

Lithium Niobate

Lithium niobate (LiNbO₃) is a ferroelectric crystal that belongs to the trigonal crystal system.

Lithium niobate is transparent between 0.25 and 5.3 μm (fig. 1). It can be used in visible, near IR and middle IR region.

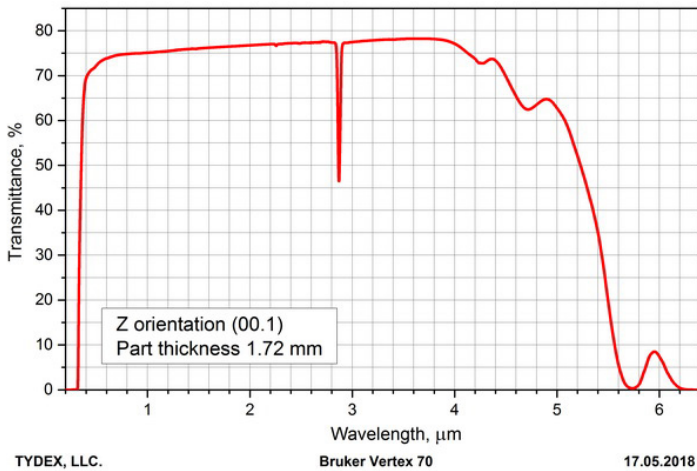


Fig. 1. Transmittance spectrum of lithium niobate.

As any ferroelectric, lithium niobate demonstrates piezoelectric effect, nonlinear optic effects, photoelastic effect and Pockels effect (linear electro-optic effect). What makes lithium niobate stand out is that the coefficients characterizing these effects are several times greater than those of similar ferroelectrics, facilitating its usage for various applications.

Due to its high electro-optical coefficients, lithium niobate is used for optical amplitude and phase modulators, Pockels cells, laser Q-switching modulators.

Non-linear optical properties of lithium niobate allow its application for optical parametric oscillators and parametric amplifiers for a wide wavelength range.

Lithium niobate is the best choice for second harmonic generator in Nd:YAG laser operating at 1.064 μm, as well as semiconductor lasers operating at 1.3 and 1.55 μm.

It should be noted that non-doped lithium niobate exhibits high photorefraction. Therefore in high-power laser applications, magnesium oxide-doped crystals (MgO:LiNbO₃) are used. They have a higher Laser Damage Threshold. At the same time, the doping has no effect on the optical properties of the crystal.

Physical properties of lithium niobate crystals are summarized in the table below.

Table 1. Key physical properties of optical grade non-doped lithium niobate crystals.

Crystal structure	Rhombohedral, space group R3c, point group 3m
Primitive cell dimensions, Å	a=5.148, c=13.868
Refractive indices	n _o =2.220, n _e =2.146 @1300 nm n _o =2.232, n _e =2.156 @1064 nm n _o =2.286, n _e =2.203 @632.8 nm
Optical homogeneity, cm ⁻¹	~5×10 ⁻⁵
Density, g/cm ³	4.64

Curie temperature, °C	1157
Melting point, °C	1253
Mohs hardness	5
Thermal expansion coefficients (@ 25°C), K ⁻¹	c=4×10 ⁻⁶ , ⊥c=15.7×10 ⁻⁶
Thermal conductivity, W/(m × K)	c=4.61, ⊥c=4.19
Specific heat capacity, J/(kg × K)	648
Shear modulus (G), Pa	7.99 × 10 ¹⁰
Elastic constants, GPa (@298 K)	C ₁₁ ^E =204, C ₃₃ ^E =246, C ₄₄ ^E =60, C ₁₃ ^E =75, C ₁₄ ^E =9
Piezoelectric constants, C/N	D ₂₂ =20.8×10 ⁻¹² , D ₃₃ =6.5×10 ⁻¹²
Dielectric constants (@300 K)	ε _{11/ε0} ^T =85.2, ε _{33/ε0} ^T =30, ε _{11/ε0} ^S =45, ε _{33/ε0} ^S =27.5
Nonlinear optic coefficients, m/V	d ₃₃ =37.8×10 ⁻¹² , d ₃₁ =5.1×10 ⁻¹² , d ₂₂ =2.46×10 ⁻¹²
Sellmeier equation coefficients (λ in μm)	n _o ² =4.9048+0.11768/(λ ² -0.04750)- 0.027169λ ² n _e ² =4.5820+0.099169/(λ ² -0.04443)- 0.02195λ ²
Damage Threshold, MW/cm ² (10 ns, 1064 nm)	100
Water solubility	Insoluble

The properties of LiNbO₃ optical parts produced by our company are listed below:

- Maximum diameter (length) of the parts – up to 100 mm;
- Crystal orientation – on request;
- Orientation tolerance – ±10';
- Surface quality – 20/10 scr/dig;
- Surface parallelism – 20 arcseconds;
- Perpendicularity – 5 arcminutes.

Please pay attention that this article is only for your information. We do not supply lithium niobate in boules, ingots as well as semi-finished products. Our standard products are finished (polished, coated) parts.