Potassium Titanyl Phosphate (KTiOPO4, KTP)

Introductions

Potassium Titanyl Phosphate (KTiOPO4 or KTP) Crystal

Potassium Titanyl Phosphate (KTiOPO4 or KTP) is widely used in both commercial and military lasers including laboratory and medical systems, range-finders, lidar, optical communication and industrial systems.

Basic Properties

Items	Specifications
Crystal Structure	Orthorhombic, space group Pna21,point group mm2
Lattice Parameter	a=6.404⊕, b=10.616⊕, c=12.814⊕, Z=8
Melting Point	About 1172°C
Mohs Hardness	5
Density	3.01 g/cm3
Thermal Conductivity	13W/m/K
Thermal Expansion Coefficient	αx=11x10-6/0C, αy=9x10-6/0C, αz=0.6x10-6/0C
Transparency Range	350~4500nm
SHG Phase Matchable Range	497 ~ 1800nm (Type II)
Therm-optic Coefficient (/°C, λ in μm)	dnx/dT=1.1X10-5 dny/dT=1.3X10-5 dnz/dT=1.6X10-5
Absorption Coefficient	<0.1%/cm at 1064nm <1%/cm at 532nm
For Type II SHG of a Nd:YAG laser at 1064nm	Temperature Acceptance: 24°C-cm Spectral Acceptance: 0.56nm-cm Angular Acceptance: 14.2mrad-cm (φ); 55.3mrad-cm (θ) Walk-off Angle: 0.55°
NLO Coefficient	deff(II)≈ (d24 - d15)sin2φsin2θ - (d15sin2φ + d24cos2φ)sinθ
Non-vanished NLO susceptibilities	d31=6.5 pm/V d24=7.6 pm/V d32= 5 pm/V d15=6.1 pm/V d33=13.7 pm/V
Sellmeier Equations (λ in μm)	nx2=3.0065+0.03901/(λ2-0.04251)-0.01327λ2 ny2=3.0333+0.04154/(λ2-0.04547)-0.01408λ2 nz2=3.0065+0.05694/(λ2-0.05658)-0.01682λ2
Electro-optic coefficients:	Low frequency (pm/V) High frequency (pm/V)
r13	9.5 8.8
r23	15.7 13.8
r33	36.3 35.0
r51	7.3 6.9
r42	9.3 8.8
Dielectric constant:	εeff=13

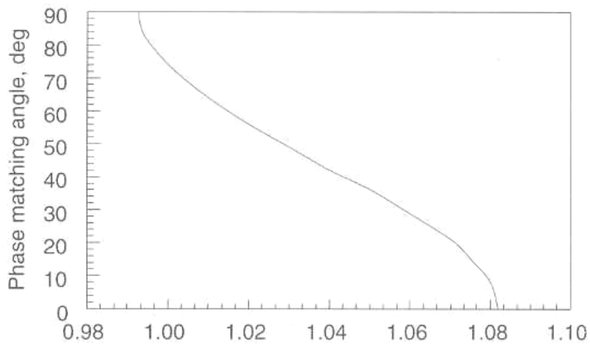
Applications for SHG and SFG of Nd: lasers

KTP is the most commonly used material for frequency doubling of Nd:YAG and other Nd-doped lasers, particularly when the power density is at a low or medium level. To date, extra- and intra-cavity frequency doubled Nd:lasers using KTP have become a preferred pumping source for visible dye lasers and tunable Ti:Sapphire lasers as well as their amplifiers. They are also useful green sources for many research and industry applications.

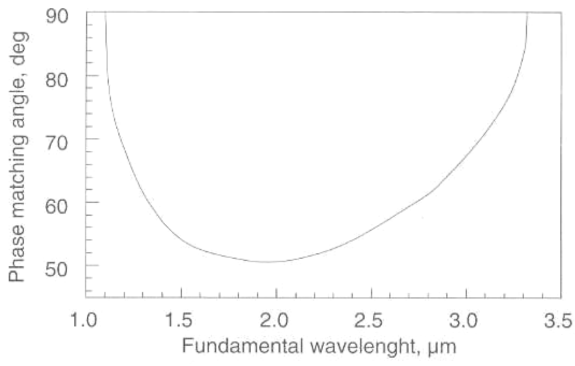
◇ More than 80% conversion efficiency and 700mJ green laser were obtained with a 900mJ injection-seeded Q-switch Nd:YAG lasers by using extra-cavity KTP.

◇ 8W green laser was generated from a 15W LD pumped Nd:YVO4 with intra-cavity KTP.

KTP is also being used for intracavity mixing of 0.81μm diode and 1.064μm Nd:YAG laser to generate blue light and intracavity SHG of Nd:YAG or Nd:YAP lasers at 1.3μm to produce red light.



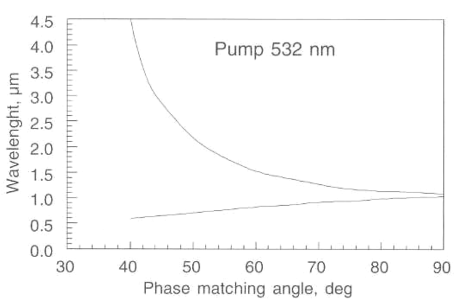
Type II KTP SHG in XY Plane



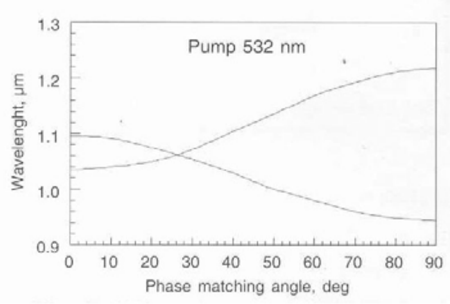
Type II KTP SHG in XZ Plane

Applications for OPG, OPA and OPO

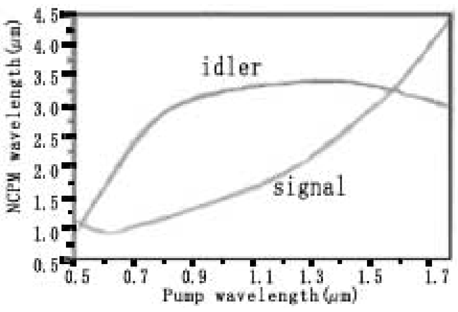
As an efficient OPO crystal pumped by a Nd:laser and its second harmonics, KTP plays an important role for parametric sources for tunable outputs from visible (600nm) to mid-IR (4500nm), Generally, KTP's OPOs provide stable and continuous pulse outputs (signal and idler) in fs, with 108 Hz repetition rate and a miliwatt average power level. A KTP's OPO that are pumped by a 1064nm Nd:YAG laser has generated as high as above 66% efficiency for degenerately converting to 2120nm.



OPO pumped at 532 in X-Z plane



OPO pumped at 532 in X-Y plane



Type II NCPM OPO

The novel developed application is the non-critical phase-matched(NCPM) KTP's OPO/OPA. As Shown in the left curve for pumping wavelength range from 0.7μm to 1μm,the output can cover from 1.04μm to 1.45μm(signal) and from 2.15μm to 3.2μm(idler). More than 45% conversion efficiency was obtained with narrow output bandwidth and good beam quality.

Applications for Optical Waveguides

Based on the ion-exchange process on KTP substrate, low loss optical waveguides developed for KTP have created novel applications in integrated optics. Table 2 gives a comparison of KTP with other optical waveguide materials.Recently, a type II SHG conversion efficiency of 20%/W/cm2 was achieved by the balanced phase matching, in which the phase mismatch from one section was balanced against a phase mismatch in the opposite sign from the second . Furthermore, segmented KTP waveguides have been applied to the type I quasi-phase-matchable SHG of a tunable Ti:Sapphire laser in range 760-960mm, and directly doubled diode lasers for the 400-430nm outputs.

Specification

Items	Specification
Dimension tolerance	(W±0.1mm)x(H±0.1mm)x(L+0.5/-0.1mm) (L≥2.5mm) (W±0.1mm)x(H±0.1mm)x(L+0.5/-0.1mm) (L≥2.5mm)
Clear aperture	> 90%
Flatness	λ/8 @ 633nm
Wavefront Distortion	λ/8 @ 633nm
Surface Quality	scratch and dig 10-5
Parallelism	20 arc second
Angle tolerance	± 0.5 °
Damage threshold[GW/cm2]:	>0.5 for 1064nm, TEM00, 10ns, 10Hz (AR-coated) >0.3 for 532nm, TEM00, 10ns, 10Hz (AR-coated)

KTiOPO4, KTP Crystal

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