

No. M30 $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$, Calcium tartrate
($M = 260.21$)

1a	Ferroelectricity in $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$ was mentioned by Gupta et al. in 1987.		87Gup1
b	phase	II	87Gup1
	state	(F)	
	crystal system	orthorhombic ^{a)}	^{a)} 35Eva
	space group ^{*)}		
	$\theta [^\circ\text{C}]$	123	
	*) Centrosymmetric space group $\text{P2}_1\text{2}_1\text{2}_1 - \text{D}_2^4$ at RT was reported in 1935.		35Eva
	Recently, however, the point group was determined to be polar $\text{mm}2$ by X-ray ^{a)} and nonlinear optical ^{b)} measurements. Contrary to these results, etch figure symmetry observation ^{c)} confirmed the nonpolar point group 222 at RT (see subsection 16).		^{a)} 87Gup1 ^{b)} 87Med ^{c)} 91Nak
2a	Crystal growth: gel technique by preparing silica gel with <i>d</i> -tartaric acid.		87Gup1
3a	Unit cell parameters in phase II: $a = 9.20 \text{ \AA}$, $b = 10.54 \text{ \AA}$, $c = 9.62 \text{ \AA}$.		87Gup1
4	Thermal expansion: abrupt contraction was found around 122 K.		90Gon
5a	Dielectric constant and dielectric loss: Fig. M30-001, Fig. M30-002, Fig. M30-003, Fig. M30-004, Fig. M30-005, Fig. M30-006. Effects of X and γ -irradiation on κ and $\tan \delta$: see		87Gup2
c	Spontaneous polarization and coercive field: $P_s = 0.8 \cdot 10^{-2} \text{ C m}^{-2}$, $E_c = 1.7 \cdot 10^4 \text{ V m}^{-1}$.		87Gup1
6a	DTA and DSC: see		93Sel
9a	Refractive indices: Table M30-001. Dispersion of the refractive indices: Table M30-002; Fig. M30-007; see also		87Med
e	Nonlinear optical susceptibilities: Table M30-003.		
15b	Polarization switching: see		74Bor
16	Etchant: 2N-hydrochloric acid. Etching figure symmetry indicates that point group of the crystal is 222.		91Nak 91Nak

Table M30-001. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. Refractive indices at $T = \text{RT}$ [87Med]. λ : wavelength of light.

λ [nm]	n_a	n_c	n_b
488	1.5306(3)	1.5428(3)	1.5649(3)
514.5	1.5270(3)	1.5388(4)	1.5613(3)
532	1.5264(4)	1.5364(3)	1.5611(3)
633	1.5125(4)	1.5220(4)	1.5477(4)
1064	1.5125(4)	1.5220(4)	1.5477(4)

Table M30-002. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. Sellmeier parameters for refractive indices at $T = \text{RT}$ [87Med]. S_0 , λ_0 : parameters in the Sellmeier formula $n^2(\lambda) - 1 = S_0 \lambda_0^2 (1 - \lambda_0^2 / \lambda^2)^{-1}$, where λ is the wavelength of light.

	S_0 [10^{14} m^{-2}]	$S_0 \lambda_0^2$
n_a	0.99	1.26
n_b	1.46	1.38
n_c	1.07	1.30

Table M30-003. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. Nonlinear optical susceptibilities at $T = \text{RT}$ [87Med].

ij	d_{ij} [pm/V]
33	0.19(3)
32	0.26(3)
31	<0.02
24	1.20(4)
15	2.30(4)

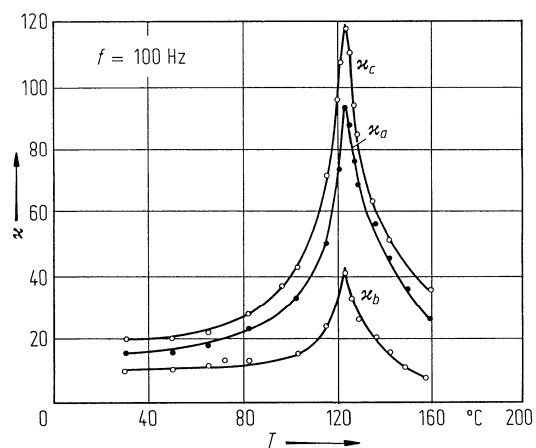


Fig. M30-001. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. κ_a , κ_b , κ_c vs. T [87Gup1]. $f = 100 \text{ Hz}$.

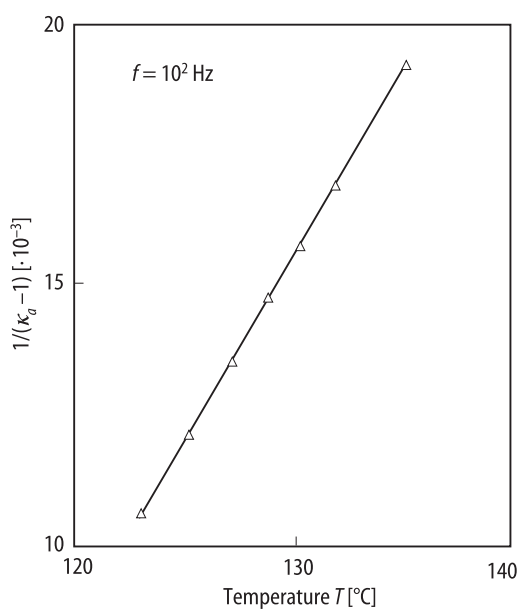


Fig. M30-002. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. $1/(\kappa_a - 1)$ vs. T [90Gon].

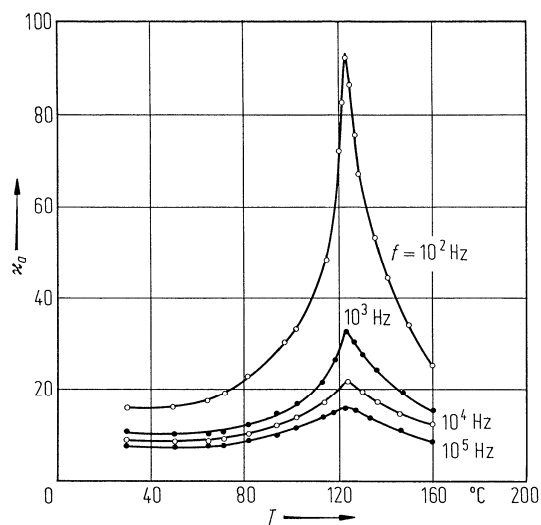


Fig. M30-003. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. κ_a vs. T [87Gup1]. Parameter: f .

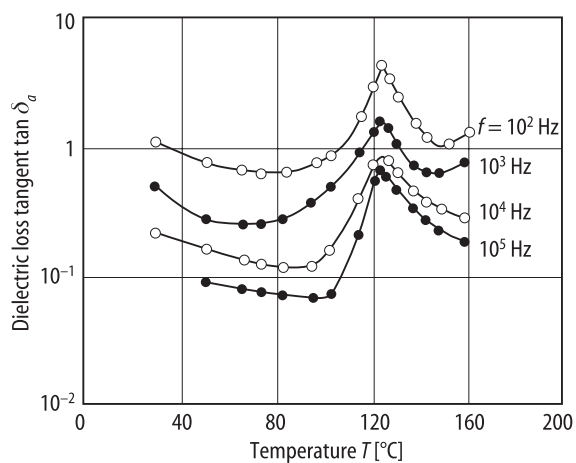


Fig. M30-004. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. $\tan \delta_a$ vs. T [87Gup1]. Parameter: f .

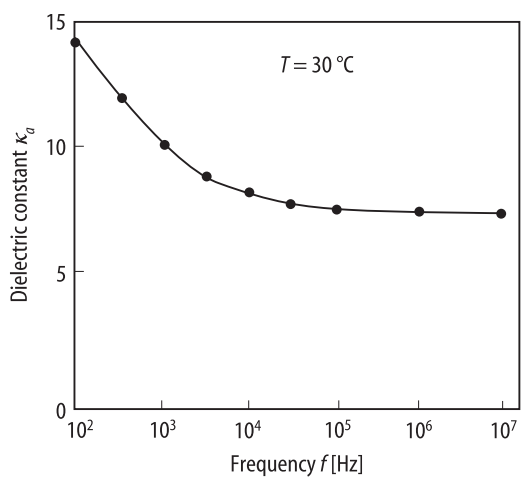


Fig. M30-005. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. κ_a vs. f [90Gon]. $T = 30\text{ }^\circ\text{C}$.

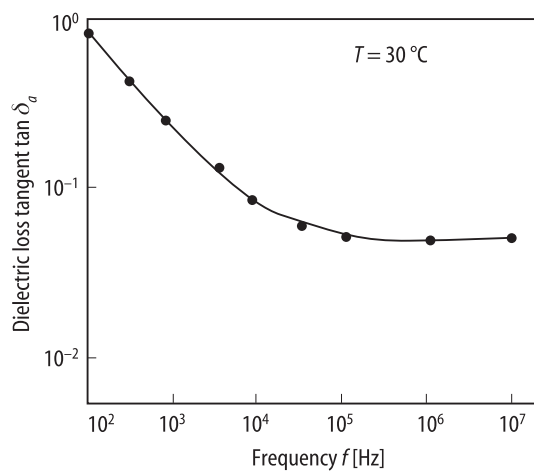


Fig. M30-006. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. $\tan \delta_a$ vs. f [90Gon]. $T = 30^\circ\text{C}$.

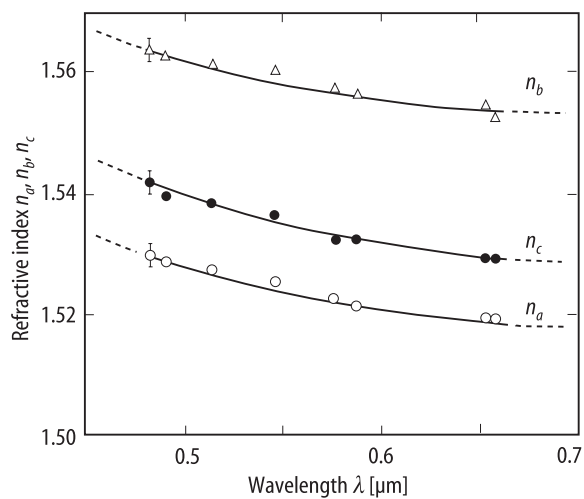


Fig. M30-007. $\text{CaC}_4\text{H}_4\text{O}_6 \cdot 4\text{H}_2\text{O}$. n_a , n_b , n_c vs. λ [87Med]. $T = \text{RT}$.

References

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