

Fe:LiNbO₃

Fe:LiNbO₃ is a common used photorefractive crystal with large electro-optic (E-O) coefficients, high photorefractive sensitivity and high diffraction efficiency. Compared to BaTiO₃ series photorefractive crystals, it has some outstanding advantages such as easy operation and storage, low cost and large size availability, which make it more suitable for volume fabrication and practical devices. Therefore, Fe:LiNbO₃ crystal has a wide range applications: Holographic Storage, Bragg Grating, Dynamic Holography, Optical Memories, Optical Phase Conjugation and Neutral Networks.

Basic Properties

Crystal Structure	Trigonal, Space group R _{3c}
Cell Parameters	a = 5.148 Å, c = 13.863 Å
Mohs Hardness	5.0
Density	4.64 g/cm ³
Melting Point	1255°C
Curie Point	1140°C
Color	Colorless to Brown
Solubility:	Insoluble in H ₂ O
Note: Please refer to the LiNbO ₃ crystal for further thermal and optical properties.	

Standard Specifications

Composition	Congruent
Iron Level	0.005 to 0.20 mol%
Available Size	Up to 40x40x40 mm or 3.0" in diameter
Orientations	0°, 45°, C-cut or others directions
Flatness	λ/4 @ 633nm
Surface Quality	Scratch/Dig 20/10 to MIL-O-13830A
Parallelism	Better than 20 arc sec.
Perpendicularity	5 arc minutes
Orientation Tolerance	± 0.5°
Clear Aperture	>90% central area
Chamfer	< 0.2 mm @ 45°
Note: Other specifications and AR coatings can be provided upon request.	

Other Photorefractive Crystals:

Bi₁₂SiO₂₀ (BSO), Bi₁₂GeO₂₀ (BGO), Bi₁₂TiO₂₀ (BTO) and Bi₄Ge₃O₁₂ (BGO) crystals

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BaTiO₃

Barium Titanate (BaTiO₃) is an excellent photorefractive material which has high SPPC (Self Pumped Phase Conjugation) and TWM (Two Wave Mixing optical amplification) efficiency. It is important material for the applications of information processing and image storage. In addition it is also an important substrate material for making of some special epitaxial films as its unique ferroelectric and other properties.

Basic Properties

Crystal Structure	Tetragonal (4m): 13 °C < T < 132 °C
Lattice Parameters	a = 3.99 Å , c = 4.04 Å
Growth Method	TSSG (Top Seeded Solution Growth)
Melting Point	1612 °C
Density	6.06 g/cm ³ (at 26 °C)
Mohs Hardness	4.5
Index of Refraction	n _o = 2.4912, n _e = 2.4247 @515nm n _o = 2.4160, n _e = 2.3630 @633nm n _o = 2.3681, n _e = 2.3235 @800nm
Transmission Wavelength	430 ~ 6300 nm
Specific Heat	0.527J/g · K (300K)
Thermal Conductivity	6W/m · K (300K)
Thermal Expansion (10 ⁻⁶ K ⁻¹)	15.7//a, 6.2//c
Dielectric Constant (ε _r)	ε _a =3000 ε _c =800
Electro-Optic Coefficients	r _{T13} =8 ± 2pm/V , r _{T33} =105 ± 10pm/V, r _{T42} =1300 ± 100pm/V,
Reflectivity of SPPC (at 0° cut)	≥ 40%
Two-Wave Mixing Coupling Constant	10 – 40cm ⁻¹
Absorption Loss	α = 0.285cm ⁻¹ @515nm α = 0.108cm ⁻¹ @633nm α = 0.033cm ⁻¹ @800nm
Wavelength Range for Photorefractive Effect	Undoped BaTiO ₃ : for visible Ce: BaTiO ₃ : 480-780nm Rh: BaTiO ₃ : for 720-1060nm

Typical Size:

Photorefractive Grade: 3 x 3 x 3, 4 x 4 x 4, 5 x 5 x 5mm; 2-6 faces polished and poled 0° or 45° cut

Substrate Grade: 5 x 5 x 1.0mm, 10 x 10 x 1.0mm; 1 face or 2 faces polished

[100], [110], [111]: unpoling; [001]: poling

Note:

- The tetragonal BaTiO₃ single crystal (the useful phase for both photorefractive effect and substrate) will change the phase when its temperature is lower than 13 °C or higher than 125 °C, so it is necessary to keep temperature in the safe range during its application, storage and transportation.
- The extra force such as compacting, cracking will cause a phase transition
- Poling is needed for [001] orientation substrate, while is not necessary for [100], [110], [111] orientations.

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Bi₄Ge₃O₁₂

Bismuth germanate (Bi₄Ge₃O₁₂ or BGO) crystal is grown by Czochralski method, it is an inorganic oxide with cubic eulytine structure, colorless, transparent and insoluble in water. Because of its high stopping power, high photopeak efficiency, non-hygroscopic, low afterglow and easy to be fabricated. BGO crystals have been widely used in photorefractive, photoconductive, electro-optics and acousto-optic application and in high energy physics, nuclear physics, space physics, nuclear medicine, geological prospecting etc.

Basic Properties

Crystal Structure	Cubic
Lattice Parameter	a = 10.518 ^⑥
Melting Point	1045 C
Transmission Range	470-750nm
Refractive Index @ 633nm	2.55
Density	7.12g/cm ³
Mohs Hardness	5
Excited Spectrum	305 nm
Fluorescence Spectrum	480-510 nm
Decay Time	300 ns
Relative Light Output	10-14% NaI(Tl)
Dielectric Constant	40
Electro-Optic Coefficient	r ₄₁ = 1.03x10 ⁻¹² m/V
Threshold Energy	10.5 MeV
Loss Tangent	0.0035

Standard Specifications

Dimensional Tolerance	(W 0.1mm) x (H 0.1mm) x (L +0.2/-0.1 mm)
Wavefront Distortion	< /4 @633 nm
Angle Tolerance	< 0.3 , < 0.3
Flatness	/8 @633 nm
Surface Quality	20/10 Scratch/Dig per MIL-O-13830A
Parallelism	< 20 arc seconds
Perpendicularity	< 5 arc minutes

Other Photorefractive Crystals

Rh doped BaTiO₃, Bi₁₂SiO₂₀ (BSO), Bi₁₂GeO₂₀ (BGO), Bi₄TiO₂₀ (BTO), Bi₄Ge₃O₁₂ (BGO), Fe:LiNbO₃, BSO, BGO, etc. are also available.

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