm}) \times (L \geq 2.5 \text{ mm})$ $(W \pm 0.1 \text{ mm}) \times (H \pm 0.1 \text{ mm}) \times (L + 0.1/-0.1 \text{ mm}) \times (L < 2.5 \text{ mm})$
Clear Aperture	Central 90% of the diameter
Surface Quality (Scratch/Dig)	10/5 to MIL-PRF-13830B
Flatness	$\leq \lambda/6 @ 633 \text{ nm}$
Parallelism	20 arc sec
Perpendicularity	$\cong 15 \text{ arc min}$
Angle Tolerance	$\Delta\theta \leq 0.25^\circ$ , $\Delta\Phi \leq 0.25^\circ$
Chamfer	$\leq 0.2 \text{ mm} \times 45^\circ$
Chip	$\leq 0.1 \text{ mm}$
Damage Threshold	$> 300 \text{ MW/cm}^2 @ 532 \text{ nm}$ , 10 ns, 10 Hz (AR-Coated); $> 150 \text{ MW/cm}^2 @ 266 \text{ nm}$ , 10 ns, 10 Hz (AR-Coated);
Quality Warranty Period	One year under proper use.

# NLO Crystals

## Coatings

- Dual or triple band AR-coating of CLBO for fourth and fifth harmonic generation of 1064 nm
- High damage threshold
- Long durability
- Other coatings are available upon request

Table 5. Reflectance of AR-coating

Base Material	AR-Coating	Reflectance
CLBO	AR- 532 nm/266 nm	R<0.2% @ 532 nm R<1% @ 266 nm
CLBO	AR- 1064 nm/523 nm/266 nm	R<1.5% @ 1064 nm R<2% @ 532 nm R<2% @ 266 nm
CLBO	AR- 1064 nm/266 nm/213 nm	R<1.5% @ 1064 nm R<2% @ 266 nm R<2% @ 213 nm

## Notes

CLBO crystal is very hygroscopic, and please use or keep it in dry and sealed environment.