LN - Lithium Niobate ($LiNbO_3$)

Introduction

Lithium Niobate ($LiNbO_3$ or LN) is widely used as frequency doublers for wavelength > 1μm, optical parametric oscillators (OPOs) pumped at 1064 nm as well as quasi-phase-matched (QPM) devices. Additionally due to its large Electro-Optic (E-O) and Acousto-Optic (A-O) coefficients, $LiNbO_3$ crystal is the most commonly used material for Pockel cells, Q-switches and phase modulators, waveguide substrates, and surface acoustic wave (SAW) wafers, etc. CASTECH can provide $LiNO_3$ crystals with high quality and large size for all these applications.

CASTECH provides

- 50,000 to 100,000 pcs/month of $LiNbO_3$ wedges used for fiber optical isolators and circulators
- Strict quality control
- Technical support
- Fast delivery
- Competitive price

Basic Properties

Table 1. Chemical and Physical Properties

Crystal Structure	Trigonal, Space group R3c, Point group 3m
Lattice Parameter	a = 5.148 Å, c = 13.863 Å
Melting Point	1253℃
Curie Temperature	1140℃
Mohs Hardness	5 Mohs
Density	4.64 g/cm^3
Elastic Stiffness Coefficients	C^e_{11} = 2.33 (× 10^{11} N/m^2) C^E_{33} = 2.77 (× 10^{11} N/m^2)

Table 2. Optical and Nonlinear Optical Properties

Transparency Range	420-5200 nm
Optical Homogeneity	~5 ×10^{-5}/cm
Refractive Indices	n_e = 2.146, n_o = 2.220 @1300 nm n_e = 2.156, n_o = 2.232 @1064 nm n_e = 2.203, n_o = 2.286 @632.8 nm
NLO Coefficients	d_{33} = 86 × d_{36}(KDP) =37.84 pm/V d_{31} = 11.6 × d_{36}(KDP) =5.10 pm/V d_{22} = 5.6 × d_{36}(KDP) =2.46 pm/V
Effective NLO Coefficients	$d_{eff}(I) = d_{31} \sin\theta - d_{22} \cos\theta \sin 3\Phi$ $d_{eff}(II) = d_{22} \cos^2\theta \cos 3\Phi$
Sellmeier Equations (λ in μm)	$n_o^2 = 4.9048 + 0.11768 / (\lambda^2 - 0.04750) - 0.027169\,\lambda^2$ $n_e^2 = 4.5820 + 0.099169 / (\lambda^2 - 0.04443) - 0.02195\,\lambda^2$
Damage Threshold	100 MW/cm^2 (10 ns, 1064 nm)

Table 3. Thermal and Electrical Properties of $LiNbO_3$

Thermal Conductivity	38 W/m/K @25 ℃
Thermal Expansion Coefficients (at 25℃)	//a, 2.0×10^{-6}/K //c, 2.2×10^{-6}/K
Resistivity	$2\times10^{-6}\Omega\cdot$cm @200 ℃
Dielectric Constants	$\varepsilon^S_{11}/\varepsilon_0 = 43$, $\varepsilon^T_{11}/\varepsilon_0 = 78$ $\varepsilon^S_{33}/\varepsilon_0 = 28$, $\varepsilon^T_{33}/\varepsilon_0 = 32$
Piezoelectric Strain Constant	$D_{22} = 2.04 \times 10^{-11}$ C/N $D_{33} = 19.22 \times 10^{-11}$ C/N
Electro-Optic Coefficients	$\gamma^T_{33} = 32$ pm/V, $\gamma^S_{33} = 31$ pm/V, $\gamma^T_{31} = 10$ pm/V, $\gamma^S_{31} = 8.6$ pm/V, $\gamma^T_{22} = 6.8$ pm/V, $\gamma^S_{22} = 3.4$ pm/V
Half-Wave Voltage, DC Electrical field // z, light ⊥ z; Electrical field // x or y, light // z;	 3.03 KV 4.02 KV

Table 4. Specifications

Dimension Tolerance	(W ± 0.1 mm) × (H ± 0.1mm) × (L ± 0.2mm)
Clear Aperture	Central 90% of the diameter
Surface Quality (Scratch/Dig)	20/10 to MIL-PRF-13830B
Flatness	λ/8 @633 nm
Transmitted Wavefront Distortion	≦λ/4 @633 nm
Parallelism	20 arc sec
Perpendicularity	≦15 arc min
Angle Tolerance	≦±0.5°
Quality Warranty Period	One year under proper use

AR-coatings

CASTECH provides the following AR-coatings:

- Dual Band AR-coating (DBAR) at 1064/532 nm on both surface, with low reflectance (R<0.2% @1064 nm and R<0.5% @532 nm)
- AR-coating and gold/chrome plated on side faces for E-O applications
- Other coatings are available upon request