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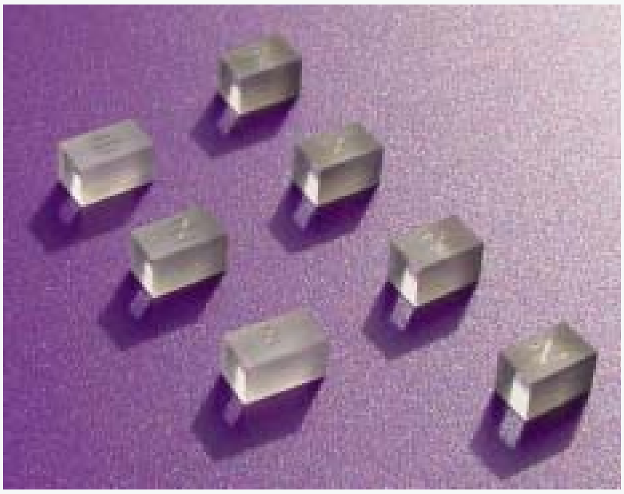
Potassium Titanyl Phosphate – KTP



KTP ($KTiOPO_4$) is a nonlinear optical crystal, which possesses excellent nonlinear, electrooptic and acousto-optical properties. A combination of high nonlinear coefficient, wide transparency range, and broad angular as well as thermal acceptances makes KTP very attractive for different nonlinear optical and wavequide applications. EKSMA Co. offers the different kind of KTP crystals depending on required application: KTP for extracavity systems (**Ex-KTP**), KTP for Intracavity (**In-KTP**) and KTP with High Gray Tracking Resistivity (**HGTR KTP**).

Ex-KTP is standard crystal with the parameters mostly used in extracavity configuration when the single pass through the crystal is required.

In-KTP crystals are optimised for SHG intracavity configuration in low peak power CW lasers. Because of large number of passes through the crystal low insertion losses and high homogeneity are essential for crystal efficiency. The special highest quality material selected by SHG efficiency mapping of each crystal, fine surface polishing and dual band AR coatings with very low losses allow EKSMA Co. to produce KTP crystals suitable for infracavity SHG application.

HGTR KTP is the new crystal type grown by special recently implemented technology. It has almost 2 times larger damage and gray tracking thresholds allowing to use HGTR KTP in high power lasers.

Transparency band edges of KTP crystal are at 0.35 μm in UV and at 3.5 μm in IR region. The phase-matching range of KTP crystal lies in 0.99–3.3 μm region. This allows to use KTP as intracavity and extracavity frequency doubler for the most commonly used lasers, such as Nd:YAG, Nd:YVO and Nd:YLF[(1)].

EKSMA offers:

- Crystal size up to 10×10×15 mm or 5×5×20 mm
- Singleband and dualband AR and BBAR coatings
- Standard and customised mounts and housings
- Free technical consulting.

EKSMA guarantees:

- Accurate quality control
- One month customer's satisfaction term
- Conformity of crystal specifications to highest standards
- Attractive prices
- Fast delivery.

Fig. 1 represents Type 2 SHG tuning curve of KTP in x-y plane. In x-y plane the slope $\partial(\Delta k)/\partial\theta$ is small. This corresponds to quasi-angular noncritical phase-matching, which ensures the double advantage of a large acceptance angle and a small walk off. Otherwise in x-z plane the slope $\partial(\Delta k)/\partial\lambda$ is almost zero for wavelengths in the range 1.5–2.5 μm and this corresponds to quasi-wavelength noncritical phase-matching, which ensures a large spectral acceptance (see Fig. 2). Wavelength noncritical phase-matching is highly desirable for frequency conversion of short pulses.

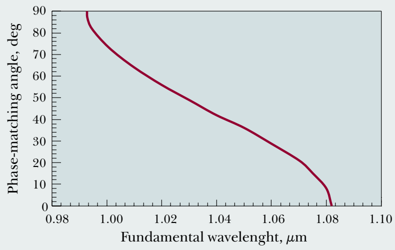


Fig. 1. Type 2 SHG in x-y plane

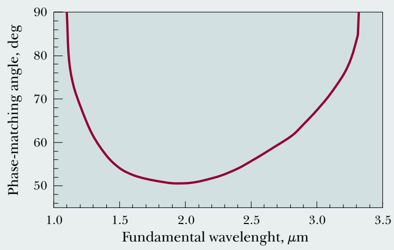


Fig. 2. Type 2 SHG in x-z plane

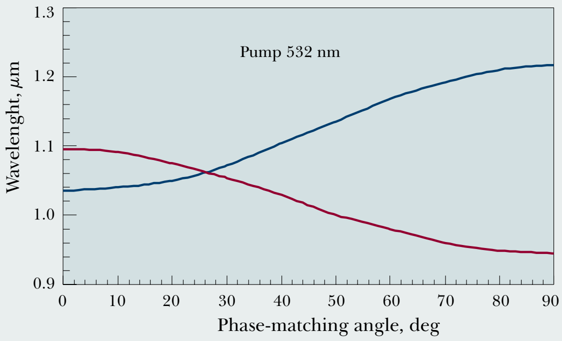


Fig. 3. OPO tuning curve in x-y plane

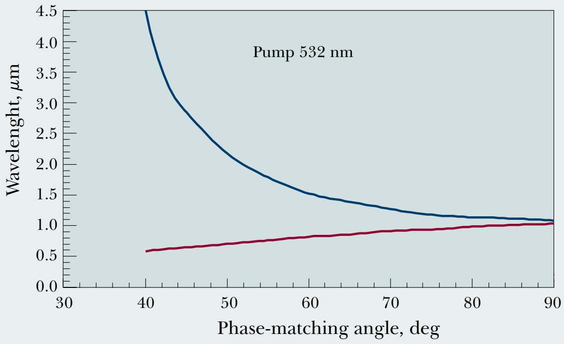


Fig. 4. OPO tuning curve in x-z plane

As a lasing material for OPG, OPA or OPO, KTP can most usefully be pumped by Nd lasers and their second harmonic or any other source with intermediate wavelength, such as a dye laser (near 600 nm). Fig. 3 and Fig. 4 shows the phase-matching angles for OPO/OPA pumped at 532 nm in x-y and x-z plane respectively.

REFERENCES:

1. R. F. Belt, G. Gashurov, Y. S. Liu, "KTP as a harmonic generator for Nd:YAG lasers," Laser Focus 21, 110 (1985).
2. J. D. Bierlein, H. Vanherzeele, "Potassium titanyl phosphate: properties and new applications," J. Opt. Soc. Am. B/Vol. 6, No. 4, 622-633 (1989).
3. D. A. Roberts, "Simplified characterization of uniaxial and biaxial nonlinear optical crystals: A plea for standardization of nomenclature and conventions," IEEE J. Quantum Electron., vol. 28, No. 10, 2057-2074 (1992).
4. V. G. Dmitriev, G.G. Gurzadyan, D. N. Nikogosyan, "Handbook of nonlinear optical crystals" First edition (1993).

* *Unreferenced data were determinated by EKSMA Co.*

PHYSICAL PROPERTIES

Crystal structure[2]	orthorhombic
Point group[2]	mm
Space group[2]	$Pna2_1$
Lattice constants [Å]	a=12.814, b=6.404, c=10.616
Density [g/cm^3]	3.0
Melting point[3] [°C]	1150
Transition temperature[3] [°C]	936
Mohs hardness	5
Thermal expansion coefficients[3] [°C^{-1}]	$a_1=11\times10^{-6}$, $a_2=9\times10^{-6}$, $a_3=0.6\times10^{-6}$
Thermal conductivity[3] [W/cm°C]	$k_1 = 2.0\times10^{-2}$, $k_2 = 3.0\times10^{-2}$, $k_3 = 3.3\times10^{-2}$
Not hygroscopic	

OPTICAL PROPERTIES

Transparency	350÷4400 nm	
Refractive indices	at 1064 nm	at 532 nm
	n_x = 1.7400	n_x = 1.7787
	n_y = 1.7469	n_y = 1.7924
	n_z = 1.8304	n_z = 1.8873

Thermooptic coefficients in 0.4 ÷ 1.0 µm range[4]

dn_x/dT = 1.1“10^{-5} (K)$^{-1}$
dn_y/dT = 1.3“10^{-5} (K)$^{-1}$
dn_z/dT = 1.6“10^{-5} (K)$^{-1}$

Wavelength dispersion of refractive indices[4]

$$n_x^2=2.1146+0.89188/(1-(0.20861/\lambda)^2)-0.01320\lambda^2$$
$$n_y^2=2.1518+0.87862/(1-(0.21801/\lambda)^2)-0.01327\lambda^2$$
$$n_z^2=2.3136+1.00012/(1-(0.23831/\lambda)^2)-0.01679\lambda^2$$

NONLINEAR PROPERTIES

Phase matching range for:	
Type 2 SHG in x-y plane	0.99÷1.08 µm
Type 2 SHG in x-z plane	1.1÷3.4 µm
Walk-off for SHG @ 1.06 µm	1 mrad
Angular acceptances for SHG @ 1064nm:	$\Delta\theta$ = 75 mrad $\Delta\varphi$ = 18 mrad
Thermal acceptance[3]	25 K×cm
Up to 80% extracavity SHG efficiency	

Effective nonlinearity[4]

x-y plane: $d_{eoe}=d_{oee}=d_{15}\sin^2\varphi+d_{24}\cos^2\varphi$
x-z plane: $d_{oeo}=d_{eoo}=d_{24}\sin\theta$

$d_{31}= \pm$ 6.5 pm/V, $d_{32}=\pm$ 5 pm/V
$d_{33}= \pm$ 13.7 pm/V, $d_{24}= \pm$ 7.6 pm/V
$d_{15}= \pm$ 6.1 pm/V

Damage threshold >500 MW/cm^2
for pulses λ=1064nm, τ=10 ns, 10 Hz, TEM_{00}