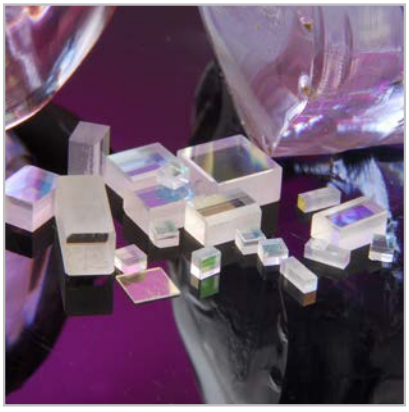
Nonlinear Crystals



The generation of beams with a double frequency (i.e. half wavelength) or other multiple frequencies is done with so-called nonlinear crystals.

Various crystal materials are available. These materials vary in the wavelength range that can be used, crystal structure, and therma properties. Our product specialists would be more than happy to assist you when choosing an appropriate crystal for your application.

Typical Applications for Nonlinear Crystals

- Frequency multiplication (SHG, THG, …)
- Frequency mixing (SFM, DFM)
- Optical parametric oscillators/amplifiers (OPO/OPA)
- Electro-optical components (Pockels cells, Q-switches)

You can find a list of common nonlinear crystals in the following table. Additional crystals not listed here are available upon request.

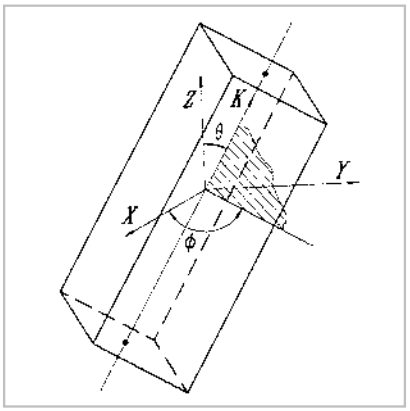
Crystal	Transparency Range [nm]	Typ. Application*)	Damage Threshold for 1.06 µm, 10 ns, 10 Hz [GW/cm²]	Details
BBO	190 – 3500	(1), (2), (3), (4)	>1	SHG coefficient 6 times greater than that of KDP
LBO	160 – 2600	(1), (3)	>10	High damage threshold
KTP	350 – 4500	(1), (2), (3), (4)	0.45	High nonlinear coefficient, non hygroscopic
$LiNbO_3$	420 – 5200	(1), (3), (4)	0.1	Most commonly used for pockelscells, waveguides
KDP	200 – 1500	(1), (3), (4)	>5	Widely used as electro-optical modulators, q-switches, pockelscells
KD*P	200 – 1600	(1), (4)	>3	
RTP	350 – 4500	(1), (2), (3), (4)	≈ 0.9	A promising crystal for electro-optical applications at high repetition rate
BiB_3O_6	286 – 2500	(1), (3)	>0.3	Relatively new, promising doubling crystal to produce blue laser

*)
(1) Frequency multiplication (SHG, THG, …)
(2) Frequency mixing (SFM, DFM)
(3) Optical parametric oscillators/amplifiers (OPO/OPA)
(4) Electro-optical components (Pockels cells, Q-switches)

United Kingdom
Laser Components (UK) Ltd.
Tel: +44 1245 491 499
Fax: +44 1245 491 801
info@lasercomponents.co.uk
www.lasercomponents.co.uk

Definitions

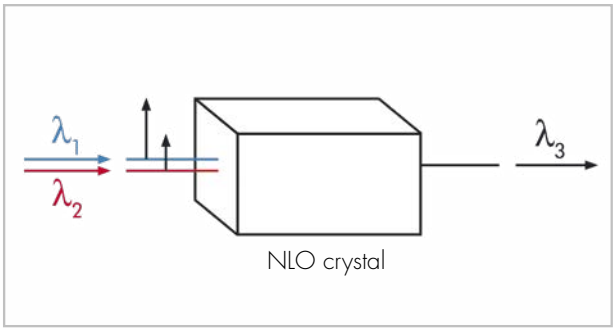
- θ: polar angle between the optical axis and the propagation direction
- ϕ: azimuthal angle between the projection of propagation direction onto the x/y plane and the x axis



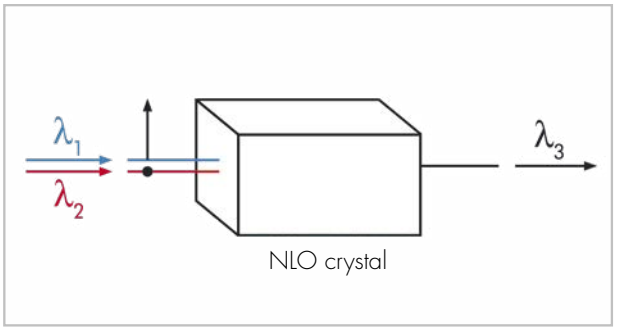
Polar coordinate system in crystal
(K is the light propagation direction)

Phase Matching

- CPM:
  critical phase matching (θ ≠ 0° or ≠ 90°)
- NCPM:
  non-critical phase matching (θ = 0° or 90°)
- Type I:
  the polarizations of the two input beams are parallel to each other
- Type II:
  the polarizations of the two input beams are perpendicular to each other



Type I Phase Matching



Type II Phase Matching

The following information is required when requesting a quotation:

- Type of crystal
- Application (e.g. SHG1064 → 532)
- Phase adjustment (Type I or Type II)
- Orientation (θ, ϕ)
- Dimensions (length x width x height)
- Cutting angle (plane, Brewster cut)
- Coating

Mounts and special accessories such as ovens or temperature control units are also available.

United Kingdom
Laser Components (UK) Ltd.
Tel: +44 1245 491 499
Fax: +44 1245 491 801
info@lasercomponents.co.uk
www.lasercomponents.co.uk

Please have the following laser data ready:

- Input wavelength in nm
- For cw lasers: power density in W/cm²
- For pulsed lasers: energy density in J/cm² and pulse length as well as pulse rate
- Possibly additional information such as mode or divergence

Typical Specifications

Diameter tolerance	± 0.1 mm
Length tolerance	± 0.5 mm
Surface figure	λ/10 at 633 nm
Surface quality	10-5 per MIL-O-1380A
Parallelism	< 10 arc sec
Perpendicularity	< 15 arc min
Chamfer	<0.1 mm at 45°

United Kingdom
Laser Components (UK) Ltd.
Tel: +44 1245 491 499
Fax: +44 1245 491 801
info@lasercomponents.co.uk
www.lasercomponents.co.uk