NEW SOURCE TECHNOLOGY LLC

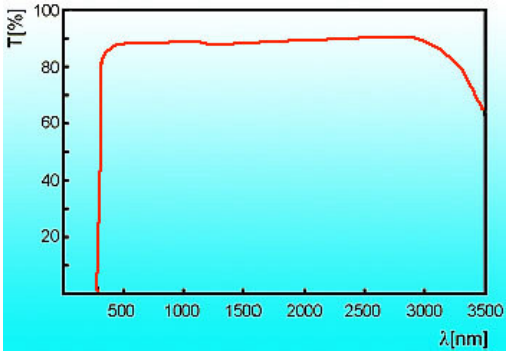
KTP Crystals

Introduction

Potassium Titanyl Phosphate (KTP) has the following exceptional properties that make it a very important nonlinear crystal:

- Large nonlinear optical coefficient
- Wide angular bandwidth and small walk-off angle
- Broad temperature and spectral bandwidth
- High electro-optic coefficient and low dielectric constant
- Large figure of merit
- Nonhydroscopic, chemically and mechanically stable
- High thermal conductivity
- Moisture free
- Minimum mismatch gradient
- Low cost compare with BBO and LBO

KTP is a negative biaxial crystal, with the principal axes X, Y, and Z ($n_z > n_y > n_x$) parallel to the crystallographic axes a, b, and c, respectively.



Structural and Physical Properties:

Crystal structure	Orthorhombic, space group $Pna2_1$,point group mm2
Cell parameters	a=6.404Å, b=10.616Å, c=12.814Å, Z=8
Melting point	1172°C incongruent
Curie point	936°C
Mohs hardness	≈5
Density	3.01 g/cm^3
Color	colorless
Hygroscopic susceptibility	no
Specific heat	0.1643 cal/g·°C
Thermal conductivity	0.13 W/cm/°K
Electrical conductivity	$3.5x10^{-8}$ s/cm (c-axis, 22°C, 1KHz)

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Linear Optical Properties:

Transmitting range:	350 nm - 4500 nm
Sellmeier equations: (λ in μm)	$n_x^2=3.0065+0.03901/(\lambda^2-0.04251)-0.01327\lambda^2$ $n_y^2=3.0333+0.04154/(\lambda^2-0.04547)-0.01408\lambda^2$ $n_z^2=3.0065+0.05694/(\lambda^2-0.05658)-0.01682\lambda^2$
Therm-optic coefficients:	$dn_x/dT=1.1x10^{-5}$/°C, $dn_y/dT=1.3x10^{-5}$/°C, $dn_z/dT=1.6x10^{-5}$/°C
Absorption coefficient:	$\alpha < 1\%$ cm^{-1} @1064nm and 532nm

Nonlinear Optical Properties:

Phase matchable SHG range:	497 - 1800nm	
Nonlinear optical coefficients:	$d_{31}=6.5$pm/v, $d_{32}=5$pm/v, $d_{33}=13.7$pm/v, $d_{24}=7.6$pm/v, $d_{15}=6.1$pm/v	
Effective nonlinearity expressions	$d_{eff}(II)\approx (d_{24}-d_{15})\sin2\phi\sin2\theta - (d_{15}\sin^2\phi + d_{24}\cos^2\phi)\sin\theta$	
For type II SHG of a Nd:YAG: Laser at 1064nm:	PM angle: $\theta=90°$, $\phi=23.5°$ Effective SHG coefficient: $d_{eff}\approx 8.3xd_{36}$(KDP) Angular acceptance: 20 mrad-cm Temperature acceptance: 25°C-cm Spectral acceptance: 5.6 Å -cm Walk-off angle: 4.5 mrad (0.26°) Optical damage threshold: > 450MW/cm^2, (@ 1064nm, 10ns, 10Hz)	
Electro-optic coefficients:	Low frequency (pm/V)	High frequency (pm/V)
r_{13}	9.5	8.8
r_{23}	15.7	13.8
r_{33}	36.3	35.0
r_{51}	7.3	6.9
r_{42}	9.3	8.8
Dielectric constant:	$\varepsilon_{eff}=13$	

KTP's Applications:

- Frequency doubling (SHG) of Nd-doped lasers for green/red outputs.
- Frequency mixing (SFM) of Nd laser and diode laser for blue outputs.
- Parametric sources (OPG, OPA and OPO) for 600nm-4500nm tunable outputs.
- E-O modulators, optical switches, directional couplers.
- Optical waveguides for integrated NLO and E-O devices.

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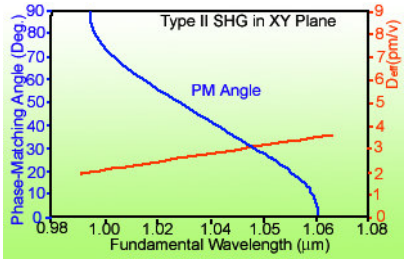
SHG and SFG of Nd:lasers

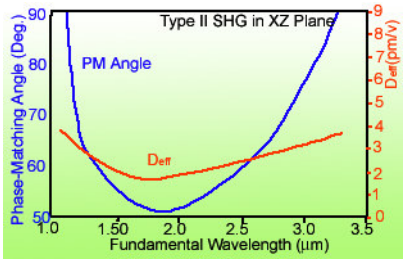
KTP is the most commonly used material for frequency doubling of Nd lasers, particularly for the low or medium level power density. Applied to diode-pumped Nd:YVO_4 lasers, KTP has provided the basis for the construction of compact green solid state laser systems in industry applications.

OPG, OPA and OPO

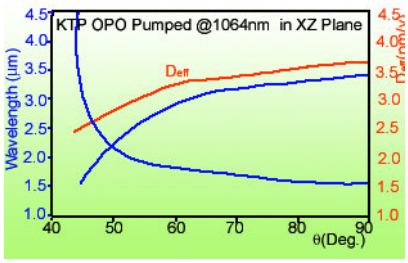
As an efficient OPO crystal pumped by a Nd:laser and its second harmonics, KTP plays an important role for parametric sources for tunable outputs from visible (600nm) to mid-IR (4500nm).



Type II SHG in XY Plane



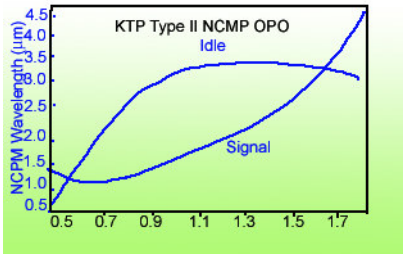
Type II SHG in XZ Plane



OPO Pumped at 1064 nm

NCPM KTP for OPO

The recently developed new application is the non-critical phase-matched (NCPM) KTP OPO/OPA application. The NCPM KTP OPO keeps the KTP crystal fixed in X-axis and tunes the pumping wavelength. If 1064nm pumping source, the output will be at 1.57μm (signal) and 3.3 μm (idler). Due to the favorable NLO properties of NCPM KTP, as high as 45% conversion efficiency was obtained with narrow output bandwidth and good beam quality.



KTP Specifications:

Transmitting wavefront distortion: less than λ/4 @ 633 nm
Dimension tolerance: (W ± 0.1 mm) x (H ± 0.1 mm) x (L + 0.2 mm/-0.1mm)
Clear aperture: > 90% central area
Flatness: λ/8 @ 633 nm
Scratch/Dig code: 10/5 to MIL-O-13830A
Parallelism: better than 20 arc seconds

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Perpendicularity: 5 arc minutes

Angle tolerance: $\Delta\theta < \pm 0.5°$, $\Delta\phi < \pm 0.5°$
AR coating: R< 0.2% at 1064nm and R<1.0% at 532 nm.
Quality Warranty Period: one year under proper use.

New Source Technology can supply:

- More than 200,000pcs/year ability
- High inside quality without any defection.
- Large crystal size up to 20x20x40mm^3
- Low absorption at 532nm
- Large quantity standard products in-stock
- Fast delivery. (2-4 weeks ARO)
- Strict quality control;

Standard Products

Part No.	Dimension	Application	Coating	Type
KTP2203	2x2x3mm	SHG@1064nm	AR/HR coating	II
KTP2205	2x2x5mm	SHG@1064nm	AR/AR coating	II
KTP2210	2x2x10mm	SHG@1064nm	DBAR-coating	II
KTP2305	3x3x5mm	SHG@1064nm	DBAR-coating	II
KTP2310	3x3x10mm	SHG@1064nm	DBAR-coating	II
KTP2605	6x6x5mm	SHG@1064nm	DBAR-coating	II
KTP2705	7x7x5mm	SHG@1064nm	DBAR-coating	II
KTP2907	9x9x7mm	SHG@1064nm	DBAR-coating	II
KTP2720	7x7x20mm	OPO for 1064→1570nm	AR coating	II

AR Coating: AR@1064nm&532nm; HR Coating: HR@1064nm&HT@532nm

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