33 KDP (KH_2PO_4) family

33A Pure compounds

Data on deuterated compounds are given in bracket as [D:].

No. 33A-1 KH_2PO_4, Potassium dihydrogen phosphate (KDP)

(M = 136.09; [D: 138.10])

1a Ferroelectricity of KH_2PO_4 was first reported by Busch and Scherrer in 1935. — 35Bus

b

phase	IV	III	II	I	35Bus
state	F	P			
crystal system	orthorhombic	tetragonal	monoclinic [a] [b]		[a] 72Gru
space group	$Fdd2-C_{2v}^{19}$	$I\bar{4}2d-D_{2d}^{12}$ ($F\bar{4}d2$*)	$P2_1-C_2^2$ or $P2_1/m-C_{2h}^2$ [c]		[b] 68Bli1 [c] 75Ito
Θ [K]	123 [D: 213]	450 [d] [D: 383] [a]	≈506 [d]		[d] 70Rap

Phase I was reported to exist between 506 K and T_{melt} for KH_2PO_4. See the phase diagram Fig. 33A-1-001, Fig. 33A-1-002.

Slightly different values for Θ_{III-II} were reported: 448 K [a] [b] and 453 K [e] for KH_2PO_4, and 375 K [e] for KD_2PO_4. — [e] 67OKe1

Phase II is metastable at RT, and can be brought to RT by cooling the crystal from above Θ_{III-II}. Highly deuterated KDP crystallizes in the monoclinic form at RT: Fig. 33A-1-003.

Highly deuterated crystals, $KH_{2(1-x)}D_{2x}PO_4$ with x ≥ 0.98 were reported to be stable or at least metastable in the monoclinic phase from RT to 6 K [f] when cooled very slowly. — [f] 76Ken

Transition from phase III to IV is first order [g] with a thermal hysteresis of 0.83 K [h]; [D : 1.01 K [i]]. — [g] 71Oka, [h] 71Kob, [i] 72Sid

Phase diagram at high pressure: Fig. 33A-1-001, Fig. 33A-1-002; see also Table 33A-1-030; Fig. 33A-1-054, Fig. 33A-1-055, Fig. 33A-1-056 in 5a.

$\Theta_f = \Theta_{IV-III}$ of $KH_{2(1-x)}D_{2x}PO_4$: Θ_f = (121.7 + 107 x) K with the maximum of Θ_f = 228 K for x = 0.985; see also Fig. 33A-1-043 in 5a. — 74Loi

Θ_{III-II} of $KH_{2(1-x)}D_{2x}PO_4$: Fig. 33A-1-004.

P_s ∥ [001] in the phase IV. — 35Bus

T_{melt} = 260(1) °C. — 70Rap

$\rho = 2.338 \cdot 10^3$ kg m^{-3}; [D: $2.345 \cdot 10^3$ kg m^{-3}]. — 66Bec

Transparent, colorless.

Relatively stable monoclinic KH_2PO_4 with space group P2/c at RT was obtained from a solution containing $K_4P_2O_7 \cdot 3H_2O_4$. — 95Mat

* For the relation between the two space groups, see Fig. 33A-1-013 in 3b.

2a Crystal growth: evaporation or cooling method from aqueous solution, see — 74Jos, 77Jos, 93Loi

Industrial growth of deuterated KDP crystals: see — 75Lag

	Also refer to the method for No. 33A-5 $NH_4H_2PO_4$.	50Wal
	Solubility in H_2O: Table 33A-1-001, Table 33A-1-002; Fig. 33A-1-005, Fig. 33A-1-006, see also	77Str
	Influence of supersaturation on the face step velocity: Fig. 33A-1-007, Fig. 33A-1-008.	
	Effect of supersaturation on crystal habit: see	95Ras
	Crystal growth in gel: see	71Bre, 78Jos
	Effect of deuterium concentration in aqueaous solution on deuteration rate in the grown crystal: see	77She
b	Crystal form: Fig. 33A-1-009.	
3a	Unit cell parameters: Table 33A-1-003, Table 33A-1-004, Table 33A-1-005, Table 33A-1-006;	
	see also Table 33A-1-007, Table 33A-1-017, Table 33A-1-018, Table 33A-1-020 in 3b.	
	Pressure effect: Table 33A-1-017, Table 33A-1-018; Fig. 33A-1-010, Fig. 33A-1-011;	
	see also Table 33A-1-021, Table 33A-1-022, Table 33A-1-023; Fig. 33A-1-019 in 3b.	
	Lattice parameters of monoclinic KH_2PO_4: a = 7.4399(7) Å, b = 7.2634(9) Å, c = 9.3629(13) Å, β = 127.696(8)° at RT.	95Mat
	c/a vs. radii of metallic ions: see Fig. 33A-11-002 in No. 33A-11.	
b	Z = 4 in $I\bar{4}2d$ cell, Z = 8 in $F\bar{4}d2$ cell.	30Wes
	[D: Z = 8 in a monoclinic cell].	47Ubb
	Crystal structure of tetragonal crystal: Fig. 33A-1-012, Fig. 33A-1-013, Fig. 33A-1-014.	
	Fractional coordinates and temperature parameters: Table 33A-1-007, Table 33A-1-008, Table 33A-1-009, Table 33A-1-010, Table 33A-1-011, Table 33A-1-012, Table 33A-1-013, Table 33A-1-014; Fig. 33A-1-015, Fig. 33A-1-016;	
	see also	74Nak, 72Nel, 74Tom
	Mean square displacement of atoms: Fig. 33A-1-017.	
	Interatomic distances and bond angles: Table 33A-1-015, Table 33A-1-016, Table 33A-1-017, Table 33A-1-018, Table 33A-1-019, Table 33A-1-020; Fig. 33A-1-018, Fig. 33A-1-019;	
	see also Table 33A-1-057, Table 33A-1-065 in 13a, b and Table 33A-2-007 in No. 33A-2.	
	Effect of hydrostatic pressure: Table 33A-1-021, Table 33A-1-022, Table 33A-1-023; Fig. 33A-1-019.	
	Density maps of proton and deuteron: Fig. 33A-1-020, Fig. 33A-1-021, Fig. 33A-1-022, Fig. 33A-1-023.	
	Structure related to hydrogen bonds, see also	74Nel, 76Ken
	Temperature dependence of proton ordering: Table 33A-1-024; Fig. 33A-1-024.	
	Anharmonic distribution of P atom: Fig. 33A-1-025.	
	Ferroelectric eigenvector for each ion: see Table 33A-1-073 in 14b.	
	Crystal structure of monoclinic KD_2PO_4: Table 33A-1-025.	
	Crystal structure of monoclinic KH_2PO_4: Table 33A-1-026, Table 33A-1-027, Table 33A-1-028; Fig. 33A-1-026, Fig. 33A-1-027.	
	Relation between transition temperature and interatomic distance: Fig. 33A-1-028, Fig. 33A-1-029.	
4	Temperature dependence of unit cell parameters: Fig. 33A-1-030.	
	Effect of E_{bias} on a, b vs. T: Fig. 33A-1-031, Fig. 33A-1-032.	
	Thermal expansion: Table 33A-1-029; Fig. 33A-1-033, Fig. 33A-1-034, Fig. 33A-1-035, Fig. 33A-1-036, Fig. 33A-1-037, Fig. 33A-1-038;	
	see also	70Kob

Temperature and pressure dependence of shear angle: Fig. 33A-1-039, Fig. 33A-1-040.
Spontaneous shear strain measured by neutron diffraction: see 74Sem, 76Zey, 78Bas
Effect of p: see Fig. 33A-1-010, Fig. 33A-1-011 in 3a; see also 72Mor

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5a Dielectric constant κ_c vs. T at low frequencies: Fig. 33A-1-041, Fig. 33A-1-042.
Effect of deuteration on κ_c: Fig. 33A-1-043.
κ_c vs. T determined from thermal noise: see 77Tsu
Increase of κ'_c below 0.1 Hz was reported: see 76Pau
For κ_c below 6 K, see 76Hol
Reciprocal dielectric constant κ_c^{-1} vs. T: Fig. 33A-1-044.
Effect of deuteration on κ_c^{-1} vs. T: Fig. 33A-1-045, Fig. 33A-1-046;
see also 73Sam
C and Θ_p in $\kappa_c = C/(T - \Theta_p)$ for $T > \Theta_f$: Fig. 33A-1-047 and Table 33A-1-031 in 5b;
see also 63Sli, 72Str, 73Sam, 74Zhe
κ_a vs. T: Fig. 33A-1-048, Fig. 33A-1-049 and see also Fig. 33A-1-041.
Effect of p on κ: Fig. 33A-1-050, Fig. 33A-1-051, Fig. 33A-1-052, Fig. 33A-1-053.
Θ vs. p: Table 33A-1-030; Fig. 33A-1-054, Fig. 33A-1-055, Fig. 33A-1-056;
see also Fig. 33A-1-001 and Fig. 33A-1-002 in 1b.
Effect of E_{bias} on Θ_f: Fig. 33A-1-057.
$d\Theta_f/dE_{bias} = 1.92 \cdot 10^{-6}$ K m V^{-1} [a]) [D: $1.25(5) \cdot 10^{-6}$ K m V^{-1} [b])]. [a]) 71Kob [b]) 71Gla
Critical point of DKDP in E–T plane: $T_{crit} = 212.6(15)$ K, $E_{crit} = 8.3(6) \cdot 10^5$ V m^{-1} [b])
(T_{crit}: temperature above which the double hysteresis loop vanishes. E_{crit}: see Fig. IB-2 in Introduction).
Tricritical point of KDP; $T_t = 109.8(2)$ K, $p_t = 2640(40) \cdot 10^5$ Pa; 80Zis
see also Fig. 33A-1-040 in 4.
Effects of deuteration on κ', κ'', $\tan\delta$ at 9.2 GHz: Fig. 33A-1-058, Fig. 33A-1-059,
Fig. 33A-1-060, Fig. 33A-1-061, Fig. 33A-1-062.
κ at 139 GHz: Fig. 33A-1-063, Fig. 33A-1-064, Fig. 33A-1-065, Fig. 33A-1-066;
see also 76Per
For κ in far-infrared region, see 9a and 10a.
Dielectric dispersion: Fig. 33A-1-067, Fig. 33A-1-068, Fig. 33A-1-069,
Fig. 33A-1-070, Fig. 33A-1-071, Fig. 33A-1-072, Fig. 33A-1-073, Fig. 33A-1-074,
Fig. 33A-1-075, Fig. 33A-1-076, Fig. 33A-1-077, Fig. 33A-1-078, Fig. 33A-1-079.
κ at $f = 5 \ldots 80$ MHz: see 77Tor
Dielectric dispersion in the range $f = 1.8 \cdot 10^{11} \ldots 3.6 \cdot 10^{11}$ Hz ($6 \ldots 12$ cm^{-1}): see 78Koz1
Polarization relaxation time: see 80Vaj, 80Vol
Dielectric constant related with domain freezing: Fig. 33A-1-080;
see also 87Kur, 85Kur, 88Nak, 92Nak
Effect of X-irradiation: Fig. 33A-1-081, Fig. 33A-1-082, Fig. 33A-1-083.
Effects of γ- and electron-irradiation on κ_c and $\tan\delta_c$: see 87Kam
κ vs. T for monoclinic DKDP: Fig. 33A-1-084, Fig. 33A-1-085.

b	Nonlinear dielectric properties: $\xi = -1.54(8) \cdot 10^{10}$ V m^5 C^{-3}, $\zeta = 3.9(3) \cdot 10^{13}$ V m^9 C^{-5}.	77Oka
	See also Table 33A-1-031 and	74Zhe
	For $KH_{2(1-x)}D_{2x}PO_4$ (x = 0.85), $\xi = -4.5 \cdot 10^{10}$ V m^5 C^{-3}, $\zeta = 1.8 \cdot 10^{13}$ V m^9 C^{-5}, $\Theta_f = 211.73$ K, $\Theta_p = 210.80$ K.	72Sid
	Effect of hydrostatic pressure on ξ, ζ and C: Table 33A-1-032; Fig. 33A-1-086. Effect of E_{bias} on κ_c: Fig. 33A-1-087; see also Fig. 33A-1-078, Fig. 33A-1-079 in 5a. Effect of E_{bias} on κ and tanδ for DKDP at 620 MHz: Fig. 33A-1-088, Fig. 33A-1-089.	
	Nonlinear components of κ_c below Θ_f were obtained by digital Fourier transform technique.	94Kur
c	P_s and E_c vs. T: Fig. 33A-1-090, Fig. 33A-1-091, Fig. 33A-1-092, Fig. 33A-1-093, Fig. 33A-1-094, Fig. 33A-1-095. E_c vs. maximum applied electric field: Fig. 33A-1-096. Effect of E_{bias} on P_3: Fig. 33A-1-097, Fig. 33A-1-098, Fig. 33A-1-099, Fig. 33A-1-100. Effect of deuteration on saturation polarization: see Fig. 33A-1-047 in 5a. Effect of hydrostatic pressure on P_s: Fig. 33A-1-101, Fig. 33A-1-102.	
d	Pyroelectric coefficient P_3 below 20 K: see	79Vie
	Electrocaloric effect: Fig. 33A-1-103.	
6a	Heat capacity: Fig. 33A-1-104, Fig. 33A-1-105, Fig. 33A-1-106, Fig. 33A-1-107, Fig. 33A-1-108. Effect of E_{bias} on C_p: Fig. 33A-1-109. Heat capacity at low temperatures: Fig. 33A-1-110;	
	see also	76Law, 82Law, 85Foo, 86San
	Transition heat ΔQ_m and transition entropy ΔS_m at Θ_f:	

ΔQ_m [J mol^{-1}]	ΔS_m [J K^{-1} mol^{-1}]	
238 [D: 418]	1.97 [D: 1.97]	42Ban
364	3.09	44Ste
	4.01 [D: 2.89]	68Str

	Effect of deuteration on ΔS_m: Fig. 33A-1-111.	
	DTA around Θ_{III-II}: see	93Kha
b	Thermal conductivity: Fig. 33A-1-112, Fig. 33A-1-113, Fig. 33A-1-114, Fig. 33A-1-115, Fig. 33A-1-116; Fig. 33A-1-117, Fig. 33A-1-118, Fig. 33A-1-119, Fig. 33A-1-120.	
	See also	94Bae
7a	Piezoelectricity: Table 33A-1-033; Fig. 33A-1-121, Fig. 33A-1-122.	
	Nonlinear electromechanical parameters: see	82Zai
c	Nonlinear piezoelectric constant: $e_{345} = 0.07$ N V^{-1} m^{-1} at RT.	90Str
8a	Elastic compliance and stiffness: Table 33A-1-034; Fig. 33A-1-123, Fig. 33A-1-124, Fig. 33A-1-125, Fig. 33A-1-126, Fig. 33A-1-127, Fig. 33A-1-128, Fig. 33A-1-129, Fig. 33A-1-130; Fig. 33A-1-131. Elastic stiffness obtained from Brillouin scattering: Fig. 33A-1-132; see also Fig. 33A-1-241 in 10b. Effect of p: Fig. 33A-1-133, Fig. 33A-1-134.	
	Effect of p on strain: see	78Bas
	Ultrasonic velocity and attenuation: Fig. 33A-1-135, Fig. 33A-1-136;	

	see also	70Shi
	Internal friction: Fig. 33A-1-137, Fig. 33A-1-138.	
b	Polarization relaxation time obtained by ultrasonic measurement: Fig. 33A-1-139, Fig. 33A-1-140.	
	Nonlinear elastic constant: $c_{456} = 0.08(2) \cdot 10^{11}$ N m^{-2} at RT.	90Str
9a	Refractive indices: Table 33A-1-035, Table 33A-1-036, Table 33A-1-037, Table 33A-1-038, Table 33A-1-039; Fig. 33A-1-141, Fig. 33A-1-142, Fig. 33A-1-143, Fig. 33A-1-144; see also	76Vol, 79Mit
	Coefficients for Sellmeier formula: Table 33A-1-040, Table 33A-1-041.	
	$\partial n/\partial T$ for several λ: Table 33A-1-042.	
	Birefringence: Fig. 33A-1-145, Fig. 33A-1-146, Fig. 33A-1-147, Fig. 33A-1-148, Fig. 33A-1-149, Fig. 33A-1-150; see also	84Tro
	Transmission and absorption: Fig. 33A-1-151, Fig. 33A-1-152, Fig. 33A-1-153, Fig. 33A-1-154.	
	Effect of X-irradiation on optical absorption: Fig. 33A-1-155.	
	Optical absorption of KH_2PO_4:Tl: Table 33A-1-043; Fig. 33A-1-156.	
	Optical absorption due to VO^{2+} ions: see	85Aga
	Infrared absorption and reflection: Fig. 33A-1-157, Fig. 33A-1-158, Fig. 33A-1-159, Fig. 33A-1-160, Fig. 33A-1-161, Fig. 33A-1-162, Fig. 33A-1-163, Fig. 33A-1-164, Fig. 33A-1-165.	
	Far-infrared spectra: Table 33A-1-044, Table 33A-1-045, Table 33A-1-046; Fig. 33A-1-166, Fig. 33A-1-167, Fig. 33A-1-168, Fig. 33A-1-169, Fig. 33A-1-170, Fig. 33A-1-171; see also	70Sug, 77Bes, 78Rat, 84ElS
	κ' and κ'' in infrared and far-infrared region: Fig. 33A-1-172, Fig. 33A-1-173, Fig. 33A-1-174, Fig. 33A-1-175, Fig. 33A-1-176, Fig. 33A-1-177, Fig. 33A-1-178, Fig. 33A-1-179, Fig. 33A-1-180, Fig. 33A-1-181, Fig. 33A-1-182, Fig. 33A-1-183; see also	81Bre, 88Sim
	Fluorescence life time: Fig. 33A-1-184.	
	Activation energy for ultraviolet-induced transient absorption: $\Delta U = 0.52 ... 0.56$ eV for KH_2PO_4, $\Delta U = 0.46 ... 0.55$ eV for KD_2PO_4.	94Mar
	Linear and nonlinear light scatterings from growth band show considerable increase near Θ_f.	94Dre
b	Electrooptic effect: Table 33A-1-047, Table 33A-1-048, Table 33A-1-049; Fig. 33A-1-185, Fig. 33A-1-186, Fig. 33A-1-187, Fig. 33A-1-188, Fig. 33A-1-189; see also	44Zwi, 69Adh, 77Shu
	Electrooptic effect in the ultraviolet region near the absorption edge: see	76Ona
	Electrooptic effect in far-infrared region: see	79Akt
	Quadratic electrooptic constant: $\lvert L_{11} - L_{12} \rvert = 2.5 \cdot 10^{-20}$ m^2 V^{-2} at $\lambda = 633$ nm, T = RT.	87Gor
	Nonlinear electrooptic effect: see	68Per, 69Per, 71Son, 79Jam1, 83Kuc, 87Eim, 90Gor

	Effect of dopants on r_{63} and V_π: see	83Var
	Pockels cell for a short light pulse: see	78Joh
	Electrooptic constant of monoclinic $K(H_{0.06}D_{0.94})_2PO_4$ at RT: $n_1^3 r_{12} - n_2^3 r_{22} = 4.2(8) \cdot 10^{-12}$ m V^{-1} at $\lambda = 632.8$ nm.	79Jam2
c	Piezooptic constant for **T**: Table 33A-1-050; Fig. 33A-1-190, Fig. 33A-1-191; see also	77Mad
	Effect of p on refractive indices: Fig. 33A-1-192.	
	p_{66}^{E} obtained from Brillouin scattering: Fig. 33A-1-193.	
	Piezooptic constant for **S**: Table 33A-1-050, Table 33A-1-051; Fig. 33A-1-194, Fig. 33A-1-195, Fig. 33A-1-196.	
	Effect of dopants to piezooptic constant: see	83Ram
d	Gyration tensor: $g_{11} = 2.54 \cdot 10^{-4}$ for $\lambda = 462$ nm and $2.28 \cdot 10^{-4}$ for $\lambda = 506$ nm. See also Fig. 33A-1-197, Fig. 33A-1-198, Fig. 33A-1-199, Fig. 33A-1-200.	78Kob
	Quadratic electrogyration coefficient: Fig. 33A-1-201, Fig. 33A-1-202, Fig. 33A-1-203, Fig. 33A-1-204.	
	Verdet constant: $V = 204(11)$ K^{-1} m^{-1} for $\lambda = 632.8$ nm.	76Kor
	See also Fig. 33A-1-205, Fig. 33A-1-206, and Fig. 33A-8-006 in No. 33A-8, and	91Mun
e	Nonlinear susceptibility for SHG:	
	KH_2PO_4: $d_{36} = 0.44 \cdot 10^{-12}$ m V^{-1} for $\lambda = 1.06$ µm. $\lvert d_{14} / d_{36}^{\mathrm{KDP}} \rvert = 1.00(6)$ or 0.86(5) for $\lambda = 694.3$ nm and 1.03(5) for $\lambda = 1.06$ µm.	72Lev
	KD_2PO_4: $\lvert d_{36} / d_{36}^{\mathrm{KDP}} \rvert = 1.05(5)$ for $\lambda = 694.3$ nm and 1.06(5) for $\lambda = 1.06$ µm. [a])	[a]) 72Lev
	$\lvert d_{14} / d_{36}^{\mathrm{KDP}} \rvert = 0.97(8)$ or 0.85(10) for $\lambda = 694.3$ nm and 1.05(5) for $\lambda = 1.06$ µm. [b])	[b]) 69Hol
	See also Fig. 33A-1-207, Fig. 33A-1-208.	
	Third order nonlinear susceptibilities: see	77Nik, 77Eic
	Third and fourth harmonic generation of Nd-glass laser at $\lambda = 1.06$ µm: see	77And, 88Beg
	Two photon absorption of DKDP at $\lambda = 266.1$ nm: see	77Rei
	Optical rectification properties: see	80Mor
10a	Raman and hyper-Raman scatterings: Fig. 33A-1-209, Fig. 33A-1-210, Fig. 33A-1-211, Fig. 33A-1-212, Fig. 33A-1-213, Fig. 33A-1-214, Fig. 33A-1-215, Fig. 33A-1-216, Fig. 33A-1-217, Fig. 33A-1-218, Fig. 33A-1-219, Fig. 33A-1-220, Fig. 33A-1-221, Fig. 33A-1-222, Fig. 33A-1-223, Fig. 33A-1-224, Fig. 33A-1-225; see also	73Ham, 73Ree, 84Dav, 85Gon
	Relaxation time obtained by Raman and hyper-Raman scattering: Fig. 33A-1-226.	
	Effect of deuteration: see Fig. 33A-1-217; see also	76Bli, 76Pee, 77Shi
	Coupled mode analysis: Fig. 33A-1-227; see also	72She, 76Maz, 77Kat
	Comparison between Raman and neutron scattering of vibration modes: see Table 33A-1-074; Fig. 33A-1-297 in 14b.	
	Effect of p: Fig. 33A-1-228, Fig. 33A-1-229.	
	Polariton and near forward scattering: see	78Tom, 77Akt
	Spectra in the monoclinic phase (phase II): see	75She

	Spectra of highly deuterated KDP in the monoclinic phase at RT: see	78Rat
b	Brillouin and Rayleigh scattering: Fig. 33A-1-230, Fig. 33A-1-231, Fig. 33A-1-232, Fig. 33A-1-233, Fig. 33A-1-234, Fig. 33A-1-235, Fig. 33A-1-236, Fig. 33A-1-237, Fig. 33A-1-238, Fig. 33A-1-239, Fig. 33A-1-240; see also	77Lag, 79Saw1, 80Saw, 81Mer
	Impulsive stimulated Brillouin scattering: see	84Rob
	Brillouin scattering of the soft acoustic mode near the tricritical point: see	83Gam
	Thermal central peak was studied under an applied electric field: see	81Cou
	Brillouin scattering up to $p = 4.7 \cdot 10^8$ Pa: see	86Shi
	Effect of uniaxial stress: see	85Tak1
	c_{ij} obtained from Brillouin scattering: Fig. 33A-1-241; see also 8a.	
	p_{66}^{E} obtained from Brillouin scattering: see 9c.	
	See also	74Azo
	Rayleigh scattering in the vicinity of Θ_f: Fig. 33A-1-242; see also	78Cou
	Rayleigh scattering at $T \approx \Theta_{III-II}$: see	73Shu
11	Electrical conductivity: Fig. 33A-1-243, Fig. 33A-1-244, Fig. 33A-1-245, Fig. 33A-1-246. See also	50Mas, 62Sch, 66Har, 87Rat, 89Bar, 92Lic
	Conductivity of monoclinic KD_2PO_4: see	88Yak
	Conductivity of Co^{2+} doped KDP: see	77Sha
	Conductivity of MoO_4^{2-} doped KDP: see	87Rat
	Anomalies in σ are reported to occur at 180 °C in KH_2PO_4 and at 102 °C in KD_2PO_4; see also	67Oke1, 72Gru
	Electric breakdown: see	46Dav
	Activation energy: Table 33A-1-052; see also	66Har
	Non-ohmic behavior of pure and doped KH_2PO_4 (dopants: Cu^{2+}, Ni^{2+}, Fe^{3+}, SO_4^{2-}): see	82Die
	Arrhenius law for conductivity $\sigma = \sigma_0 \exp(\Delta U/kT)$ with $\sigma_0 = 6.89 \cdot 10^7\ \Omega^{-1}\,m^{-1}$ and $\Delta U = 0.99$ eV in the range 404…471 K.	86deO
	Frequency and temperature dependence of ac conductivity: see	90Hen
	Thermally stimulated exoelectron emission into vacuum from polarized KDP single crystal was observed between 80 and 300 K.	87Bie
13a	NMR, NQR of proton or deuteron: Table 33A-1-053, Table 33A-1-054; Fig. 33A-1-247, Fig. 33A-1-248, Fig. 33A-1-249, Fig. 33A-1-250, Fig. 33A-1-251; see also	62Sch, 67Bjo, 71Bli1, 73Gol, 74Bur1
	NQR of ^{39}K: Table 33A-1-055; Fig. 33A-1-252, Fig. 33A-1-253, Fig. 33A-1-254; see also	69Tsu
	NQR of ^{31}P: Table 33A-1-056; Fig. 33A-1-255, Fig. 33A-1-256, Fig. 33A-1-257; see also	74Ter, 74Bur2
	NQR of ^{17}O: Table 33A-1-057, Table 33A-1-058; Fig. 33A-1-258.	

b	ESR of VO^{2+}: Table 33A-1-059.	
	ESR of Mn^{2+} and Cu^{2+}: Table 33A-1-060.	
	ESR of Ni^{2+}: see	84Die
	ESR of Tl^{2+}: Table 33A-1-061, Table 33A-1-062; Fig. 33A-1-259, Fig. 33A-1-260, Fig. 33A-1-261; see also	79Efi
	ESR of Fe^{3+}: Table 33A-1-063.	
	ENDOR of Cr^{3+}: Table 33A-1-064, Table 33A-1-065.	
	ESR of Cr^{3+} from the growth band at RT: see	89Bra
	Slow ferroelectric cluster dynamics was studied by ESR of ^{54}Cr in KH_2PO_4.	76Mul
	ESR and ENDOR of SeO_4^{3-} : Table 33A-1-066, Table 33A-1-067; Fig. 33A-1-262, Fig. 33A-1-263, Fig. 33A-1-264, Fig. 33A-1-265, Fig. 33A-1-266, Fig. 33A-1-267, Fig. 33A-1-268, Fig. 33A-1-269, Fig. 33A-1-270, Fig. 33A-1-271, Fig. 33A-1-272.	
	Tensor components of ESR in KD_2PO_4: SeO_4^{3-} : g_{xx} = 2.002(5), g_{yy} = 2.001(5), g_{zz} = 2.001(3), A_{xx} = 2988(8) MHz, A_{yy} = 3138(8) MHz, A_{zz} = 3486(6) MHz, $Z \parallel c$, angle between x and a = 30(2)°.	82Dal
	Estimation of deuteron concentration by ESR of SeO_4^{3-} center: see	84Aka
	ENDOR of AsO_4^{4-} : Table 33A-1-068; Fig. 33A-1-273, Fig. 33A-1-274, Fig. 33A-1-275, Fig. 33A-1-276.	
	See also Table 33A-1-066.	
	ESR and ENDOR of CrO_4^{3-} : $g_{\parallel}$ = 1.9560(5), $g_{\perp}$ = 1.9759(5), $A_{\parallel}$ = 29(1) · 10^{-4} T, $A_{\perp}$ = 10(4) · 10^{-4} T at 300 K (∥: c direction); [D: $g_{\parallel}$ = 1.9561(5), $g_{\perp}$ = 1.9758(5), $A_{\parallel}$ = 28.5(5) · 10^{-4} T, $A_{\perp}$ = 10(4) · 10^{-4} T].	88Dal
	Table 33A-1-069; Fig. 33A-1-277, Fig. 33A-1-278.	
	ESR of MoO_4^{3-} : see	87Bat
	ESR and ENDOR of X-ray and γ-ray irradiated crystal: Table 33A-1-069, Table 33A-1-070, Table 33A-1-071, Table 33A-1-072.	
	See also	73Han, 73Tsu, 75Tsu, 75Vol, 77Dal, 78Huk, 78McM
c	Mössbauer effect: Fig. 33A-1-279.	
14b	X-ray diffuse scattering: Fig. 33A-1-280, Fig. 33A-1-281, Fig. 33A-1-282.	
	Ferroelectric eigenvector for each atom from X-ray critical scattering: Table 33A-1-073.	
	Inelastic neutron scattering: Fig. 33A-1-283, Fig. 33A-1-284; see also Fig. 33A-3-094 in No. 33A-3 and	63Wak
	Neutron diffuse scattering: Fig. 33A-1-285, Fig. 33A-1-286, Fig. 33A-1-287.	
	Neutron scatttering intensity distribution by domain structure: Fig. 33A-1-288, Fig. 33A-1-289, Fig. 33A-1-290.	
	Neutron incoherent scattering: Fig. 33A-1-291, Fig. 33A-1-292, Fig. 33A-1-293, Fig. 33A-1-294, Fig. 33A-1-295, Fig. 33A-1-296.	
	Comparison of neutron and Raman scatterings of vibrational modes: Table 33A-1-074; Fig. 33A-1-297.	
15a	Domain structure: domain walls are perpendicular to the a axis of the tetragonal phase: Fig. 33A-1-298.	
	Observation by polarized light: see	53Mit, 87Abe

	Observation by dew method: Fig. 33A-1-299.	
	Observation by scanning electron microscope: see	76Mau
	Observation by X-ray topography: see	82Ale1, 85Ale
	Thickness dependence of domain width: see	85HaD, 87Abe, 90Bor
	Differential γ-ray diffraction due to domain structure: see	80Bor
	Laser diffraction due to domain structure: see	69Vel, 85HaD
	Domain patterns are approximately characterized with fractal of the pentad Cantor set:	94Oza
	Structure of domain walls: see	86And, 87Afo
	Phonon scattering from domain walls: see	93Wei
	X-ray diffraction and X-ray topographic studies on structure of domain walls: see	86And, 87Afo
b	Switching characteristics: Fig. 33A-1-300, Fig. 33A-1-301; see also	76Bas
	Direct observation of domain wall motion by polarized light: see	75Bor, 70Bor, 84Bor
	Polarization reversal measured with AsO_4^{4-} ESR spectra: see	83Tru1, 83Tru2
16	Surface layer: in the vicinity of Θ_f a layer of low dielectric constant ($\kappa \approx 21$) with the thickness of about $6.63 \cdot 10^{-7}$ m is reported to exist.	76Man
	Whiskers are grown along [100] (rarely along [101]) from aqueous solution.	67Ued
	Internal friction: see Fig. 33A-1-137 and Fig. 33A-1-138 in 8a; see also	78Gri
	Strain distribution and domain switching studied by γ-ray diffractometry: see	76Bas
	Dislocations and interdomain interaction: see	72Bor
	X-ray topographic studies of dislocations: see	76Bel
	Dislocations in partially deuterated crystals were observed by X-ray topography.	76Bel
	Dislocation structures at various temperature were observed by X-ray topography.	94Smo
	Diffraction contrast in transmission electron microscope due to inclusions of orthorhombic symmetry in a tetragonal crystal at room temperature was observed.	94Suv
	AFM observation of {101} face with vicinal hillocks: see	94DeY