CLBO - Cesium Lithium Borate ($CsLiB_6O_{10}$)

Introduction

Cesium Lithium Borate ($CsLiB_6O_{10}$ or CLBO) is a newly developed crystal with excellent UV nonlinear feature, and widely used for semiconductor inspection, micro processing, 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 (℃·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 Å, c = 8.939 Å
Symmetry	Z = 4
Melting Point	About 844.5 ℃

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℃·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 ° at 1064 nm, 1.83 ° at 532 nm, 0.98 ° 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	$d_{eff}(I) = d_{36} \sin\theta_m \sin(2\Phi)$ $d_{eff}(II) = d_{36} \sin(2\theta_m) \sin(2\Phi)$
Sellmeier Equations (λ in μm)	CLBO at 20 ℃ $n_o^2 = 2.2104 + 0.01018 / (\lambda^2 - 0.01424) - 0.01258\ \lambda^2$ $n_e^2 = 2.0588 + 0.00838 / (\lambda^2 - 0.01363) - 0.00607\ \lambda^2$ (0.1914 μm<λ<2.09 μm)

CLBO's Parameters

Table 4. Specifications

Dimension Tolerance	(W ± 0.1 mm) × (H ± 0.1 mm) × (L + 0.5/-0.1 mm) × (L≧2.5 mm) (W ± 0.1 mm) × (H ± 0. 1 mm) × (L + 0.1/-0.1 mm) × (L＜2.5 mm)
Clear Aperture	Central 90% of the diameter
Surface Quality (Scratch/Dig)	10/5 to MIL-PRF-13830B
Flatness	≦λ/6 @633 nm
Parallelism	20 arc sec
Perpendicularity	≦15 arc min
Angle Tolerance	Δθ≦0.25 °, ΔΦ≦0.25 °
Chamfer	≦0.2 mm × 45 °
Chip	≦0.1 mm
Damage Threshold	＞300 MW/cm² @532 nm, 10 ns, 10 Hz (AR-Coated); ＞150 MW/cm² @266 nm, 10 ns, 10 Hz (AR-Coated);
Quality Warranty Period	One year under proper use.

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/532 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.