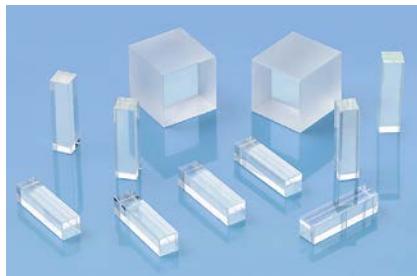


# Nonlinear Crystals

## LBO – LITHIUM TRIBORATE



LBO is well suited for various nonlinear optical applications:

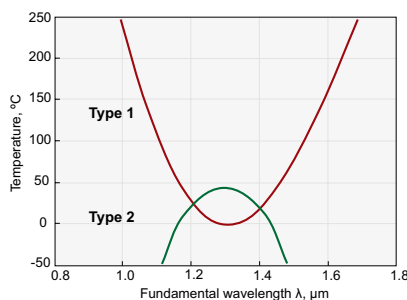
- frequency doubling and tripling of high peak power pulsed Nd doped, Ti:Sapphire and Dye lasers
- optical parametric oscillators (OPO) of both Type 1 and Type 2 phase-matching
- non-critical phase-matching for frequency conversion of CW and quasi-CW radiation.

### Standard specifications

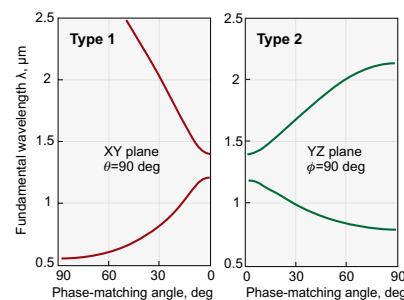
Flatness	$\lambda/8$ at 633 nm
Parallelism	< 20 arcsec
Surface quality	10 – 5 scratch & dig (MIL-PRF-13830B)
Perpendicularity	< 5 arcmin
Angle tolerance	< 30 arcmin
Aperture tolerance	$\pm 0.1$ mm
Clear aperture	90% of full aperture

### Features

- Wide transparency region
- Broad Type 1 and Type 2
- Non-critical phase-matching (NCPM) range
- Small walk-off angle
- High damage threshold
- Wide acceptance angle
- High optical homogeneity



NCPM SHG temperature dependence of LBO



SHG tuning curves of LBO

### We offer:

- Crystals length up to 90 mm and aperture up to 60 × 60 mm
- AR, BBAR, P-coatings
- Different mounting and repolishing services

### Standard Crystals list

Size, mm	$\theta$ , deg	$\phi$ , deg	Coating	Application	Catalogue number	Price, EUR
3x3x10	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-401	245
3x3x15	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-402	325
4x4x10	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-301	510
4x4x15	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-302	630
4x4x20	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-303	745
5x5x10	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-501	655
5x5x15	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-503	765
5x5x20	90	11.6	AR/AR @ 1064+532 nm	SHG @ 1064 nm	LBO-502	940
3x3x15	90	0	AR/AR @ 1064+532 nm	NCPM SHG @ 1064 nm, T = 149 °C	LBO-404	325
3x3x20	90	0	AR/AR @ 1064+532 nm	NCPM SHG @ 1064 nm, T = 149 °C	LBO-405	405
3x3x30	90	0	AR/AR @ 1064+532 nm	NCPM SHG @ 1064 nm, T = 149 °C	LBO-409	710
3x3x50	90	0	AR/AR @ 1064+532 nm	NCPM SHG @ 1064 nm, T = 149 °C	LBO-410	1300
4x4x10	90	0	AR/AR @ 1064+532 nm	NCPM SHG @ 1064 nm, T = 149 °C	LBO-304	510
4x4x15	90	0	AR/AR @ 1064+532 nm	NCPM SHG @ 1064 nm, T = 149 °C	LBO-305	630
4x4x20	90	0	AR/AR @ 1064+532 nm	NCPM SHG @ 1064 nm, T = 149 °C	LBO-306	745
3x3x10	42.2	90	AR/AR @ 1064+532/355 nm	THG @ 1064 nm	LBO-406	245
3x3x15	42.2	90	AR/AR @ 1064+532/355 nm	THG @ 1064 nm	LBO-407	325
4x4x10	42.2	90	AR/AR @ 1064+532/355 nm	THG @ 1064 nm	LBO-307	510
4x4x15	42.2	90	AR/AR @ 1064+532/355 nm	THG @ 1064 nm	LBO-308	630
5x5x10	42.2	90	AR/AR @ 1064+532/355 nm	THG @ 1064 nm	LBO-507	655
5x5x15	42.2	90	AR/AR @ 1064+532/355 nm	THG @ 1064 nm	LBO-508	765

## Physical and Optical properties

Chemical formula	LiB <sub>3</sub> O <sub>5</sub>		
Crystal structure	orthorhombic, mm2		
Optical symmetry	Negative biaxial		
Space group	Pna2 <sub>1</sub>		
Density	2.47 g/cm <sup>3</sup>		
Mohs hardness	6		
Optical homogeneity	∂n = 10 <sup>-6</sup> cm <sup>-1</sup>		
Transparency region at "0" transmittance level	155 – 3200 nm		
Linear absorption coefficient at 1064 nm	< 0.01 % cm <sup>-1</sup>		
Refractive indices:	n <sub>x</sub>	n <sub>y</sub>	n <sub>z</sub>
at 1064 nm	1.5656	1.5905	1.6055
at 532 nm	1.5785	1.6065	1.6212
at 355 nm	1.5971	1.6275	1.6430
Sellmeier equations (λ, μm)	$n_x^2 = 2.4542 + 0.01125 / (\lambda^2 - 0.01135) - 0.01388 \lambda^2$ $n_y^2 = 2.5390 + 0.01277 / (\lambda^2 - 0.01189) - 0.01849 \lambda^2 + 4.3025 \times 10^{-5} \lambda^4 - 2.9131 \times 10^{-5} \lambda^6$ $n_z^2 = 2.5865 + 0.0131 / (\lambda^2 - 0.01223) - 0.01862 \lambda^2 + 4.5778 \times 10^{-5} \lambda^4 - 3.2526 \times 10^{-5} \lambda^6$		
Phase matching range Type 1 SHG	554 – 2600 nm		
Phase matching range Type 2 SHG	790 – 2150 nm		
NCPM SHG temperature dependence:			
Type 1 range 950 – 1300 nm	T1 = - 1893.3λ <sup>4</sup> + 8886.6λ <sup>3</sup> - 13019.8λ <sup>2</sup> + 5401.5λ + 863.9		
Type 1 range 1300 – 1800 nm	T2 = 878.1λ <sup>4</sup> - 6954.5λ <sup>3</sup> + 20734.2λ <sup>2</sup> - 26378λ + 12020		
Type 2 range 1100 – 1500 nm	T3 = - 21630.6λ <sup>4</sup> + 112251λ <sup>3</sup> - 220460λ <sup>2</sup> + 194153λ - 64614.5		
NCPM SHG at 1064 nm Type 1 temperature	149 °C		
NCPM SHG at 1319 nm Type 2 temperature	43 °C		
Walk-off angle	7 mrad (Type 1 SHG 1064 nm)		
Thermal acceptance	6.4 K×cm (Type 1 SHG 1064 nm)		
Angular acceptance	6.5 mrad×cm (Type 1 SHG 1064 nm) 248 mrad×cm (Type 1 NCPM SHG 1064 nm)		
Nonlinearity coefficients	d <sub>31</sub> = (1.05±0.09) pm/V; d <sub>32</sub> = -(0.98±0.09) pm/V; d <sub>33</sub> = (0.05±0.006) pm/V		
Effective nonlinearity:			
XY plane	d <sub>ooe</sub> = d <sub>32</sub> cosφ		
YZ plane	d <sub>ooo</sub> = d <sub>ooo</sub> = d <sub>31</sub> cosθ		
Expansion coefficients	α <sub>x</sub> = 10.8 × 10 <sup>-5</sup> K <sup>-1</sup> ; α <sub>y</sub> = - 8.8 × 10 <sup>-5</sup> K <sup>-1</sup> ; α <sub>z</sub> = 3.4 × 10 <sup>-5</sup> K <sup>-1</sup>		
Laser induced damage threshold (LIDT)	> 5 J/cm <sup>2</sup> (>500 MW/cm <sup>2</sup> ), 1064 nm, 10 ns, 10 Hz		

Please contact EK SMA OPTICS for further information or nonstandard specifications.

## Related Products

LBO crystals for SHG of Yb:KGW/KYW laser frequency conversion. See page 2.17

Crystal Oven TC2

See page 2.28



149 °C temperature is required to achieve Non-Critical Phase Matching (NCPM) in LBO at type 1 SHG of 1064 nm application. **TC2 oven** is specially designed for this purpose.

Heatpoint  
Crystal Oven

See page 2.29



**Heatpoint** is a compact round oven designed for heating (30 – 80 °C) of humidity sensitive nonlinear crystals. It is used to prevent moisture condensation on crystal faces or for thermostabilization of the crystals.