No. 1A-8 $SrTiO_3$, Strontium titanate
(M = 183.52)

1a Youngblood reported that dielectric constants of $SrTiO_3$ single crystal increases with lowering temperature and reaches $(1.7...1.8)\cdot10^4$ near 10 K. Gränicher reported in 1956 that the crystal exhibits extraordinarily high dielectric constant at liquid-He temperature and D–E hysteresis character is closely related to ferroelectrics. — 55You, 56Gra

See also — 50Hul, 53Lin, 59Wea

b

phase	II [*])	I	
state		P	62Rim1
crystal system	tetragonal	cubic	
space group	$I4/mcm - D_{4h}^{18}$ [a])	$Pm3m - O_h^1$	[a]) 67Uno
Θ [K]	≈ 105		

The phase transition at 105 K associated with zone-boundary phonon condensation at R-point was found by ESR [a]), Raman scattering [b]), Brillouin scattering [c]), neutron inelastic scattering [d]) and ultrasonic measurements [e]). — [b]) 68Fle1, [c]) 70Lau, [d]) 69Shi, [e]) 75Oka

T_{melt} = 2080 °C. — 71Mos
$\rho = 5.13\cdot10^3\ \mathrm{kg\,m^{-3}}$. — 71Mos
a = 3.905 Å at RT. — 64Lyt
Transparent, colorless. — 71Mos
Hardness: Mohs 6...6.5, Knoop 595. — 71Mos

[*]) In phase II, a slim hysteresis loop showing ferroelectric tendency was observed [f,g]), but the remanent polarization depends upon the amplitude of applied field. There exist other data suggesting that the phase II consists of multiple phases [h]). Physical properties of $SrTiO_3$ at low temperatures depend sensitively on the quality of samples; some exhibit weak ferroelectric activity but others do not [f,i]). — [f]) 59Wea, [g]) 61Mit, [h]) 64Lyt, [i]) 65Saw

As for Θ–p phase diagram and some other phases, see subsubsection 5a.

2a Phase diagram of SrO–TiO_2 system: see [a]) and its supplemental volumes; Figs. 289, 297 on 1964 edition, Fig. 2334 on 1969 edition and Fig. 4232 on 1975 edition. — [a]) 64Lev

Material preparation: see — 88Rav, 93Pfa, 87Are

Ultrafine powders: see — 92Pot

Single crystal growth:

An index to literature on the growth of single crystals and their properties: see — 88Nas

Flux method: — 57Nov, 68Rob, 68Sug

Flame-fusion (Verneuil) method; — 77Bed

Top-seeded solution technique; — 71Bel

	Thin film preparation: see	69Pen, 80Tom, 90Ish, 91Sel, 91Yam, 93Bra, 93Kam
	and see also subsection 16.	
	Etching and chemical polishing: see subsection 16.	
3a	Unit cell parameters:	
	a = 3.905 Å at RT (in phase I).	64Lyt
	Temperature dependence: Fig. 1A-8-001, Fig. 1A-8-002.	
b	Z = 1 in phase I.	67Uno,
	Z = 4 in phase II; $a \approx \sqrt{2}a_0$, $c \approx 2a_0$, $c/\left(\sqrt{2}a\right) - 1 \approx 10^{-3}$ with a_0 = 3.905 Å.	73Oka
	Crystal structure: Fig. 1A-8-003, Fig. 1A-8-004.	
	Atomic position at 78 K (in phase II): Table 1A-8-001.	
	Rotation of oxygen octahedron below 105 K and structure refinement: see	67Uno, 81Hut, 69Shi, 70Uno1, 79Fuj
	and see also subsubsection 13b.	
4	Thermal expansion: Fig. 1A-8-005, Fig. 1A-8-006.	
	Thermal strain along <110> and <111> in the vicinity of Θ_{II-I} : see	70Gol
	Critical exponent for lattice parameters: Fig. 1A-8-007, Fig. 1A-8-008.	
	Thermal dilatation and expansion coefficients: Fig. 1A-8-009.	
5a	Dielectric constant at low frequencies: Figs. 1A-8-010, 1A-8-011, 1A-8-012, 1A-8-013; see also	67Roz, 70Sai, 71Sak, 94Via
	Curie-Weiss law: $\kappa = C/(T - \Theta_p)$ for T > 70 K where $C = 7.83\cdot10^4$ K and Θ_p = 28 K;	61Mit
	$\kappa = M/[(T_1/2)\coth(T_1/2T) - T_0]$ for T < 50 K where T_0 = 38 K, T_1 = 84 K and $M = 9\cdot10^4$ K.	62Saw
	Dielectric dispersion: Fig. 1A-8-014, Fig. 1A-8-015; see also	71Are, 70Joh
	Microwave loss above 37 K: see	62Rup
	Dielectric constant at infrared and ultraviolet regions: see subsubsection 9a.	
	Effect of biasing electric field on dielectric constant: Figs. 1A-8-016, 1A-8-017, 1A-8-018; see also	64Heg
	Effect of mechanical stress and of hydrostatic pressure: Figs. 1A-8-019, 1A-8-020, 1A-8-021, 1A-8-022, 1A-8-023, 1A-8-024, 1A-8-025, 1A-8-026; see also	65Sam, 67Heg
	$\Theta - p$ phase diagram: Fig. 1A-8-027, Fig. 1A-8-028.	
	$d\Theta_{II-I}/dp_1 = 3.6(1)\cdot10^{-8}$ K $N^{-1}m^2$ (p_1: uniaxial pressure along [100]),	
	$d\Theta_{II-I}/dp_{1,2} = 9.2(3)\cdot10^{-8}$ K $N^{-1}m^2$ ($p_{1,2}$: biaxial pressure along [110] and $[1\bar{1}0]$).	72Fos
	A trigonal non-ferroelectric phase with space group $R\bar{3}c$ is induced by a mechanical stress applied in <111> direction below 120 K: see Fig. 1A-8-136.	

	A ferroelectric phase is induced at low temperatures by a mechanical stress along <100> (see Fig. 1A-8-021) and by a stress along <110> (see Fig. 1A-8-020).	71Bur
	Dielectric anisotropy occurring below about 65 K: Fig. 1A-8-029.	
	Dielectric constant of thin films: Fig. 1A-8-030, Fig. 1A-8-031; see also	93Kam
	For a thin film on $YBa_2Cu_3O_7$ layer, see	92Wal
	Coefficients of free energy expansion at low temperature: see	66Cro
b	Nonlinear dielectric constant: Figs. 1A-8-032, 1A-8-033, 1A-8-034; see also	72Buz, 78Iva, 81Bel
d	Electrocaloric effect: Fig. 1A-8-035; see also	61Heg, 61Mit, 64Kik, 65Heg, 80Rad, 89Bor, 92Boi
6a	Heat capacity: Figs. 1A-8-036, 1A-8-037, 1A-8-038; see also	61Gol, 62Heg
	Specific heat at low temperature: Fig. 1A-8-039.	
b	Thermal conductivity: Fig. 1A-8-040, Fig. 1A-8-041; see also	68See, 74Sal
7a	Piezoelectric constants induced by dc biasing field: Fig. 1A-8-042, Fig. 1A-8-043; see also	67Rup
b	Electrostriction: Fig. 1A-8-044, Fig. 1A-8-045.	
	Electrostrictive mixing: Fig. 1A-8-046.	
8a	Elastic compliance and stiffness: Table 1A-8-002; Figs. 1A-8-047, 1A-8-048, 1A-8-049; see also	80Hoc
	Ultrasonic velocity: Fig. 1A-8-050, Fig. 1A-8-051; see also	84Fos1
	Ultrasonic attenuation: Figs. 1A-8-052, 1A-8-053, 1A-8-054, 1A-8-055, 1A-8-056, 1A-8-057; see also	69Ber, 71Reh, 72Fos, 84Fos2
	Electric field effect: Fig. 1A-8-058, Fig. 1A-8-059.	
	Pressure effect: Figs. 1A-8-060, 1A-8-061, 1A-8-062.	
	Effect of magnetic field: see	72WuC
	Surface wave velocity: Fig. 1A-8-063, Fig. 1A-8-064.	
b	Third order elastic constant: Table 1A-8-003; Fig. 1A-8-065, Fig. 1A-8-066; see also	81Ach
	Nonlinear elastic effect under electric field: Fig. 1A-8-067.	
	Third harmonic generation of sound: Fig. 1A-8-068.	
9a	Refractive index: Table 1A-8-004; see also	57Gia, 65Car, 85Afa
	Birefringence: Fig. 1A-8-069.	
	Optical constants in ultraviolet region: Fig. 1A-8-070; see also	65Car
	Infrared reflectivity: Fig. 1A-8-071, Fig. 1A-8-072; see also	65Car, 62Bar

	Kramers-Kronig analysis: Figs. 1A-8-073, 1A-8-074, 1A-8-075, 1A-8-076, 1A-8-077, 1A-8-078; see also	62Spi, 64Mur
	Refractive index in near mm wave region: Fig. 1A-8-079.	
	Optical transmission: Fig. 1A-8-080.	
	Infrared transmission: Figs. 1A-8-081, 1A-8-082, 1A-8-083.	
	Lattice vibration frequency: Fig. 1A-8-084.	
	Optical absorption: Fig. 1A-8-085; see also	65Car, 70Cap, 71Ber, 71Bla
	Optical absorption in transition metal doped crystals: Fig. 1A-8-086.	
	Optical absorption due to Ce^{3+} ions: see	81Bla1
	Infrared absorption spectra due to crystal defects: see	81Bre
b	Quadratic electrooptic constants: M_{11} = + 0.15 m^4C^{-2}; M_{12} = + 0.04 m^4C^{-2}; M_{44} = + 0.88 m^4C^{-2} (λ = 632.8 nm, T = 300 K);	70Fuj
	see also	64Geu, 68Son
c	Photoelasticity (piezooptic effect): Table 1A-8-005; see also	76Aso
	Piezooptic constant for strain: p_{11} = 0.15, p_{12} = 0.095, p_{44} = 0.072 for λ = 632.8 nm at RT.	68Rei
d	Faraday rotation: Fig. 1A-8-087.	
e	Electric-field-induced nonlinear optical susceptibilities: $\mid d_{33}/d_{11}^{quartz}\mid$ = 1.11(13), $\mid d_{31}/d_{11}^{quartz}\mid$ = 1.51(21), $\mid d_{33}/d_{31}\mid$ = 0.74(4) for $E = 20.5\cdot10^5\ Vm^{-1}$ at 120 K.	76Fuj
	Fig. 1A-8-088.	
	Two-photon absorption spectra: Fig. 1A-8-089.	
	Second harmonic generation (field-induced SHG): Fig. 1A-8-090.	
10a	Raman scattering: Figs. 1A-8-091, 1A-8-092, 1A-8-093, 1A-8-094, 1A-8-095, 1A-8-096; see also	73Ste1, 68Fle1
	Hyper-Raman scattering:	
	Dispersion parameters at RT deduced from hyper-Raman and far-infrared reflectivity spectrum: Table 1A-8-006.	
	Soft TO mode observation at low temperatures: Fig. 1A-8-097.	
	Refractive index, and dielectric constant derived from hyper-Raman scattering: Figs. 1A-8-098, 1A-8-099, 1A-8-100.	
	Soft mode frequency and polariton effect: see	81Ino
b	Brillouin scattering: Figs. 1A-8-101, 1A-8-102, 1A-8-103; see also	77Lyo, 74Ste, 66Kai
	Depolarized central peak and Brillouin spectra: Fig 1A-8-104.	
	Rayleigh scattering: Fig. 1A-8-105; see also	66Kai, 73Ste2
11	Electrical conductivity: $\sigma \approx 10^{-10}\ \Omega^{-1}m^{-1}$ (donor content $n \approx 10^{18}...10^{21}\ m^{-3}$) at RT: see	85Ded
	Electrical transport properties (resistivity, Hall coefficient and mobility) of reduced and doped $SrTiO_3$: Table 1A-8-007; Figs. 1A-8-106, 1A-8-107, 1A-8-108, 1A-8-109;	

	see also	69Gur
	Conductivity vs. oxygen partial pressure (T = 800...1050 °C): see	81Bal
	Conductivity in impurity doped $SrTiO_3$: see	85Mai
	Band structure: see	72Mat1, 64Kah, 70Sro, 78Hen, 84Rei, 85Uwe
	Charge transfer band in Fe-doped $SrTiO_3$: see	81Mic
	Density-of-state effective mass: $m^* = 1.3(2)\cdot m_0$, d-band width: 3.4 eV.	72Mat2, 70Sro
	Drift mobility of small polaron: see	84Ker
	Photoconductivity, photoluminescence: see	82Fen
	Surface photoconductivity: Fig. 1A-8-110.	
	Photo-Hall effect: see	67Yas, 68Yas
	Photoemission: see	66Tre
	Photochromic and thermochromic effect: see	66Tre, 71Wil, 73Wil, 75Bla
	Piezoresistivity: Figs. 1A-8-111, 1A-8-112, 1A-8-113.	
	Magnetoresistivity: see	75Kuc
	Electroreflectance: Fig. 1A-8-114; see also	71Gho, 74Mac
	Fundamental absorption edge: see	87Gol
	Color center: see	80Bla
	Additional data concerning electrical conduction:	61Gol, 64Fre, 67Tuf, 70Roz, 71Amo, 71Lee, 73Wil, 76Per, 78Per
	Superconductivity:	
	Superconductivity was discovered in semiconductive $SrTiO_3$ by Schooley et al. in 1964.	64Sch
	Figs. 1A-8-115, 1A-8-116, 1A-8-117, 1A-8-118; see also	66Sch, 67Sch
	Superconductivity in semiconducting $SrTiO_{3-x}$ tunneling junctions: see	74Bin
12	Magnetic susceptibility: Table 1A-8-008.	
	Effects of intense magnetic field on the dielectric constant: see	85Law
	Shubnikov-de Haas oscillation: see	85Uwe
	Effect of intense magnetic field on soft mode: see subsection 14 below.	
13a	NMR of ^{87}Sr in $SrTiO_3$:	
	Signal amplitude and linewidth: Fig. 1A-8-119.	
	Nuclear spin-lattice relaxation time of ^{87}Sr: see	76Rig
b	ESR:	
	Spin Hamiltonian parameters: Table 1A-8-009.	

	Temperature dependence of ESR parameters: Figs. 1A-8-120, 1A-8-121, 1A-8-122, 1A-8-123, 1A-8-124, 1A-8-125, 1A-8-126, 1A-8-127, 1A-8-128.	
	Electric field effect: Fig. 1A-8-129; see	73Uno, 81Pec, 91Koo
	Hydrostatic pressure effect: Figs. 1A-8-130, 1A-8-131, 1A-8-132, 1A-8-133.	
	Uniaxial stress effect: Figs. 1A-8-134, 1A-8-135, 1A-8-136, 1A-8-137; see also	73von1
	ESR of Fe^{3+}, Fe^{3+}–$V(O^{2-})$: Fig. 1A-8-138.	
	See also Figs. 1A-8-122....1A-8-140.	72von1, 73von2, 74Mul1, 74Mul2, 75Mul, 78Ber, 81Bli, 81Pec
	Energy levels for Fe^{3+}: Fig. 1A-8-139, Fig. 1A-8-140.	
	ESR of Gd^{3+}: Figs. 1A-8-127, 1A-8-129, 1A-8-131; see also	74Uno
	EPR Zeeman field for Mn^{2+}: see	77Ser
	EPR of Mo^{5+}: see	72Fau
	EPR for low-spin Ni^{3+}: see	69Mul
	EPR of low-spin Co^{4+}: see	83Bla
	EPR of Ir^{4+}: Fig. 1A-8-141.	
	ESR of Cr^{3+}: Fig. 1A-8-132; see also	69Mul, 71Mei, 83Mul
	EPR for Cr^{5+}: Figs. 1A-8-142, 1A-8-143, 1A-8-144, 1A-8-145; see also	72Lag, 79Glo
	EPR of reduced crystals; Sr vacancies in as-grown, flame-fusion and top-seeded-solution-grown crystals: no indication of Sr vacancy in flux-grown crystals: see	81Bla2
	EPR in flux-grown crystals with low dislocation density: see	83DIo
	EPR of photochromic crystal:	69Fau, 70Ens, 71Fau, 75Bla
	Ti^{3+} off center on Sr^{2+} site in neutron-irradiated crystal: see	73Sch
	Trap centers Ti^{3+}–$V(O^{2-})$ in fine particles during water photolysis: see	90Kut
c	Mössbauer effect of Fe in $SrTiO_3$: Figs. 1A-8-146, 1A-8-147, 1A-8-148, 1A-8-149; see also	80Wil, 84Mul
14a	X-ray scattering and R-point instability: Fig. 1A-8-150, Fig. 1A-8-151.	
	X-ray superlattice reflection: see	79Fuj
	Diffuse streak in electron diffraction: see	84Are
b	Inelastic neutron scattering for soft mode: Figs. 1A-8-152, 1A-8-153, 1A-8-154, 1A-8-155; see also	64Cow, 69Yan, 69Shi, 73Iiz
	Phonon dispersion curve: Figs. 1A-8-156, 1A-8-157, 1A-8-158, 1A-8-159.	

	Inelastic neutron scattering spectra for R-point soft mode: Fig. 1A-8-160, Fig. 1A-8-161.	
	Soft Γ and R modes in reduced crystal: Fig. 1A-8-162, Fig. 1A-8-163.	
	Neutron scattering study of time-dependent strain: Fig. 1A-8-164.	
	Dispersion of TO phonon in semiconducting crystal: Fig. 1A-8-165.	
	Effect of magnetic field on soft mode with no frequency shift: see	81Com
16	Surface layer: see	78Hen, 78LoW
	Etching and chemical polishing: see	66Rho
	Twin structure in phase II: see	61Mit, 63Saw, 64Lyt
	Thin film growth:	
	RF magnetron sputtering: see	92Nam
	Plasma enhanced CVD: see	92Hol
	Laser ablation: see	92San
	Laser molecular beam epitaxy: see	92Yos
	Focussed electron beam evaporation method: see	91Mor
	Ion beam sputtering: see	91Yam

Table 1A-8-001. $SrTiO_3$. Crystal structure of low temperature phase II [69Shi]. Approximate fractional coordinates of atoms in the unit cell at 78 K determined by neutron diffraction experiment. Tetragonal cell containing one molecular unit (Z = 1) is assumed.

Space group	$I4/mcm\text{–}D_{4h}^{18}$		
Unit cell	$\sqrt{2}a \cdot \sqrt{2}a \cdot 2c\,(Z=4)$		
4 Ti	000	$00\frac{1}{2}$	$(+\frac{1}{2}\,\frac{1}{2}\,\frac{1}{2})$
4 Sr	$0\frac{1}{2}\,\frac{1}{4}$	$\frac{1}{2}\,0\,\frac{1}{4}$	
4 O	$00\frac{1}{4}$	$00\frac{3}{4}$	
8 O	$\pm(x,\ \frac{1}{2}+x,\ 0)$	$\pm(\frac{1}{2}+x,\ \bar{x},\ 0)$	
	x = 0.244		

Table 1A-8-002. $SrTiO_3$. Elastic constants at RT [58Poi, 63Bel, 63Wac].

s_{11}	s_{12}	s_{13}	c_{11}	c_{12}	c_{13}	Method	Note	Ref.
[10^{-12} m^2 N^{-1}]			[10^{11} N m^{-2}]					
3.3	–0.74	8.4	3.48	1.01	1.19	composite bar	[a])	58Poi
3.729	–0.909	8.091	3.181	1.025	1.236	pulse	[b])	63Bel
3.772(23)	–0.926(10)	8.233(40)	3.156(27)	1.027(27)	1.215(6)	pulse	[b])	63Wac

[a]) *c* calculated from *s*. [b]) *s* calculated from *c*.

Table 1A-8-003. $SrTiO_3$. Third order elastic constant [71Pet]. Temperature: RT.

Crystal direction	Combination of third-order elastic constants	Sample length [cm]	2^{nd}-harmonic results [71Mac]	[71Pet]	3^{rd}-harmonic results [71Pet]
[100]	C_{111}	3.68	–50(4)	–48(4)	–55(8)
		1.94	–50(4)	–57(4)	–64(8)
[110]	$^1/_4\ (C_{111}+3C_{112}+12C_{165})$	3.51	–27(3)	–36(3)	–33(6)
[111]	$^1/_9\ (C_{111}+6C_{112}+12C_{144}) +24C_{166}+2C_{123}+16C_{456})$	3.25	–28(3)	–33(3)	–33(6)

Table 1A-8-004. $SrTiO_3$. Refractive indices [65Bon].

λ [μm]	n	λ [μm]	n
0.45	2.537	1.8	2.270
0.5	2.472	2.0	2.264
0.6	2.402	2.2	2.258
0.7	2.363	2.4	2.2524
0.8	2.340	2.6	2.2490
0.9	2.326	2.8	2.2395
1.0	2.315	3.0	2.2315
1.1	2.306	3.2	2.2236
1.2	2.299	3.4	2.2143
1.4	2.287	3.6	2.2058
1.6	2.279	3.8	2.1951

Table 1A-8-005. $SrTiO_3$. Piezooptic constants [57Gia].

λ	$\Pi_{21}-\Pi_{11}$	Π_{44}	λ	$\Pi_{21}-\Pi_{11}$	Π_{44}
[nm]	[$\cdot 10^{-13}$ m^2 N^{-1}]		[nm]	[$\cdot 10^{-13}$ m^2 N^{-1}]	
420	9.03	–3.69	600	9.95	–4.92
430	9.23	–3.74	610	9.94	–4.99
440	9.03	–3.78	620	9.91	–5.05
450	9.26	–3.99	630	9.84	–5.12
460	9.12	–3.965	640	9.82	–5.13
470	9.12	–4.13	650	9.88	–5.18
480	9.14	–4.09	660	9.96	–5.22
490	9.16	–4.22	670	9.92	–5.29
500	9.35	–4.33	680	9.98	–5.52
510	9.44	–4.32	690	9.99	–5.48
520	9.61	–4.41	700	9.91	–5.555
530	9.54	–4.51	710	9.92	–5.62
540	9.68	–4.59	720	9.94	–5.77
550	9.56	–4.575	730	9.99	–5.73
560	9.85	–4.62	740	10.05	–5.78
570	9.85	–4.69	750	9.90	–5.79
580	9.86	–4.79	760	9.92	–5.825
590	9.88	–4.85	770	10.02	–5.98

Table 1A-8-006. $SrTiO_3$. Dispersion parameters deduced from hyper-Raman scattering (HR) and far-infrared reflectivity (IR) spectra [81Vog]. ν_0: mode frequency, Γ: damping constant, $| Z / Z_1 |$: effctive charge relative to that of TO1 mode, $\partial \nu_0 / \partial p$: mode Grüneisen parameter.

Mode [a])	Symmetry		Classical dispersion analysis						$\partial\nu_0/\partial p$
		ν_0 [cm^{-1}]	ν_0 [cm^{-1}]		Γ [cm^{-1}]		$\|Z/Z_1\|$		[cm^{-1} kbar^{-1}]
		HR' [b])	HR	IR [d])	HR	IR [d])	HR	IR [d])	HR'' [c])
TOl	F_{1u}	88	87.9	87.5; 87.7	23.7	26.3; 43.9	1	1	1.02
LOI		175							
TO2	F_{1u}	175	173.8	178	6.1	6.1; 6.9	0.22	0.22	0.20
LO2		266							
TO3	F_{2u} (silent)	266							
LO3		474							
TO4	F_{1u}	545	544.0	546; 544	18.0	26.8; 26.7	0.40	0.50; 0.44	
LO4		795							0.60

[a]) The numbering of the modes is in order of increasing frequencies [66Bar], [64Cow].
Note that LO3 corresponds to TO2, whereas LO2 and TO3 are degenerate and silent.
[b]) [79Vog]. [c]) [85Ino]. [d]) [62Spi].

Table 1A-8-007. $SrTiO_3$. Optical absorption α and carrier concentration N of various samples prepared under different reduction and doping conditions [75Lee]. For ρ, R_H and μ_H see Fig. 1A-8-107, Fig. 1A-8-108, Fig. 1A-8-109.

Sample	Reduction		Atmosphere	Doping and other	α at 1.5 µm	N at 300 K
No.	T [°C]	t [h:min]		treatment	[m^{-1}]	[m^{-3}]
1	750	1:35	vacuum		$6.92 \cdot 10^2$	$1.22 \cdot 10^{23}$
2	750	2:00	H_2	1700°C, 1 h preannealing in air	$37.1 \cdot 10^2$	$1.53 \cdot 10^{24}$
3	750	2:00	H_2		$22.0 \cdot 10^2$	$4.24 \cdot 10^{23}$
4	663	1:50	H_2		$11.1 \cdot 10^2$	$1.00 \cdot 10^{23}$
5	757	1:47	H_2	Nb: $3 \cdot 10^{24}$ m^{-3}	$91 \cdot 10^2$	$6.0 \cdot 10^{24}$
6				Nb: 0.03 wt %		$1.55 \cdot 10^{24}$

Table 1A-8-008. $SrTiO_3$. Magnetic susceptibility in pure and reduced crystals [66Fre]. $\Delta\chi_{magn\ \rho}$: contribution to $\chi_{magn\ \rho}$ from charge carriers, which is estimated by subtracting "pure" diamagnetic and Van Vleck contributions from measured susceptibility. T_{deg}: degeneracy temperature, m^*: density-of-state effective mass.

Sample	N at 4.2 K	T_{deg}	$\chi_{magn\ \rho}$ or $\Delta\chi_{magn\ \rho}$ [$4\pi\cdot10^{-10}$ m^3 kg^{-1}]				m^* at 4.2 K
	[m^{-3}]	[K]		300 K	78 K	4.2 K	[m_0]
Pure	–	–	χ	–1.02	–1.00	–0.92	–
28 h, 950°C hydrogen	$6\cdot10^{24}$	28	$\Delta\chi_1$	+0.037	+0.073	–	–
5 h, 1200°C hydrogen (carbon boat)	$7.5\cdot10^{25}$	148	$\Delta\chi_2$	+0.270	+0.523	+0.928	5.1
Reoxidized 18 h, 700°C, air	–	–	χ	–1.016	–1.012	–0.919	–
27 h, 1370°C hydrogen (carbon boat)	$5.3\cdot10^{26}$	550	$\Delta\chi_3$	+1.704	+1.763	+1.719	4.9

Table 1A-8-009 (part I). $SrTiO_3$. Summary of results on ESR spectra for various doped paramagnetic ions.

*)	Site	S	**H**	ν	T	g-factor		FS (E = 0)	HFS		Ref.
				[GHz]	[K]	$g_{\parallel}$	$g_{\perp}$	D, a [$\cdot 10^{-2}$ m^{-1}]	I	^{n}A [$\cdot 10^{-2}$ m^{-1}]	
Cr^{3+}	Ti^{4+}	3/2	(5)	9	80	1.9788(70)	(isotropic)	D = 2.0(3)	3/2	^{53}A = 0	f) 58Mul1
					300	1.9780(70)	(isotropic)	D = 0		^{53}A = 16.2(3)	62Mul
Mn^{4+}	Ti^{4+}	3/2	(5)	10	77	1.994(1)	(isotropic)	D = +1.0	5/2	^{55}A = –69.4(10)	59Mul
					RT	1.994(1)	(isotropic)	D = –0.7		^{55}A = –69.4(10)	
Fe^{3+}	Ti^{4+}	5/2	(7)	9	1.9	2.004(1)	(isotropic)	D = +17.9(10), a = –230(10)			59Dob
					4.2	2.004(1)	(isotropic)	D = +16.1(7), a = –225.6(19)			a) 59Dob b)
					4.2	2.0037(5)		D = +11.2(2), a = +226.6(1)			67Uno
					77	2.0037(5)		D = +6.27(8), a = +227.3(4)			67Uno
					77	2.004(1)	(isotropic)	D = +7.3(3), a = –220.8(11)			f) 59Dob g)
					300	2.004(1)	(isotropic)	D<1.0, a = –197.7(7)			59Dob
Ni^{2+}	Ti^{4+}	1	(4)	10	80	2.204(1)	(isotropic)				c) 62Rub
Ni^{1+} or Ni^{3+}	Ti^{4+}	1/2	(2)	10	20						d) 62Rub
					80	2.029(1)	2.352(1)				
					203						e)
Ni^{3+}	Ti^{4+}	1/2	(2)	10	4.2	2.110(2)	2.213(2)				e) 62Rub
					20	2.136(1)	2.202(1)				e)
					80	2.172(1)	2.184(1)				
					203	(isotropic)	2.180(2)				

Table 1A-8-009 (part II). $SrTiO_3$. Summary of results on ESR spectra for various doped paramagnetic ions.

*)	Site	S	**H**	ν [GHz]	T [K]	g-factor $g_{\parallel}$	$g_{\perp}$	FS D, a [$\cdot 10^{-2}$ m^{-1}]		HFS I	^{n}A [$\cdot 10^{-2}$ m^{-1}]	Ref.
Ce^{3+}	–	1/2	(2)	10	4.2	3.005(5)	1.118(3)					e) 62Rub
Nd^{3+}	–	1/2	(2)	10	4.2	2.609(3)	2.472(3)					e) 62Rub
				16	2	2.61(1)	2.470(5)					62Rim2
				35		2.62(1)	2.470(5)					
Yb^{3+}	–	1/2	(3)	16	2	2.11(1)	2.780(5)					62Rim2
				35		2.10(1)				1/2	$\lvert ^{171}A_{\parallel}\rvert$ = 530(20)	
											$\lvert ^{171}A_{\perp}\rvert$ = 720(5)	
										5/2	$\lvert ^{173}A_{\perp}\rvert$ = 211(5)	
				16	50	2.18(1)	2.720(5)					
				35		2.170(5)	2.720(5)					
				35	65	(2.25)	2.70(1)					
						g (isotropic)	FS [$\cdot 10^{-2}$ m^{-1}] b_{20}	b_{40}	b_{60}			
Eu^{2+}	–	7/2	(8)	16	2	1.990(1)	–10(4)	106.6(20)	6.7(20)	5/2	$\lvert ^{151}A_{\parallel}\rvert$ = 36.2	62Rim2
										5/2	$\lvert ^{153}A_{\perp}\rvert$ = 17.6	f)
					300	1.990(1)	0	105.9(20)	1.1(20)			
Gd^{3+}	Sr^{2+}	7/2	(8)	16	2	1.992(2)	–362.5(5)	–3.2(5)	1.4(5)			f) 62Rim2
				12,18	4.2	1.992(2)	–362.5(5)	–3.24(50)	1.4(5)			h) 62Rim1
					77	1.992(2)	–233.6(5)	–4.8(5)	–0.25(50)			
					300	1.992(2)		–5.7(2)	0.5(3)			

*) Paramagnetic center.
a) ξ = [100], η = [0l0], ζ = [001].
b) Deviations from Spin Hamiltonian (7) is ascribed to a covalent bonding by Müller [58Mul2]. However, Aisenberg et al. find a negligible contribution of the covalent bonding [59Ais].
c) Spectrum is due to a double quantum absorption between S_z = –1 and S_z = +1 levels.
d) At least fifteen inequivalent sites are observed.
e) Three inequivalent spectra are observed with axes parallel to the cubic [100], [010] and [001].
f) Effects of temperature and pressure on Cr^{3+}, Fe^{3+}, Eu^{2+} and Gd^{3+} spectra [64Rim].
g) Fe^{3+} spectra due to nearest charge compensation [64Kir].
h) Electric field dependence of Gd^{3+} spectra [66Sak].

References

50Hul Hulm, J.K.: Proc. Phys. Soc. (London) **A63** (1950) 1184.
53Lin Linz Jr., A.: Phys. Rev. **91** (1953) 753.
55You Youngblood, J.F.: Phys. Rev. **98** (1955) 1201.
56Gra Granicher, H.: Helv. Phys. Acta **29** (1956) 210.
57Gia Giardini, A.A.: J. Opt. Soc. Am. **47** (1957) 726.
57Nov Novosil'tsev, N.S., Khodakov, A.L., Sholokhovich, M.L., Fesenko, E.G., Kramarov, O.P.: Izv. Akad. Nauk SSSR, Ser. Fiz. **21** (1957) 295; Bull. Acad. Sci. USSR, Phys. Ser. (English Transl.) **21** (1957) 303.
58Mul1 Müller, K.A.: Arch. Sci. (Geneva) **11** (1958) 150.
58Mul2 Müller, K.A.: Helv. Phys. Acta **31** (1958) 173.
58Poi Poindexter, E., Giardini, A.A.: Phys. Rev. **110** (1958) 1069.
59Ais Aisenberg, S., Statz, H., Koster, G.F.: Phys. Rev. **116** (1959) 811.
59Dob Dobrov, W.I., Vieth, R.F., Browne, M.E.: Phys. Rev. **115** (1959) 1073.
59Mul Müller, K.A.: Phys. Rev. Lett. **2** (1959) 341.
59Wea Weaver, H.E.: J. Phys. Chem. Solids **11** (1959) 274.
61Gol Goldsmith, A., Waterman, T.E., Hirschborn, H.J.: Handbook of Thermophysical Properties of Solid Materials, Vol. III, Ceramics, New York: Macmillan, 1961.
61Heg Hegenbarth, E.: Cryogenics **1** (1961) 242.
61Mit Mitsui, T., Westphal, W.B.: Phys. Rev. **124** (1961) 1354.
62Bar Barker Jr., A.S., Tinkham, M.: Phys. Rev. **125** (1962) 1527.
62Cow Cowley, R.A.: Phys. Rev. Lett. **9** (1962) 159.
62Heg Hegenbarth, E.: Phys. Status Solidi **2** (1962) 1544.
62Mul Müller, K.A.: Proceedings of the 1st International Conference on Paramagnetic Resonance, held at Jerusalem, 1962; Paramagnetic Resonance, Vol. I, New York: Academic Press, 1963, p. 17.
62Rim1 Rimai, L., deMars, G.A.: Phys. Rev. **127** (1962) 702.
62Rim2 Rimai, L., deMars, G.A.: Proceedings of the 1st International Conference on Paramagnetic Resonance, held at Jerusalem, 1962; Paramagnetic Resonance, Vol. I, New York: Academic Press, 1963, p. 51.
62Rub Rubins, R.S., Low, W.: Proceedings of the 1st International Conference on Paramagnetic Resonance, held at Jerusalem, 1962; Paramagnetic Resonance, Vol. I, New York: Academic Press, 1963, p. 59.
62Rup Rupprecht, G., Bell, R.O.: Phys. Rev. **125** (1962) 1915.
62Saw Sawaguchi, E., Kikuchi, A., Kodera, Y.: J. Phys. Soc. Jpn. **17** (1962) 1666.
62Spi Spitzer, W.G., Miller, R.C., Kleinman, D.A., Howarth, L.E.: Phys. Rev. **126** (1962) 1710.
63Bel Bell, R.O., Rupprecht, G.: Phys. Rev. **129** (1963) 90.
63Saw Sawaguchi, E., Kikuchi, A., Kodera, Y.: J. Phys. Soc. Jpn. **18** (1963) 459.
63Sch Schmidt, G., Hegenbarth, E.: Phys. Status Solidi **3** (1963) 329.
63Wac Wachtman Jr., J.B., Wheat, M.L., Marzullo, S.: J. Res. Natl. Bur. Stand., Sect. A **67** (1963) 193.
63Web Weber, M.J., Allen, R.R.: J. Chem. Phys. **38** (1963) 726.
64Cow Cowley, R.A.: Phys. Rev. **134** (1964) A981.
64Fre Frenderikse, H.P.R., Thurber, W.R., Hosler, W.R.: Phys. Rev. **134** (1964) A442.
64Geu Geusic, J.E., Kurtz, S.K., Van Uitert, L.G., Wemple, S.H.: Appl. Phys. Lett. **4** (1964) 141.
64Heg Hegenbarth, E.: Phys. Status Solidi **6** (1964) 333.
64Kah Kahn, A.H., Leyendecker, A.J.: Phys. Rev. **135** (1964) A1321.
64Kik Kikuchi, A., Sawaguchi, E.: J. Phys. Soc. Jpn. **19** (1964) 1497.
64Kir Kirkpatrick, E.S., Müller, K.A., Rubins, R.S.: Phys. Rev. **135** (1964) A86.

64Lev Levin, M.L., Robins, C.R., McMurdie, H.: Phase Diagrams for Ceramists, Columbus, Ohio, American Ceramic Society, 1964.
64Lyt Lytle, F.W.: J. Appl. Phys. **35** (1964) 2212.
64Mur Murzin, V.N., Demeshina, A.I.: Fiz. Tverd. Tela **6** (1964) 182; Sov. Phys. Solid State (English Transl.) **6** (1964) 144.
64Per Perry, C.H., Khanna, B.N., Rupprecht, G.: Phys. Rev. **135** (1964) A408.
64Rim Rimai, L., Deutsch, T., Silverman, B.D.: Phys. Rev. **133** (1964) A1123.
64Rup Rupprecht, G., Bell, R.O.: Phys. Rev. **135** (1964) A748.
64Sch Schooley, J.F., Hosler, W.R., Cohen, M.L.: Phys. Rev. Lett. **12** (1964) 474.
65Bon Bond, W.L.: J. Appl. Phys. **36** (1965) 1674.
65Car Cardona, M.: Phys. Rev. **140** (1965) A651.
65Heg Hegenbarth, E.: Phys. Status Solidi **8** (1965) 59.
65Sam Samara, G.A., Giardini, A.A.: Phys. Rev. **140** (1965) A954.
65Saw Sawaguchi, E., Kikuchi, A., Kodera, Y., Tamura, H.: Jpn. J. Appl. Phys. **4** (1965) 617.
65Sch Schooley, J.F., Hosler, W.R., Ambler, E., Becker, J.H., Cohen, M.L., Koonce, C.S.: Phys. Rev. Lett. **14** (1965) 305.
65Sue Suemune, Y.: J. Phys. Soc. Jpn. **20** (1965) 174.
66Amb Ambler, E., Colwell, J.H., Hosler, W.R., Schooley, J.F.: Phys. Rev. **148** (1966) 280.
66Bar Barker Jr., A.S.: Phys. Rev. **145** (1966) 391.
66Cad Caddes, D.E., Quate, C.F., Wilkinson, C.D.W.: Appl. Phys. Lett. **8** (1966) 309.
66Cro Cross, L.E., Chakravorty, D.: Proceedings of the International Meeting on Ferroelectricity, Vol. I, held at Prague, 1966; Institute of Physics of the Czechoslovak Academy of Sciences, Prague, 1966, p. 394.
66Fre Frederikse, H.P.R., Candela, G.A.: Phys. Rev. **147** (1966) 583.
66Heg Hegenbarth, E.: Proceedings of the International Meeting on Ferroelectricity, Vol. I, held at Prague, 1966; Institute of Physics of the Czechoslovak Academy of Sciences, Prague, 1966, p. 104.
66Kai Kaiser, W., Zurek, R.: Phys. Lett. **23** (1966) 668.
66Rho Rhodes, W.H.: J. Am. Ceram. Soc. **49** (1966) 110.
66Sak Sakudo, T., Unoki, H., Fujii, Y.: J. Phys. Soc. Jpn. **21** (1966) 2739.
66Sam Samara, G.A.: Phys. Rev. **151** (1966) 378.
66Sch Schooley, J.F., Thurber, W.R.: J. Phys. Soc. Jpn. **21** Suppl. (1966) 639.
66Tre Tredgold, R.H., Williams, R.H.: J. Phys. Soc. Jpn. **21** Suppl. (1966) 46.
66Tuf Tufte, O.N., Stelzer, E.L.: Phys. Rev. **141** (1966) 675.
67Bae Baer, W.S.: J. Phys. Chem. Solids **28** (1967) 677.
67Bhi Bhide, V.G., Bhasin, H.C.: Phys. Rev. **159** (1967) 586.
67Heg Hegenbarth, E., Frenzel, C.: Cryogenics **7** (1967) 331.
67OSh O'Shea, D.C., Kolluri, R.V., Cummins, H.Z.: Solid State Commun. **5** (1967) 241.
67Pfe Pfeiffer, E.R., Schooley, J.F.: Phys. Rev. Lett. **19** (1967) 783.
67Roz Rozhdestvenskaya, M.V., Kunin, V.Ya.: Izv. Akad. Nauk SSSR, Ser. Fiz. **31** (1967) 1915; Bull. Acad. Sci. USSR, Phys. Ser. (English Transl.) **31** (1967) 1959.
67Rup Rupprecht, G., Winter, W.H.: Phys. Rev. **155** (1967) 1019.
67Sch Schooley, J.F., Frederikse, H.P., Hosler, W.R., Pfeiffer, E.R.: Phys. Rev. **159** (1967) 301.
67Tuf Tufte, O.N., Chapman, P.W.: Phys. Rev. **155** (1967) 796.
67Uno Unoki, H., Sakudo, T.: J. Phys. Soc. Jpn. **23** (1967) 546.
67Wor Worlock, J.M., Fleury, P.A.: Phys. Rev. Lett. **19** (1967) 1176.
67Yas Yasunaga, H., Nakada, I.: J. Phys. Soc. Jpn. **22** (1967) 338.
68Bae Baer, R., Wessel, G., Rubins, R.S.: J. Appl. Phys. **39** (1968) 23.
68Bhi Bhide, V.G., Bhasin, H.C.: Phys. Rev. **172** (1968) 290.
68Fle1 Fleury, P.A., Scott, J.F., Worlock, J.M.: Phys. Rev. Lett. **21** (1968) 16.
68Fle2 Fleury, P.A., Worlock, J.M.: Phys. Rev. **174** (1968) 613.
68Mul Müller, K.A., Berlinger, W.: Phys. Rev. Lett. **21** (1968) 814.

68Rei Reintjes, J., Schulz, M.B.: J. Appl. Phys. **39** (1968) 5254.
68Rob Robbins, C.R.: J. Cryst. Growth **2** (1968) 402.
68See Seehra, M.S., Castner Jr., T.G.: Phys. Kondens. Mater. **7** (1968) 185.
68Son Sonin, A.S., Perfilova, V.E.: Fiz. Tverd. Tela **10** (1968) 305; Sov. Phys. Solid State (English Transl.) **10** (1968) 242.
68Sug Sugai, T., Hasegawa, S., Ohara, G.: Jpn. J. Appl. Phys. **7** (1968) 358.
68Yas Yasunaga, H.: J. Phys. Soc. Jpn. **24** (1968) 1035.
69Ale Alefeld, B.: Z. Phys. **222** (1969) 155.
69Ber Berre, B., Fossheim, K., Müller, K.A.: Phys. Rev. Lett. **23** (1969) 589.
69Bur Burke, W.J., Pressley, R.J.: Solid State Commun. **7** (1969) 1187.
69Cow Cowley, R.A., Buyers, W.J.L., Dolling, G.: Solid State Commun. **7** (1969) 181.
69Fau Faughnan, B.W., Kiss, Z.J.: IEEE J. Quant. Electron. **QE-5** (1969) 17.
69Gur Gurevich, V.M.: Elektroprovodnost' Segnetoelektrikov, Moskva: Izdatel'stvo Komiteta Standartov, Mer i Izmeritel'nykh Priborov pri Sovete Ministrov SSSR, 1969; Electric conductivity of Ferroelectrics, Jerusalem: Israel Program for Scientific Translation, 1971.
69Mac Mackey, J.E., Arnold, R.T.: J. Appl. Phys. **40** (1969) 4806.
69Mei Meierling, D.: Z. Naturforsch. **24a** (1969) 1662.
69Mul Müller, K.A., Berlinger, W., Rubins, R.S.: Phys. Rev. **186** (1969) 361.
69Nav Nava, R., Callarotti, R., Ceva, H., Martinet, A.: Phys. Rev. **188** (1969) 1456.
69Pen Pennebaker, W.B.: IBM J. Res. Dev. **13** (1969) 686.
69Shi Shirane, G., Yamada, Y.: Phys. Rev. **177** (1969) 858.
69Yam Yamada, Y., Shirane, G.: J. Phys. Soc. Jpn. **26** (1969) 396.
70Cap Capizzi, M., Frova, A.: Phys. Rev. Lett. **25** (1970) 1298.
70Ens Ensign, T.C., Stokowski, S.E.: Phys. Rev. B **1** (1970) 2799.
70Fuj Fujii, Y., Sakudo, T.: J. Appl. Phys. **41** (1970) 4118.
70Gol Golding, B.: Phys. Rev. Lett. **25** (1970) 1439.
70Joh Johnson, D.W., Cross, L.E., Hummel, F.A.: J. Appl. Phys. **41** (1970) 2828.
70Lau Laubereau, A., Zurek, R.: Z. Naturforsch. **25a** (1970) 391.
70Lut Luthi, B., Moran, T.J.: Phys. Rev. B **2** (1970) 1211.
70Mee Meeks, E.L., Arnold, R.T.: Phys. Rev. B **1** (1970) 982.
70Mul Müller, K.A., Berlinger, W., Slonczewski, J.C.: Phys. Rev. Lett. **25** (1970) 734.
70Reh1 Rehwald, W.: Solid State Commun. **8** (1970) 1483.
70Reh2 Rehwald, W.: Solid State Commun. **8** (1970) 607.
70Roz Rozhdestvenskaya, M.V., Sheftel' I.T., Stogova, V.A., Kozyreva, M.S., Krayukhina, E.K.: Fiz. Tverd. Tela **12** (1970) 873; Sov. Phys. Solid State (English Transl.) **12** (1970) 674.
70Sai Saifi, M.A., Cross, L.E.: Phys. Rev. B **2** (1970) 677.
70Sak Sakudo, T., Fujii, Y.: J. Phys. Soc. Jpn. **28** Suppl. (1970) 87.
70Sor1 Sorge, G., Schmidt, G., Hegenbarth, E., Frenzel, Ch.: Phys. Status Solidi **37** (1970) K17.
70Sor2 Sorge, G., Hegenbarth, E., Schmidt, G.: Phys. Status Solidi **37** (1970) 599.
70Sro Sroubek, Z.: Phys. Rev. B **2** (1970) 3170.
70Uno1 Unoki, H., Sakudo, T.: Phys. Lett. A **32** (1970) 368.
70Uno2 Unoki, H., Sakudo, T.: J. Phys. Soc. Jpn. **28** Suppl. (1970) 125.
71Ale Aleshechkin, V.N., Meriakri, V.V., Ushatkin, F.F., Tsykalov, V.G.: Izv. Akad. Nauk SSSR, Ser. Fiz. **35** (1971) 1924; Bull. Acad. Sci. USSR, Phys. Ser. (English Transl.) **35** (1971) 1746.
71Amo Amodei, J.J., Roach, W.R.: J. Phys. Chem. Solids **32** Suppl. (1971) 93.
71Bea Beattie, A.G., Samara, G.A.: J. Appl. Phys. **42** (1971) 2376.
71Bel Belruss, V., Kalnajs, J., Linz, A., Folweiler, R.C.: Mater. Res. Bull. **6** (1971) 899.
71Ber Berre, B., Fossheim, K.: Structural Phase Transitions and Soft Modes, Proceedings of the NATO Advanced Study Institute, held at Geilo (1971), Samuelsen, E.J., Andersen, E., Feder, J. (eds.), Oslo, Bergen, Tromsö: Universitetsforlaget, 1971, p. 255.
71Bla Blazey, K.W.: Phys. Rev. Lett. **27** (1971) 146.

71Bur Burk, W.J., Pressley, R.J.: Solid State Commun. **9** (1971) 191.
71Fau Faughnan, B.W.: Phys. Rev. B **4** (1971) 3623.
71Gho Ghosh, A.K.: J. Phys. Chem. Solids **32** Suppl. (1971) 99.
71Lee Lee, C., Yahia, J., Brebner, J.L.: Phys. Rev. B **3** (1971) 2525.
71Mei Meierlling, H.D.: Phys. Status Solidi (b) **43** (1971) 191.
71Mor Morimoto, K.: Phys. Lett. A **35** (1971) 472.
71Mos Moses, A.J.: Optical Materials Properties in Handbook of Electronic Materials, Vol. 1, New York: IFI/Plenum, 1971.
71Mul Müller, K.A.: Unpublished work cited in [91Mul].
71Otn Otnes, K., Riste, T., Shirane, G., Feder, J.: Solid State Commun. **9** (1971) 1103.
71Pet Peters, R.D., Arnold, R.T.: J. Appl. Phys. **42** (1971) 980.
71Reh Rehwald, W.: Phys. Kondens. Mater. **14** (1971) 21.
71Sak Sakudo, T., Unoki, H.: Phys. Rev. Lett. **26** (1971) 851; erratum: **26** (1971) 1147.
71Wil Williams, R.: J. Appl. Phys. **42** (1971) 1131.
71Wor Worlock, J.M., Olsen, D.H.: Proceedings of the Second International Conference on Light Scattering in Solids, held in Paris (1971), Paris: Flammarion Sciences, 1971, p. 410.
72Buz Buzin, I.M., Ivanov, I.V., Rukin E.I., Chuprakov, V.F.: Fiz. Tverd. Tela **14** (1972) 2053; Sov. Phys. Solid State (English Transl.) **14** (1973) 1770.
72Cou Courtens, E.: Phys. Rev. Lett. **29** (1972) 1380.
72Fau Faughnan, B.W.: Phys. Rev. B **5** (1972) 4925.
72Fos Fossheim, K., Berre, B.: Phys. Rev. B **5** (1972) 3292.
72Lag Lagendijk, A., Morel, R.J., Glasbeek, M., van Voorst, J.D.W.: Chem. Phys. Lett. **12** (1972) 518.
72Mat1 Mattheiss, L.F.: Phys. Rev. B **6** (1972) 4718.
72Mat2 Mattheiss, L.F.: Phys. Rev. B **6** (1972) 4740.
72Mul Müller, K.A., Berlinger, W.: Phys. Rev. Lett. **29** (1972) 715.
72Nev Neville, R.C., Hoeneisen, B., Mead, C.A.: J. Appl. Phys. **43** (1972) 2124.
72Red Redfield, D., Burke, W.J.: Phys. Rev. B **6** (1972) 3104.
72Sha Shapiro, S.M., Axe, J.D., Shirane, G., Riste, T.: Phys. Rev. B **6** (1972) 4332.
72Sti Stirling, W.G.: J. Phys. C **5** (1972) 2711.
72von1 von Waldkirch, Th., Müller, K.A., Berlinger, W., Thomas, H.: Phys. Rev. Lett. **28** (1972) 503.
72von2 von Waldkirch, Th., Müller, K.A., Berlinger, W.: Phys. Rev. B **5** (1972) 4324.
72WuC Wu, Chhi-Chong, Tsai, Jen-San: J. Phys. C **5** (1972) 2419.
73Fre Frenzel, C., Gladun, A., Gladun, C., Hegenbarth, E., Knorn, M.: Phys. Status Solidi (a) **15** (1973) K61.
73Hoc Höchli, U.T.: Solid State Commun. **13** (1973) 1369.
73Iiz Iizumi, M., Gesi, K., Harada, J.: J. Phys. C **6** (1973) 3021.
73Lui Luiskutty, C.T., Ouseph, P.J.: Solid State Commun. **13** (1973) 405.
73Oka Okazaki, A., Kawaminami, M.: Mater. Res. Bull. **8** (1973) 545.
73Sch Schirmer, O.F., Müller, K.A.: Phys. Rev. B **7** (1973) 2986.
73Ste1 Steigmeier, E.F., Auderset, H.: Solid State Commun. **12** (1973) 565.
73Ste2 Steigmeier, E.F., Auderset, H., Harbeke, G.: Solid State Commun. **12** (1973) 1077.
73Uno Unoki, H., Sakudo, T.: J. Phys. Soc. Jpn. **35** (1973) 1128.
73von1 von Waldkirch, Th., Müller, K.A.: Helv. Phys. Acta **46** (1973) 331.
73von2 von Waldkirch, Th., Müller, K.A., Berlinger, W.: Phys. Rev. B **7** (1973) 1052.
73Wil Wild, R.L., Rockar, E.M., Smith, J.C.: Phys. Rev. B **8** (1973) 3828.
74Bin Binnig, G., Hoenig, H.E.: Solid State Commun. **14** (1974) 597.
74Fra Franke, V., Hegenbarth, E.: Phys. Status Solidi (a) **25** (1974) K17.
74Fre Frenzel, C., Hegenbarth, E.: Phys. Status Solidi (a) **23** (1974) 517.
74Mac Mack, S.A., Handler, P.: Phys. Rev. B **9** (1974) 3415.
74Mul1 Müller, K.A.: Ferroelectrics **7** (1974) 17.

74Mul2 Müller, K.A., Berlinger, W., West, C.H., Heller, P.: Phys. Rev. Lett. **32** (1974) 160.
74Oka Okazaki, A., Kawaminami, M.: Ferroelectrics **7** (1974) 91.
74Sal Salamon, M.B., Garnier, P.R.: J. Phys. Chem. Solids **35** (1974) 851.
74Sor Sorse, G., Beige, H., Schmidt, G.: Phys. Status Solidi (a) **26** (1974) K153.
74Ste Steigmeier, E.F., Auderset, H., Harbeke, G.: Anharmonic Lattices, Structural Transitions and Melting, Proceedings of the NATO Advanced Study Institute, held at Geilo (1973), Riste, K. (ed.), Leiden: Noordhoff International Publishing, 1974, p. 152.
74Uno Unoki, H., Sakudo, T.: J. Phys. Soc. Jpn. **37** (1974) 145.
75Bla Blazey, K.W., Schirmer, O.F., Berlinger, W., Müller, K.A.: Solid State Commun. **16** (1975) 589.
75Kuc Kuchar, F., Frankus, P.: Solid State Commun. **16** (1975) 181.
75Lee Lee, C., Destry, J., Brebner, J.L.: Phys. Rev. B **11** (1975) 2299.
75Mul Müller, K.A., Berlinger, W.: Phys. Rev. Lett. **35** (1975) 1547.
75Oka Okai, B., Yoshimoto, J.: J. Phys. Soc. Jpn. **39** (1975) 162.
76Aso Aso, K.: Jpn. J. Appl. Phys. **15** (1976) 1277.
76deJ deJong, H.J., Glasbeek, M.: Solid State Commun. **19** (1976) 1197.
76Fir Firnstein, L.A., Barbosa, G.A., Porto, S.P.S.: Proceedings of the Third International Conference on Light Scattering in Solids, held in Campinas (1975), Balkanski, M., Leite, R.C.C. (eds.), Paris: Flammarion Sciences, 1976, p. 866.
76Fuj Fujii, Y., Sakudo, T.: Phys. Rev. B **13** (1976) 1161.
76Per Perluzzo, G., Destry, J.: Can. J. Phys. **54** (1976) 1482.
76Rig Rigamonti, A.: Local Properties at Phase Transitions, Proceedings of the International School of Physics "Enrico Fermi", Course LIX, held at Varenna on Lake Como (1973), Müller, K.A., Rigamonti, A. (eds.), Amsterdam: North-Holland Publishing Co., 1976, p. 271.
76Uwe Uwe, H., Sakudo, T.: Phys. Rev. B **13** (1976)271.
77Bed Bednorz, J.G., Scheel, H.J.: J. Cryst. Growth **41** (1977) 5.
77Bje Bjerkan, L., Fossheim, K.: Solid State Commun. **21** (1977) 1147.
77Hat Hatta, I., Shiroishi, Y.: Phys. Rev. B **16** (1977) 1138.
77Lyo Lyons, K.B., Fleury, P.A.: Solid State Commun. **23** (1977) 477.
77Ser Serway, R.A., Berlinger, W., Müller, K.A., Collins, R.W.: Phys. Rev. B **16** (1977) 4761.
78Bau Bauerle, D., Braun, W., Saile, V., Sprussel, G., Koch, E.E.: Z. Phys. B **29** (1978) 179.
78Ber Berney, R., Cowan, D.: Solid State Commun. **26** (1978) 579.
78deJ deJong, H.J., Glasbeek, M.: Solid State Commun. **28** (1978) 683.
78Has Hastings, J.B., Shapiro, S.M., Frazer, B.C.: Phys. Rev. Lett. **40** (1978) 237.
78Hen Henrich, V.E., Dresselhaus, G., Zeiger, H.J.: Phys. Rev. B **17** (1978) 4908.
78Iva Ivanov, I.V., Belokopytov, G.W., Buzin, I.M., Sychev, V.M., Chuprakov, V.F.: Ferroelectrics **21** (1978) 405.
78LoW Lo, W.J., Somorjai, G.A.: Phys. Rev. B **17** (1978) 4942.
78Per Perluzzo, G., Destry, J.: Can. J. Phys. **56** (1978) 453.
79Fle Fleury, P.A., Lyons, K.B.: Solid State Commun. **32** (1979) 103.
79Fuj Fujishita, H., Shiozaki, Y., Sawaguchi, E.: J. Phys. Soc. Jpn. **46** (1979) 581.
79Gla Glasbeek, M., deJong, H.J., Koopmans, W.E.: Chem. Phys. Lett. **66** (1979) 203.
79Mul Müller, K.A., Burkard, H.: Phys. Rev. B **19** (1979) 3593.
79Sha Shablaev, S.I., Danishevskii, A.M., Subashiev, V.K., Babashkin, A.A.: Fiz. Tverd. Tela **21** (1979) 1140; Sov. Phys. Solid State (English Transl.) **21** (1979) 662.
79Vog Vogt, H., Neumann, G.: Phys. Status Solidi (b) **92** (1979) 57.
80Bau Bäuerle, D., Wagner, D., Wöhlecke, M., Dorner, B., Kraxenberger, H.: Z. Phys. B **38** (1980) 335.
80Bet Betzler, K.: Ferroelectrics **26** (1980) 819.
80Bla Blazey, K.W., Koch, R., Bednorz, J.G.: J. Phys. (Paris) Colloq. **41** (1980) Suppl. C6, 511.
80Den Denisov, V.N., Mavrin, B.N., Podobedov, V.B., Smerin, Kh.E.: Fiz. Tverd. Tela **22** (1980) 2839; Sov. Phys. Solid State (English Transl.) **22** (1980) 1657.

80Hoc Höchli, U.T., Bruce, A.D.: J. Phys. C **13** (1980) 1963.
80Rad Radebaugh, R., Lawless, W.N., Siegwarth, J.D., Morrow, A.: Ferroelectrics **27** (1980) 205.
80Rei Reiter, G.F., Berlinger, W., Müller, K.A., Heller, P.: Phys. Rev. B **21** (1980) 1.
80Ser Servoin, J.L., Luspin, Y., Gervais, F.: Phys. Rev. B **22** (1980) 5501.
80Tom Tomashpolsky, Yu.Ya., Sevostianov, M.A.: Ferroelectrics **29** (1980) 87.
80Wag Wagner, D., Bäuerle, D., Schwabl, F., Wöhlecke, M., Dorner, B., Kraxenberger, H.: Ferroelectrics **26** (1980) 725.
80Wil Wildner, W., Gonser, U., Schmit, H., Albers, J., Date, S.K.: Ferroelectrics **23** (1980)193.
81Ach Achat, B.N.N., Barsch, G.R., Cross, L.E.: Phys. Rev. B **24** (1981) 1209.
81Bal Balachandran, U., Eror, N.G.: J. Solid State Chem. **39** (1981) 351.
81Bel Belokopytov, G.W., Buzin, I.M., Ivanov, I.V., Atrepetova, N.N., Chuprakov, V.F.: Fiz. Tverd. Tela **23** (1981) 141; Sov. Phys. Solid State (English Transl.) **23** (1981) 79.
81Bla1 Blasse, G., Dirksen, G.J.: J. Solid State Chem. **37** (1981) 390.
81Bla2 Blazey, K.W., Koch, R., Müller, K.A.: Mater. Res. Bull. **16** (1981) 1149.
81Bli Bliznyuk, V.N., Glinchuk, M.D., Pechenyi, A.P., Litvinov, L.A.: Phys. Status Solidi (a) **63** (1981) K43.
81Bre Brebner, J.L., Jandl, S., Lépine, Y.: Phys. Rev. B **23** (1981) 3816.
81Com Comés, R., Shapiro, S.M., Frazer, B.C., Shirane, G.: Phys. Rev. B **24** (1981) 1559.
81Hut Hutton, J., Nelmes, R. J.: J. Phys. C **14** (1981) 1713.
81Ino Inoue, K., Asai, N., Sameshima, T.: J. Phys. Soc. Jpn. **50** (1981) 1291.
81Mic Michel-Calendini, F.M., Müller, K.A.: Solid State Commun. **40** (1981) 255.
81Pec Pechenyi, A.P., Glinchuk, M.D., Bliznyuk, V.N.: Fiz. Tverd. Tela **23** (1981) 2121; Sov. Phys. Solid State (English Transl.) **23** (1981) 1237.
81Roz Rozova, M.N., Onopko, D.E., Titov, S.A., Kostikov, Yu.P.: Fiz. Tverd. Tela **23** (1981) 1704; Sov. Phys. Solid State (English Transl.) **23** (1981) 992.
81Vog Vogt, H., Rossbroich, G.: Phys. Rev. B **24** (1981) 3086.
82Fen Feng, T.: Phys. Rev. B **25** (1982) 627.
82Gal Galzerani, J.C., Katiyar, R.S.: Solid State Commun. **41** (1982) 515.
82Mul Müller, K.A., Berlinger, W.: Z. Phys. B **46** (1982) 81.
83Bla Blazey, K.W., Müller, K.A.: J. Phys. C **16** (1983) 5491.
83Bro Brody, P.S., Sattler, J.P., Simonis, G. J.: Ferroelectrics **50** (1983) 319.
83Bru Bruce, D.A., Stirling, W.G.: J. Phys. C **16** (1983) 841.
83DIo D'Iorio, M., Berlinger, W., Müller, K.A.: Phase Transitions **4** (1983) 31.
83Mul Müller, K.A., Berlinger, W.: J. Phys. C **16** (1983) 6861.
83Oka Okazaki, A., Ohama, N., Willis, B.T.M., Iwata, Y., Scheel, H.J., Müller, K.A.: Phase Transitions **3** (1983) 339.
84Are Arenas, G., Geiger, J.: Z. Naturforsch. **39a** (1984) 945.
84Bla Blazey, K.W., Weibel, H.: J. Phys. Chem. Solids **45** (1984) 917.
84Ded Dedyk, A.I., Prudan, A.M., Ter-Martirosyan, L.T.: Fiz. Tverd. Tela **26** (1984) 299; Sov. Phys. Solid State (English Transl.) **26** (1984) 181.
84Fos1 Fossum, J.O., Fossheim, K., Scheel, H.J.: Solid State Commun. **51** (1984) 839.
84Fos2 Fossum, J.O., Fossheim, K.: Ferroelectrics **54** (1984) 289.
84Hen Henning, I., Hegenbarth, E.: Phys. Status Solidi (a) **83** (1984) K23.
84Ker Kéroack, D., Lépine, Y., Brebner, J.L.: J. Phys. C **17** (1984) 833.
84Mul Multani, M.: Mater. Res. Bull. **19** (1984) 25.
84Rei Reihl, B., Bednorz, J.G., Müller. K.A., Yugnet, Y., Landgren, G., Morar, J.F.: Phys. Rev. B **30** (1984) 803.
84Sha Shablaev, S.I., Danishevskii, A.M., Subashiev, V.K.: Fiz. Tverd. Tela **26** (1984) 179; Sov. Phys. Solid State (English Transl.) **26** (1984) 105.
84Shi Shirmer, O.F., Förster, A., Hesse, H., Wöhlecke, M., Kapphan, S.: J. Phys. C **17** (1984) 1321.

84Tsu Tsunekawa, S., Watanabe, H.F.J., Takei, H.: Phys. Status Solidi (a) **83** (1984) 467; erratum: **86** (1984) 467.

85Afa Afanasjev, V., Korpela, S., Tuomi, T.: Ferroelectrics **65** (1985) 175.

85Ded Dedyk, A.I., Prudan, A.M., Ter-Martirosyan, L.T.: Fiz. Tverd. Tela **27** (1985) 1615; Sov. Phys. Solid State (English Transl.) **27** (1985) 973.

85Fos1 Fossum, J.O., Fossheim, K.: J. Phys. C **18** (1985) 5549.

85Fos2 Fossum, J.O., Cheeke, J.D.N.: J. Phys. (Paris) Colloq. **46** (1985) Suppl. C10, 755.

85Ino Inoue, K.: Jpn. J. Appl. Phys. **24**, Suppl. 24–2 (1985) 107.

85Law Lawless, W.N., Clark, C.F., Swartz, S.L.: J. Phys. Soc. Jpn. **54** (1985) 4224.

85Mai Maier, J., Schwitzgebel, G., Hagemann, H.-J.: J. Solid State Chem. **58** (1985) 1.

85Sat Sato, M., Soejima, Y., Ohama, N., Okazaki, A., Scheel, H.J., Müller, K.A.: Phase Transitions **5** (1985) 207.

85Uwe Uwe, H., Yoshizaki, R., Sakudo, T., Izumi, A., Uzumaki, T.: Jpn. J. Appl. Phys. **24**, Suppl. 24–2 (1985) 335.

86And Andrews, S.R.: J. Phys. C **19** (1986) 3721.

87Are Arendt, R.H., Pasco, W.D.: J. Electrochem. Soc. **134** (1987) 733.

87Gol Goldschmidt, D., Tuller, H.L.: Phys. Rev. B **35** (1987) 4360

87Hou Houde, D., Lépine, Y., Pépin, C., Jandl, S., Brebner, J.L.: Phys. Rev. B **35** (1987) 4948.

88Nas Nassau, K., Miller, A.E.: J. Cryst. Growth **91** (1988) 373.

88Rav Ravindranathan, Thampi K., Subba Rao, M., Schwarz, W., Gratzel, M., Kiwi, J.: J. Chem. Soc., Faraday Trans. I (Phys. Chem. Condens. Phases) **84** (1988) 1703.

89Bor Borisovskii, K.E., Prudan, A.M.: Fiz. Tverd. Tela **31** (1989) 53; Sov. Phys. Solid State (English Transl.) **31** (1989) 1308

90Deo Deorani, S.C., Naithani, U.C., Semwal, B.S.: J. Phys. Chem. Solids **51** (1990) 1277.

90Ish Ishizawa, N., Banno, H., Hayashi, M., Yoo, S.E., Yoshimura, M.: Jpn. J. Appl. Phys. **29** (1990) 2467.

90Kut Kutty, T.R.N., Avudaithal, M.: Mater. Res. Bull. **25** (1990) 821.

90Mul Müller, K.A., Aguilar, M., Berlinger, W., Blazey, K.W.: J. Phys. Condens. Matter **2** (1990) 2735.

90Ryt Rytz, D., Wechsler, B.S.A., Nelson, C.C., Kirby, K.W.: J. Cryst. Growth **99** (1990) 864.

91Koo Kool, Th.W., Glasbeek, M.: J. Phys. Condens. Matter **3** (1991) 9747.

91Mor Mori, H., Ishiwara, H.: Jpn. J. Appl. Phys. **30** (1991) L1415.

91Mul Müller, K.A., Berlinger, W., Tosatti, E.: Z. Phys. B **84** (1991) 277.

91Sel Selvaraj, U., Prasadaro, A.P., Komaruneni, S., Roy, R.: Mater. Lett. **12** (1991) 311.

91Yam Yamamichi, S., Sakuma, T., Takemura, K., Miyasaka, Y.: Jpn. J. Appl. Phys. **30** (1991) 2193.

92Boi Boisovskii, K.E., Dedyk, A.I., Prudan, A.M.: Fiz. Tverd. Tela **34** (1992) 1656; Sov. Phys. Solid State (English Transl.) **34** (1992) 880.

92Hol Holzschuh, H., Suhr, H.: Adv. Mater. **4** (1992) 357.

92Nam Nam, S.H., Cho, N.H., Kim, H.G.: J. Phys. D **25** (1992) 727.

92Pot Potdar, H.S., Dashpande, S.B., Godbole, P.D., Gunjikar, V.G., Date, S.K.: J. Mater. Res. **7** (1992) 429.

92San Sanchez, F., Varela, M., Queralt, X., Aguiar, R., Morenza, L.: Appl. Phys. Lett. **61** (1992) 2228.

92Wal Walkenhorst, A., Doughty, C., Xi, X.X., Mao, S.N., Li, Q., Venkatesan, T.: Appl. Phys. Lett. **60** (1992) 1774.

92Yos Yoshimoto, M., Ohkubo, H.J., Kanda, N., Koinuma, H.: Jpn. J. Appl. Phys. **31** (1992) 3664.

93Abe Abe, K., Komatsu, S.: Jpn. J. Appl. Phys. **32** (1993) L1157.

93Bra Braunstein, G., Pazpujalt, G.R., Mason, M.G., Blanton, T., Barnes, C.L., Margevich, D.: J. Appl. Phys. **73** (1993) 961.

93Cou Courtens, E., Coddens, G., Hennion, B., Hehlen, B., Pelous, J., Vacher, R.: Phys. Scr. **T49** (1993) 430.

93Kam Kamalasanan, M.N., Kumar, N.D., Chandra, S.: J. Appl. Phys. **74** (1993) 679.
93Mul Müller, K.A., Bazey, K.W., Kool, Th.W.: Solid State Commun. **85** (1993) 381.
93Pfa Pfaff, G.: J. Mater. Chem. **3** (1993) 721.
94Koo Kool, Th.W., deJong, H.J., Glasbeek, M.: J. Phys. Condens. Matter **6** (1994) 1571.
94Via Viana, R., Lunkenheimer, P., Hemberger, J., Bohmer, R., Loidl, A.: Phys. Rev. B **50** (1994) 601.