No. 35A-6 $KTiOPO_4$, Potassium titanyl phosphate (KTP)
(M = 197.95)

1a	Ferroelectricity in $KTiOPO_4$ was suggested by Zumsteg et al. in 1976.	76Zum
	Dielectric anomaly was confirmed by Yanovskii et al. 1985.	85Yan
	Evidence for ferroelectricity was confirmed by dielectric hysteresis loop by Shaldin and Poprawski in 1990.	90Sha

b

phase	II	I	
state	F	P	
crystal system	orthorhombic	orthorhombic	
space group	$Pna2_1 – C_{2v}^9$	$Pnam – D_{2h}^{16}$	76Zum
Θ [°C]	934(2)		90Sha

	P_s ∥ [001].	90Sha
	T_{melt} = 1148K.	88Vor
	$\rho_X = 2.99 \cdot 10^3$ kg m^{-3}.	76Zum
	See also Table 35A-6-001 in 3a.	
	Cleavage plane: (200).	86Cai
	Transparent and colorless.	86Cai
	Phase diagram for crystal growth in K_2O–P_2O_5: Fig. 35A-6-001.	
	Crystal growth from the solutions of the K_2O–P_2O_5–TiO_2–WO_3 system.	90Ili1
	Effect of heat treatment on Θ_f: Fig. 35A-6-002, Fig. 35A-6-003, Fig. 35A-6-004.	
2a	Crystal growth:	
	Hydrothermal method: see	76Zum, 86Hua, 86Lau
	Hydrothermal method for $KTiOPO_4$–KF–H_2O system.	86Jia
	Single crystals of good quality have been grown by hydrothermal method using KF + H_2O_2 as a mineralizer under medium conditions (T = 370...450 °C, $p < 1.4 \cdot 10^8$ Pa).	90Jia
	Flux method:	
	Flux method using tungstic anhydride.	86Bal
	High temperature flux method.	86Cai
	Crystal growth from phosphate fluxes.	88Liu
	Rotating flux growth. Flux: $K_6P_4O_{13}$. 20 × 40 × 50 mm^3.	89Bor
	Crystal growth from $K_6P_4O_{13}$ flux. The effect of cooling rate on the surface structure of the habit faces was investigated.	90Dha
	Crystal growth from the flux of composition $K_6P_4O_{13}$ and characterization by X-ray topography.	91Bol1
	Crystal growth from tungstate and molybdate fluxes. Crystal size: 2.5 × 3 × 5 cm^3.	91Che1
	Elimination of layer-like floss in the flux grown crystals.	91Xia
	Study of liquid surface in the K_3PO_4–KPO_3–$KTiOPO_4$ system.	92Kap
	Growth of crystals by temperature falling method in the flux $K_6P_4O_{13}$.	93Sas, 94Che1
	Growth of single crystals by means of phosphate and phosphate/sulfate fluxes.	91Bol2
	Top-seeded method:	
	Top-seeded method. Flux: $K_6P_4O_{13}$. Size: 10 × 10 × 7 mm^3.	87Bor
	Top seeded growth from molten tungstate solution. Etching experiments on natural and cleavage surfaces using aqueous solutions of 20% HCl. Screw-dislocation density: 5×10^2 cm^{-2}.	91Che2

	Top seeded solution growth.	91Bol2
	Top-seeded solution growth with pulling from $K_6P_4O_{13}$ flux.	94Ang
	Other methods of synthesis:	
	Crystallites.	86ElB
	Synthesis by flash combustion.	93Dha
	Thin film synthesis from titanium phosphate gels.	93Sch
	Preparation by sol-gel method.	94Abr
	Microstructure, orientation, and properties of sol-gel-derived thin films.	95Bar
	Simple reaction flux method.	71Mas
b	Crystal habits: Fig. 35A-6-005.	
3a	Lattice parameters: Table 35A-6-001, Table 35A-6-002, Table 35A-6-003, Table 35A-6-004; Fig. 35A-6-006; see also Table 35B-1-006, Table 35B-1-007 in No. 35B-1.	
b	$Z = 8$.	91Han
	Crystal structure: Table 35A-6-005, Table 35A-6-006, Table 35A-6-007, Table 35A-6-008, Table 35A-6-009, Table 35A-6-010, Table 35A-6-011; Fig. 35A-6-007, Fig. 35A-6-008, Fig. 35A-6-009, Fig. 35A-6-010, Fig. 35A-6-011. See also Table 35A-11-003, Table 35A-11-04; Fig. 35A-11-002 in No. 35A-11, Table 35A-21-001 in No. 35A-21, Table 35A-22-002 in No. 35A-22, Table 35B-1-013 in No. 35B-1.	
	Relation between crystal structure and morphology: see	90Bol
4	Crystal structure under high-pressure: see	96All
	Thermal expansion coefficients [K^{-1}]: $\alpha_1 = 11 \cdot 10^{-6}$, $\alpha_2 = 9 \cdot 10^{-6}$, $\alpha_3 = 0.6 \cdot 10^{-6}$.	89Bie
5a	Dielectric constant: Fig. 35A-6-012, Fig. 35A-6-013, Fig. 35A-6-014, Fig. 35A-6-015, Fig. 35A-6-016, Fig. 35A-6-017, Fig. 35A-6-018, Fig. 35A-6-019, Fig. 35A-6-020, Fig. 35A-6-021, Fig. 35A-6-022, Fig. 35A-6-023, Fig. 35A-6-024, Fig. 35A-6-025, Fig. 35A-6-026. See also Fig. 35A-6-048, Fig. 35A-6-049 in 9a.	
c	Spontaneous polarization: Fig. 35A-6-027, Fig. 35A-6-028.	
d	Pyroelectric coefficient: $7 \cdot 10^{-9}$ C K^{-1} m^{-2}.	89Bie
	Pyroelectricity: Fig. 35A-6-029.	
6a	Specific heat: 727 J kg^{-1} K^{-1}.	89Bie
	Specific heat anomaly was observed at $T = 324$K, where the crystal attains pseudo-tetragonality $a = 2b$.	91Som
7a	Piezoelectric coefficients [pm V^{-1}]: $d_{311} = 1.1(3)$, $d_{322} = 1.0(3)$, $d_{333} = -12.6(5)$, $d_{232} = 0.7(3)$, $d_{131} = 1.1(3)$.	94Hau
	Surface acoustic wave and Bleustein-Gulyaev wave generation.	93Chu1
	Excitation of surface acoustic waves in Rb-ion exchanged crystals.	91Bur1
8a	Elastic stiffnesses determined by Brillouin scattering: Table 35A-6-012.	
9a	Refractive index: Table 35A-6-013, Table 35A-6-014; Fig. 35A-6-030, Fig. 35A-6-031, Fig. 35A-6-032, Fig. 35A-6-033, Fig. 35A-6-034, Fig. 35A-6-035; see Fig. 35B-1-014 in No. 35B-1 and also	95Gho
	Temperature coefficients of refractive index [K^{-1}]: $n'_x = 1.1 \cdot 10^{-5}$, $n'_y = 1.3 \cdot 10^{-5}$, $n'_z = 1.6 \cdot 10^{-6}$.	89Bie
	Optical absorption: Table 35A-6-015; Fig. 35A-6-036, Fig. 35A-6-037, Fig. 35A-6-038, Fig. 35A-6-039, Fig. 35A-6-040, Fig. 35A-6-041, Fig. 35A-6-042, Fig. 35A-6-043.	

	Optical reflectivity: Fig. 35A-6-044, Fig. 35A-6-045, Fig. 35A-6-046, Fig. 35A-6-047, Fig. 35A-6-048, Fig. 35A-6-049.	
	Infrared spectroscopy: see Table 33A-6-020, Table 33A-6-021, Table 33A-6-022 in 10a and also	90Cra, 87Rod, 87Wyn
	Optical inhomogeneities in single crystals grown from high-temperature tungsten-containing solutions.	93Shu
b	Electrooptic effect: Table 35A-6-016, Table 35A-6-017, Table 35A-6-018.	
	Electrooptic coefficients [pm V^{-1}]: r_{113} = 7.9(5), r_{223} = 11.3(5), r_{333} = 22.7(8), r_{232} = 6.2(4), r_{131} = 10.6(6);	94Hau
	see also	88Yin
d	Optical activity: Fig. 35A-6-050.	
e	Nonlinear optical properties: Table 35A-6-018; Fig. 35A-6-051; see also Fig. 35A-6-012 in 5a, Fig. 35A-20-007 in No. 35A-20; Table 35B-1-006 in No. 35B-1.	
	Nonlinear optical coefficients [pm V^{-1}]: d_{31} = 6.5, d_{32} = 5.0, d_{33} = 13.7, d_{24} = 7.6, d_{15} = 6.1.	89Bie
	High-energy, high-efficiency second harmonic generation of 1064 nm radiation.	92Bro
	Second harmonic and sum-frequency generation down to 4589 Å.	88Kat
	Long pulse second harmonic generation of Nd:YAG laser light.	87Moo
	Type II sum frequency generation in flux and hydrothermally grown crystals.	89Sto
	Second harmonic generation of light from an AIG:Nd^{3+} laser.	86Lau
	Intracavity frequency doubling of 6.5W cw Nd:YAG laser light.	88Hua
	Third harmonic generation of a 1341.4 nm Nd:YAP laser.	91Lin
	Infrared optical parametric oscillator of Nd:YAG laser, output λ = 2.12 μm.	89Bur
	Optical parametric oscillation in the range 1.8...2.4 μm.	90Lin
	Parametric oscillation at 3.2 μm pumped at 1.064 μm.	91Kat
	Picosecond optical parametric generation. λ = 0.946...1.020 μm and 1.075...1.172 μm.	91Ebr
	Light-induced refractive index changes in single mode channel waveguides.	95Rus
10a	Raman scattering: Table 35A-6-019, Table 35A-6-020, Table 35A-6-021, Table 35A-6-022, Table 35A-6-023; Fig. 35A-6-052, Fig. 35A-6-053, Fig. 35A-6-054, Fig. 35A-6-055, Fig. 35A-6-056, Fig. 35A-6-057, Fig. 35A-6-058, Fig. 35A-6-059, Fig. 35A-6-060, Fig. 35A-6-061, Fig. 35A-6-062, Fig. 35A-6-063, Fig. 35A-6-064, Fig. 35A-6-065, Fig. 35A-6-066, Fig. 35A-6-067, Fig. 35A-6-068, Fig. 35A-6-069.	
	See also	88LiL, 86Yan, 94Sav, 90XuL, 80Mas
b	Brillouin scattering: see Table 35A-6-012 in 8a.	
11	Electrical conductivity: Table 35A-6-024; Fig. 35A-6-070, Fig. 35A-6-071, Fig. 35A-6-072, Fig. 35A-6-074, Fig. 35A-6-075, Fig. 35A-6-076, Fig. 35A-6-077, Fig. 35A-6-078, Fig. 35A-6-079, Fig. 35A-6-080, Fig. 35A-6-081, Fig. 35A-6-082, Fig. 35A-6-083, Fig. 35A-6-084.	
	Defect study by AC conductivity and infrared spectroscopy.	89Mor
	Light diffraction under a dc field relating to quasi-one-dimensional ionic conductivity.	88Yan
	Luminescence: Table 35A-6-025; Fig. 35A-6-085.	
	Parametric superfluorescence.	91Nis
	Luminescence of ions with d^{10} configuration.	92Ham
	Formation of color centers accompanying SHG.	91Ang

13a	^{31}P NMR: Fig. 35A-6-086, Fig. 35A-6-087, Fig. 35A-6-088; see also Fig. 35B-1-016 in No. 35B-1.	
b	ESR of Fe^{3+}: Table 35A-6-026.	
	ESR of VO^{2+}: Table 35A-6-027.	
	ESR of V^{4+}: Table 35A-6-028, Table 35A-6-029, Table 35A-6-030.	
	ESR of Cr^{3+}: Table 35A-6-031.	
	ESR of Cr^{3+}:	95Ahn
	site A: $g_x = 1.97577(18)$	
	$g_y = 1.97126(21)$ $B_2^0 = 0.16757(3) \cdot 10^2\ m^{-1}$	
	$g_z = 1.96371(15)$ $B_2^0 = 0.09324(3) \cdot 10^2\ m^{-1}$	
	site B: $g_x = 1.9740(21)$	
	$g_y = 1.97082(20)$ $B_2^0 = 0.13645(3) \cdot 10^2\ m^{-1}$	
	$g_z = 1.96735(17)$ $B_2^2 = 0.11949(3) \cdot 10^2\ m^{-1}$	
	ESR of W^{5+}: Table 35A-6-032.	
	ESR of Mo^{5+}: Table 35A-6-033.	
	ESR of Rh^{3+}: Table 35A-6-034.	
	ESR of V^{4+}:	91Gei
	$g_{\parallel} = 1.938(1)$, $g_{\perp} = 1.959(1)$, $\lvert A_{\parallel}\rvert = 166.0(5)\cdot 10^{-2}\ m^{-1}$, $\lvert A_{\perp}\rvert = 168(1)\cdot 10^{-2}\ m^{-1}$.	
	ENDOR of Ti^{3+}: see	94Scr
	Optical and ESR study of thermal reduction of single crystals: see	94Mar
	ESR of X-ray irradiated crystals: see	93Edw, 92And1, 87Niz
	ESR of γ-ray irradiated crystals: see	86Kar
	Identification of point defects by ESR in hydrothermally grown crystals.	91Scr
15a	Domain observation by electron microscopy, pyroelectric and electrooptical methods and decoration by nematic liquid crystals.	94Iva
	Complex domain structure similar to the Dauphine's twins was observed.	88Loi
	Domain observation by laser beam deflection using electrooptic effect and by pyroelectric current induced by the laser beam.	87Bei1
	Domain pattern observation by chemical etching and by a scanning electron microscope.	87Vor
	Mapping of domains by needle piezoelectric technique.	94Ang
	Optical observation of domains.	89Pis
b	Detection of ferroelectric domain reversal in ion exchanged crystal: see	92Lau
	Poling method: see	87Bie1
16	Doping and implantation:	
	SHG by niobium-doped crystals.	94Che2
	Sc^{3+}-doped crystals. Waveguides fabrication.	94Jon
	Self-frequency doubling by $KTiOPO_4$:Cr crystals.	94Zha
	Yb^+ and Er^+ implantation.	94Wan1
	Xe^+ implantation.	94Wan2
	Effect of Ce doping.	93Bla
	Effect of Cr^{3+} doping.	93Bol1
	Frequency doubling in He implanted planar waveguides.	93Zha
	V^{5+} substituted crystals.	95Cha
	Zr^{4+} substituted crystals.	95Cha
	Er^+ and Yb^+ implantation: Damage and annealing.	94Wan3

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Acoustic and optical properties of thallium ion-exchanged crystals.	94Chu
Proton and ammonium exchanged optical waveguides.	93Roe
Ion exchange of Rb, Ba and Sr by molten nitrate salts.	93Roe
Determination of the optical damage threshold of Rb ion exchanged waveguides.	91Bur2
Ion exchange reactions.	89Jar
Quasi-phase matching SHG in periodically Rb-ion changed waveguides.	90Bie
Two-dimensional array of optical waveguides (Rb-ion exchanged).	90Dia
1D and 2D periodic waveguide structures by Rb^+ ion exchange.	91Bur1
Fabrication and characterization of planar ion-exchanged waveguides for frequency doubling.	91Ris
Second-harmonic generation in periodically segmented waveguides; 90 min ion exchange at 360 °C in 99 M % RNO_3: 1 M % $Ba(NO_3)_2$ molten salt bath.	90Van
Cs ion exchanged optical waveguides using molten $CsNO_3$.	91Atu
Fabrication of volume phase diffraction grating by Rb-ion exchange method. Ion exchange was made by a molten $RbNO_3$ – $Ba(NO_3)_2$ salt mixture at 350 °C.	91Dia
Fabrication of waveguides by Rb-ion exchange using molten $RbNO_3$.	90Bur

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Second harmonic and sum-frequency generation from optically trapped $KTiOPO_4$ microscopic particles.	94Sat
Effect of annealing in $KTiOPO_4$:Rb waveguides.	94Shi1
Second-harmonic generation in a waveguide with domain-inverted regions like periodic lens sequence on *Z*-face crystals.	94Yam
Laser damage “grey tracks” formation.	92Loi
Compression of short laser pulses in the crystal.	94Umb
Single shot bulk damage threshold measurements on flux grown crystals.	93Bol2
Study of gray-tracking at 1064, 532 and 355 nm.	94Bou
Electrochromic effect in pure crystals.	86Lem
Laser damage threshold.	89Ahm
Laser bulk-darkening threshold of flux-grown $KTiOPO_4$.	91Jac1
Photorefractive damage used as second-harmonic generator.	91Tym
Temperature insensitive SHG at 0.5321 μm.	93Bla
A continuous-wave mode-locked $KTiOPO_4$ parametric oscillator pumped by a Nd:YAG laser.	93Chu2
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