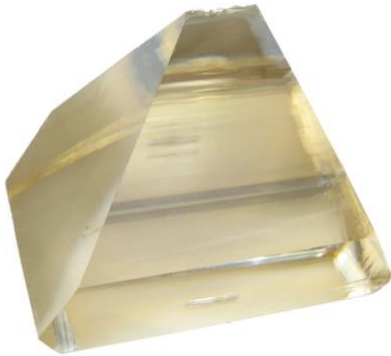




GAMDAN OPTICS

Potassium Titanium Oxide Phosphate (KTiOPO_4)



Potassium Titanium Oxide Phosphate (KTP) is an efficient nonlinear optical crystal in the visible to infrared spectral region with relatively low cost. It has large nonlinear coefficient. The effective nonlinear optical coefficient of KTP d_{eff} at 1064nm is more than 1.5 times that of BBO. Its damage threshold is near 1 GW/cm^2 for 1 Hz 10 ns pulses at 1064nm.

Features

- Efficient frequency conversion (1064nm SHG conversion efficiency is about 80%)
- Large nonlinear optical coefficients (15 times that of KDP)
- Wide angular bandwidth and small walk-off angle
- Broad temperature and spectral bandwidth
- High thermal conductivity (2 times that of BNN crystal)
- Moisture free
- Minimum mismatch gradient
- Super-polished optical surface
- No decomposition below 900°C
- Mechanically stable
- Low cost compare with BBO and LBO

Applications

- Frequency Doubling (SHG) of Nd-doped Lasers for Green/Red Output
- Frequency Mixing (SFM) of Nd Laser and Diode Laser for Blue Output
- Parametric Sources (OPG, OPA and OPO) for 0.6mm-4.5mm Tunable Output
- Electrical Optical (E-O) Modulators, Optical Switches, and Directional Couplers
- Optical Waveguides for Integrated NLO and E-O Devices

Additional applications for KTP include mixed frequency, electro-optical modulation, optical parametric generation and optical waveguide.

Potassium Titanium Oxide Phosphate

Physical Properties

Crystal Structure	Orthorhombic
Point Group	mm2
Melting Point	1172°C incongruent
Lattice Parameters	a=6.404Å b=10.615Å c=12.814Å Z=8
Temperature of Decomposition	~1150°C
Transition Temperature	936°C
Mohs Hardness	~5
Density	2.945 g/cm ³
Color	colorless
Hygroscopic Susceptibility	no
Specific Heat	0.1737 cal/g.°C
Thermal Conductivity	0.13 W/cm/°C
Electrical Conductivity	3.5x10 ⁻⁸ s/cm (c-axis, 22°C, 1KHz)
Thermal Expansion Coefficients	a1 = 11 x 10 ⁻⁶ °C ⁻¹ a2 = 9 x 10 ⁻⁶ °C ⁻¹ a3 = 0.6 x 10 ⁻⁶ °C ⁻¹
Thermal Conductivity Coefficients	k1 = 2.0 x 10 ⁻² W/cm °C k2 = 3.0 x 10 ⁻² W/cm °C k3 = 3.3 x 10 ⁻² W/cm °C
Dielectric Constant	e _{eff} = 13

Optical Properties

Transmitting Range	350nm ~ 4500nm			
Refractive Indices		n_x	n_y	n_z
	1064nm	1.7400	1.7469	1.8304
	532nm	1.7787	1.7924	1.8873
Absorption Coefficients	a < 1%/cm @1064nm and 532nm			
Thermo-Optic Coefficients	dn _x /dT=1.1x10 ⁻⁵ /°C			
	dn _y /dT=1.3x10 ⁻⁵ /°C			
	dn _z /dT=1.6x10 ⁻⁵ /°C			
Electro-Optic Coefficients		Low frequency (pm/V)	High frequency (pm/V)	
	Γ ₁₃	9.5	8.8	
	Γ ₂₃	15.7	13.8	
	Γ ₃₃	36.3	35.0	
	Γ ₅₁	7.3	6.9	
	Γ ₄₂	9.3	8.8	

Sellmeier Equations

$$\begin{aligned}n_x^2 &= 2.10468 + 0.89342\lambda^2/(\lambda^2 - 0.04438) - 0.01036\lambda^2 \\n_y^2 &= 2.14559 + 0.87629\lambda^2/(\lambda^2 - 0.0485) - 0.01173\lambda^2 \\n_z^2 &= 1.9446 + 1.3617\lambda^2/(\lambda^2 - 0.047) - 0.01491\lambda^2\end{aligned}$$

Nonlinear Optical Properties

Phase Matching Range	497nm - 3300nm
Nonlinear Coefficients (@1064nm)	$d_{31}=2.54\text{pm/V}$, $d_{31}=4.35\text{pm/V}$, $d_{31}=16.9\text{pm/V}$ $d_{24}=3.64\text{pm/V}$, $d_{15}=1.91\text{pm/V}$ at 1.064 mm
Effective Nonlinear Optical Coefficients	$d_{\text{eff}}(\text{II}) \approx (d_{24} - d_{15})\sin 2\theta \sin 2\varphi - (d_{15}\sin^2\varphi + d_{24}\cos^2\varphi)\sin\theta$

Type II SHG of 1064nm Laser

Phase Matching Angle	$\theta=90^\circ$ $\varphi=23.2^\circ$
Effective Nonlinear Optical Coefficients	$d_{\text{eff}} \approx 8.3 \times d_{36}(\text{KDP})$
Angular Acceptance	$\Delta\theta= 75 \text{ mrad}$ $\Delta\varphi= 18 \text{ mrad}$
Temperature Acceptance	25°C.cm
Spectral Acceptance	5.6 Åm
Walk-Off Angle	1 mrad
Optical Damage Threshold	1.5-2.0MW/cm ²

Main Specifications

Dimension	1x1x0.05mm - 30x30x40mm
Phase Matching Type	Type II, $\theta=90^\circ$ ϕ =phase-matching angle a) S1&S2: AR @1064nm R<0.1%; AR @ 532nm, R<0.25%. b) S1: HR @1064nm, R>99.8%; HT @808nm, T>5%, S2: AR @1064nm, R<0.1%; AR @532nm, R<0.25%
Typical Coating	Customized coating available upon customer request.
Angle Tolerance	6'
Dimension Tolerance	$\Delta\theta < \pm 0.5^\circ$, $\Delta\phi < \pm 0.5^\circ$, $\pm 0.02 - 0.1$ mm
Flatness	(W ± 0.1 mm) x (H ± 0.1 mm) x (L + 0.2mm/-0.1mm) for NKC series $\lambda/8 @ 633$ nm 10/5 Scratch/dig per MIL-O-13830A <10'
Scratch/Dig Code	better than 10 arc seconds for NKC series
Parallelism	5'
Perpendicularity	5 arc minutes for NKC series
Wavefront Distortion	less than $\lambda/8 @ 633$ nm
Clear Aperture	90% central area
Working Temperature	25°C- 80°C
Homogeneity	dn $\sim 10^{-6}$ /cm



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