No. 39A-12 $[N(CH_3)_4]_2ZnCl_4$, Tetramethylammonium tetrachlorozincate

(M = 355.49; [D: 379.64])

1a Ferroelectricity in $[N(CH_3)_4]_2ZnCl_4$ was discovered by Sawada et al. in 1978. 78Saw1

b

phase	VI	V	IV	III	II *)	I	78Saw1
state	P	P	P	F		P	
crystal system	ortho-rhombic	mono-clinic	mono-clinic	ortho-rhombic		ortho-rhombic	
space group	$P2_12_12_1$–D_2^4 a)	$P12_1/c1$–C_{2h}^5 a)	$P112_1/n$–C_{2h}^5 a)	$P2_1cn$–C_{2v}^9 a)		$Pmcn$–D_{2h}^{16}	a) 80Tan

Θ [°C]	VI → V	V → IV	IV → III	III → II	II → I	
	−118	−105	2.3	7.0	23.6 b)	b) 80Mas1
	[D: −121	−106			26.8] c)	c) 82Ges1

*) Incommensurate structural modulation was reported along the [001] direction. 78Saw2

Three kinds of transition sequences have been reported for deuterated compound between phase I and IV: I–II–II'(incommensurate) – IV d), I–II – ($\boldsymbol{q} = 3\boldsymbol{c}^*/7$) – IV e), I–II – ($\boldsymbol{q} = 3\boldsymbol{c}^*/7$) – ($\boldsymbol{q} = \boldsymbol{c}^*/2$) – IV f) with descending temperature, where $\boldsymbol{q}$ is modulation wave vector; see Fig. 39A-12-066, Fig. 39A-12-067, Fig. 39A-12-068 in subsection 14a. d) 83Iiz, e) 84Mar1, f) 81Mar1

Another phase transition was reported to occur at about –103 °C; see Fig. 39A-12-034 in subsection 6a. 85Per

See also Fig. 39B-5-001 in No. 39B-5 and Fig. 39B-6-001 in No. 39B-6.

P_s ∥ [100]. 78Saw1

Transparent, colorless. 78Saw1

Cleavage plane: (010). 85Saw

$\rho_X = 1.38 \cdot 10^3$ kg m^{-3} at RT. 59Mor

Phase diagram in regard to p: Table 39A-12-001; Fig. 39A-12-001, Fig. 39A-12-002, Fig. 39A-12-003;
see also Fig. 39A-12-070, Fig. 39A-12-071 in subsection 14a.

Phase diagram in regard to stress: Fig. 39A-12-004, Fig. 39A-12-005, Fig. 39A-12-006;
see also 91Kro

Shear stress T_{23} induces monoclinic phase with modulation wave vector $\boldsymbol{q} = \boldsymbol{c}^*/2$ for deuterated compound between phase II and IV. 81Mas

2a Crystal growth: evaporation method from aqueous solution. 78Saw1

3a Unit cell parameters: Table 39A-12-002;
see also Fig. 39A-12-013, Fig. 39A-12-014 in subsection 4.

b Z in each phase:

phase	VI	V	IV	III	II	I	a) 59Mor
Z	12 b)	4 b)	12 b)	20 b)		4 a)	b) 80Tan

Positional and temperature parameters: Table 39A-12-003, Table 39A-12-004, Table 39A-12-005, Table 39A-12-006, Table 39A-12-007, Table 39A-12-008, Table 39A-12-009;
see also 87Mad, 89Zun

Interatomic distances and angles: Table 39A-12-010, Table 39A-12-011, Table 39A-12-012, Table 39A-12-013, Table 39A-12-014.

Crystal structures: Fig. 39A-12-007, Fig. 39A-12-008, Fig. 39A-12-009, Fig. 39A-12-010, Fig. 39A-12-011, Fig. 39A-12-012.

4	Lattice distortion: Fig. 39A-12-013, Fig. 39A-12-014. Effect of p on monoclinic angle of phase V: Fig. 39A-12-015. Thermal expansion: Fig. 39A-12-016; see also	94Sor
5a	Dielctric constant: Fig. 39A-12-017, Fig. 39A-12-018, Fig. 39A-12-019, Fig. 39A-12-020, Fig. 39A-12-021. Dielectric dispersion: Fig. 39A-12-022, Fig. 39A-12-023; see also	83Zan, 85Jak
	Effect of hydrostatic pressure: Fig. 39A-12-024, Fig. 39A-12-025. Effect of stress: Fig. 39A-12-026, Fig. 39A-12-027. Thermal hysteresis and memory effect: Fig. 39A-12-028, Fig. 39A-12-029; see also	88Str, 90Mez
	Influence of defects: see	85Jan
b	Effect of E_{bias} on κ: Fig. 39A-12-030; see also	88Str, 90LeV, 93Sve
c	Spontaneous polarization and coercive field: Fig. 39A-12-031; see also	88Str
	Effect of p on spontaneous polarization: Fig. 39A-12-032. Effect of uniaxial stress on spontaneous polarization: Fig. 39A-12-033.	
6a	Heat capacity: Fig. 39A-12-034; see also	90Str
8a	Elastic stiffness: Table 39A-12-015; Fig. 39A-12-035; see also	94Sor
	Sound velocity and attenuation: Fig. 39A-12-036, Fig. 39A-12-037, Fig. 39A-12-038, Fig. 39A-12-039, Fig. 39A-12-040, Fig. 39A-12-041. Effect of p on sound velocity and attenuation: see	89Vlo, 90Vlo2
9a	Refractive indices: $n_a = 1.529$, $n_b = 1.530$, $n_c = 1.531$ for $\lambda = 514.5$ nm;	83Kar
	$n_{av} = 1.527(2)$ for $\lambda = 632.8$ nm.	92Dij
	Birefringence: Fig. 39A-12-042, Fig. 39A-12-043, Fig. 39A-12-044; see also	82Reg, 92Dij, 93Kus
	Effect of E_{bias} on birefringence: see	87Sai
	Effect of p on birefringence: see	90Vlo1
	Effect of stress on birefringence: Fig. 39A-12-045, Fig. 39A-12-046; see also	90Vlo1, 93Sve
	Effect of heating rate on birefringence: Fig. 39A-12-047. Deviation angle of the indicatrix in phase IV: Fig. 39A-12-048. Infrared absorption: see	83Sri, 85Gan, 88Mee
	Optical absorption: see	90Vlo3
b	Electrooptic effect: see	84Vlo, 87Sai
c	Photoelastic constant: $\lvert p_{11} \rvert = \lvert p_{22} \rvert = \lvert p_{33} \rvert = \lvert p_{12} \rvert = \lvert p_{13} \rvert = \lvert p_{23} \rvert = \lvert p_{21} \rvert = \lvert p_{31} \rvert = \lvert p_{32} \rvert = 0.300$, $p_{44} = p_{55} = p_{66} \approx 0$ at RT for $\lambda = 514.5$ nm.	84Ber
	Piezooptic effect: see	85Vlo

d	Optical activity: see	92Dij, 93Fol, 93Kob, 93Kus
e	SHG: Fig. 39A-12-049.	
10a	Raman scattering: Fig. 39A-12-050, Fig. 39A-12-051, Fig. 39A-12-052; see also	80Tak, 83Sri, 91Tor1, 91Tor2, 93Rat
	Low frequency Raman scattering: Fig. 39A-12-053; see also	83Hen, 90Tor, 91Tor3, 93Hen1
	Effect of p on Raman scattering: see	93Hen2
b	Brillouin scattering: Fig. 39A-12-054, Fig. 39A-12-055; see also	83Kar
	Impulsive stimulated scattering: Fig. 39A-12-056, Fig. 39A-12-057.	
13a	NMR of ^{1}H: Fig. 39A-12-058, Fig. 39A-12-059; see also	79Bli, 86Sun, 87Aru, 88Dol
	NMR of ^{13}C: Fig. 39A-12-060; see also	79Bli
	NMR of ^{14}N: Table 39A-12-016; Fig. 39A-12-061, Fig. 39A-12-062, Fig. 39A-12-063.	
	For ^{14}N nuclear quadrupole coupling tensors in phase II: see	87Dol
	See also	86Bli
b	ESR of Mn^{2+} doped crystal: Table 39A-12-017; Fig. 39A-12-064; see also	81Suz, 84Kob, 90Suh, 91Kah
14a	Integrated intensities of satellite reflections due to structural modulation and modulation wave vector: Fig. 39A-12-065, Fig. 39A-12-066, Fig. 39A-12-067, Fig. 39A-12-068, Fig. 39A-12-069; see also	80Ges, 81Mar2, 87Bzi
	Effect of p on modulation wave vector: Fig. 39A-12-070, Fig. 39A-12-071.	
	Effect of T_{22} on structural modulation: see	94Bag
	Effect of E_{bias} on II–III transition: see	88Kob
	Effect of E_{bias} on phase transition of deuterated compound: Fig. 39A-12-072, Fig. 39A-12-073.	
	Relation between the appearance of satellite with modulation wave vector $3\boldsymbol{c}^*/7$ and the splitting of dielectric anomaly around 10 °C (Fig. 39A-12-020): see	81Mas
b	Inelastic and quasielastic neutron scattering: Fig. 39A-12-074, Fig. 39A-12-075, Fig. 39A-12-076.	

15a	Ferroelectric domain structure: see	89LeB, 92Sai
16	Effect of X-ray radiation on modulated structure: see	86Kas, 87Bzi, 91Vlo2
	Defect mobility in phase II observed by X-ray topography: see	83Rib
	Observation of II–III transition by X-ray topography: see	86Rib
	Twin structure: see	85Deg, 86Rib, 89Sai, 90Rib, 90Vlo4, 92Sai
	Crystal morphology and structural modulation: see	85Dam, 86Dam1, 86Dam2, 87Dam