KTP (KTiOPO₄) is a nonlinear optical crystal, which possesses excellent nonlinear and electrooptic 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 waveguide applications.

Transparency band edges of KTP crystal are at 0.35 µm in UV and at 4.4 µm in IR region. Due to very high effective nonlinearity (dₑₙᵣᵥ ~ 8.3 x d₃₆ (KDP) at 1.06 µm) and excellent optical properties KTP perfectly suits as lasing material in various applications. The phase matching range of KTP crystal lies in 0.99-3.3 µm region. This allows to use KTP as an intracavity and extracavity frequency doubler for the most commonly used lasers, such as Nd:YAG, Nd:Glass and Nd:YLF(1). Up to 65% SHG efficiency has been obtained using KTP crystal of 10mm length pumped by injection seeded SLM Nd:YAG laser at 100 MW/cm² peak intensity and 12 ns pulse duration and up to 72% SHG efficiency at 300 MW/cm² peak intensity. The very large temperature bandwidth of KTP is particularly advantageous for maintaining pulsed energy stability of the converted beam. Due to this feature and good thermal properties, KTP has an exceptional figure of merit for doubling of high average power cw or quasi cw lasers. Relatively high bulk damage threshold combined with a low absorption loss at 1 µm, renders this material a prime choice for all intracavity frequency doubling applications.

Fig. 1 represents Type 2 SHG tuning curve of KTP in x-y plane. In x-y plane the slope d(Dk)/dθ 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 d(Dk)/dθ 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.

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). Figures 3 and 4 show the phase matching angles for OPO/OPA pumped at 532 nm in x-y and x-z plane respectively.

![Fig. 1. Type 2 SHG in x-y plane](image1)

![Fig. 2. Type 2 SHG in x-z plane](image2)
**Physical properties:**

- Crystal structure: orthorhombic\(^{(2)}\)
- Point group: mm\(^{(2)}\)
- Space group: Pna2\(_1\) \(^{(2)}\)
- Lattice constants:
  - \(a = 12.814 \text{ Å}\)
  - \(b = 6.404 \text{ Å}\)
  - \(c = 10.616 \text{ Å}\)
- Density: 3.0 g/cm\(^3\)
- Melting point: 1150 °C\(^{(3)}\)
- Transition temperature: 936 °C\(^{(3)}\)
- Mohs hardness: 5
- Thermal expansion coefficients:
  - \(a_1 = 11 \times 10^{-6} \text{ °C}^{-1}\)^{(3)}
  - \(a_2 = 9 \times 10^{-6} \text{ °C}^{-1}\)
  - \(a_3 = 0.6 \times 10^{-6} \text{ °C}^{-1}\)
- Thermal conductivity:
  - \(k_1 = 2.0 \times 10^{-2} \text{ W/cm °C}^{(3)}\)
  - \(k_2 = 3.0 \times 10^{-2} \text{ W/cm °C}^{(3)}\)
  - \(k_3 = 3.3 \times 10^{-2} \text{ W/cm °C}^{(3)}\)
- Not hygroscopic

**Optical properties:**

- Transparency: 350÷4400 nm
- Refractive indices:
  - at 1064 nm
    - \(n_x = 1.7400\)
    - \(n_y = 1.7469\)
    - \(n_z = 1.8304\)
  - at 532 nm
    - \(n_x = 1.7787\)
    - \(n_y = 1.7924\)
    - \(n_z = 1.8873\)
- Thermooptic coefficients in 0.4+1.0 μm range:
  - \(dn_x/dT = 1.1 \times 10^{-5} (\text{K})^{-1}\)^{(4)}
  - \(dn_y/dT = 1.3 \times 10^{-5} (\text{K})^{-1}\)^{(4)}
  - \(dn_z/dT = 1.6 \times 10^{-5} (\text{K})^{-1}\)^{(4)}
- Wavelength dispersion of refractive indices:
  - \(n_x^2 = 2.1146 + 0.89188 / (1-(0.20861/\lambda)^2) - 0.01320\lambda^2\)^{(4)}
  - \(n_y^2 = 2.1518 + 0.87862 / (1-(0.21801/\lambda)^2) - 0.01327\lambda^2\)
  - \(n_z^2 = 2.3136 + 1.00012 / (1-(0.23831/\lambda)^2) - 0.01679\lambda^2\)

**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 @ 1064 nm:
  - \(D_0 = 75 \text{ mrad}\)
  - \(D_\varphi = 18 \text{ mrad}\)
- Thermal acceptance: 25 K x cm\(^3\)
- Up to 80% extracavity SHG efficiency
- Effective nonlinearity\(^{(4)}\):
  - x-y plane \(d_{ooe} = d_{eoo} = d_{15}\sin^2\varphi + d_{24}\cos^2\varphi\)
  - x-z plane \(d_{oee} = d_{eoo} = d_{24}\sin\theta\)
  - \(d_{31} = \pm 6.5 \text{ pm/V}^{(4)}\)
  - \(d_{32} = \pm 5 \text{ pm/V}^{(4)}\)
  - \(d_{33} = \pm 13.7 \text{ pm/V}^{(4)}\)
  - \(d_{24} = \pm 7.6 \text{ pm/V}^{(4)}\)
  - \(d_{15} = \pm 6.1 \text{ pm/V}^{(4)}\)
- Damage threshold > 500 MW/cm\(^2\) for pulses \(\lambda = 1064\text{nm}, t = 10 \text{ ns}, 10 \text{ Hz}, \text{TEM}_{00}\)
References:


* Unreferenced data was determined by EKSMA Co.

Please feel free to contact EKSMA Co. for further information or detailed quotation.