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## Symbols

(for a complete list, see chapter IE on page 15)

$A$	solubility [kg kg <sup>-1</sup> , kg m <sup>-3</sup> , wt%]	$S_{ij}, S_{\lambda}$	component of strain tensor: $S_{\lambda} = S_{ij}$ for $i = j$ , $S_{\lambda} = 2S_{ij}$ for $i \neq j$ [m m <sup>-1</sup> ]
$B$	isotropic temperature parameter [ $\text{\AA}^2$ ]	$s_{\lambda\mu}$	elastic compliance [m <sup>2</sup> N <sup>-1</sup> ]
$B_{ij}$	anisotropic temperature parameter [numeral]	$T, T_{\text{melt}}$	temperature, melting point [K, °C]
$C$	Curie-Weiss constant [K]	$T_{ij}, T_{\lambda}$	component of stress tensor: $T_{\lambda} = T_{ij}$ [N m <sup>-2</sup> ]
$C_p, c_p$	molar [J K <sup>-1</sup> mol <sup>-1</sup> ], specific [J K <sup>-1</sup> kg <sup>-1</sup> ] heat capacity at constant pressure	$T_1$	spin-lattice relaxation time [sec, s]
$c_{\lambda\mu}$	elastic stiffness [N m <sup>-2</sup> ]	$t, t_s, t_m$	time, switching time, time for maximum switching current [sec, s]
$d_{i\lambda}$	piezoelectric strain constant [C N <sup>-1</sup> ]	$U_{ij}$	anisotropic temperature parameter [ $\text{\AA}^2$ ]
$d_{i\lambda}$	susceptibility for second harmonic generation [m V <sup>-1</sup> ]	$V$	voltage [V] or 1/2 (optical axial angle) [°] or volume of unit cell [ $\text{\AA}^3$ ]
$E, E_{\text{bias}}$	electric field strength, bias field [V m <sup>-1</sup> ]	$\nu$	sound velocity [m s <sup>-1</sup> ]
$E_c$	coercive field [V m <sup>-1</sup> ]	$\nu_m$	molar volume [m <sup>3</sup> mol <sup>-1</sup> ]
$e_{i\lambda}$	piezoelectric stress constant [C m <sup>-2</sup> ]	$X, Y, Z$	orthogonal coordinate system [ $\text{\AA}$ , m]
$e^2 q Q / h$	nuclear quadrupole coupling constant [Hz]	$x, y$	molar fraction [numeral]
$f, f_A, f_R$	frequency, antiresonance, resonance frequency [Hz]	$x, y, z$	fractional coordinates of atoms in the unit cell [numeral]
$f_{i\lambda}$	piezoelectric strain constant [m <sup>2</sup> C <sup>-1</sup> ]	$Z$	number of formula units per cell [numeral]
$g_i, g_{ij}$	principal value or component of $g$ -tensor [numeral]	$\alpha$	optical [m <sup>-1</sup> ] or acoustic absorption coefficient [m <sup>-1</sup> , dB m <sup>-1</sup> , neper m <sup>-1</sup> ]
$g_{i\lambda}$	piezoelectric strain constant [m <sup>2</sup> C <sup>-1</sup> ]	$\alpha_{ij}$	linear thermal expansion coefficient [K <sup>-1</sup> ]
$\Delta H,$	magnetic resonance half width, separation	$\alpha, \beta, \gamma$	interaxial angles: $b \wedge c, c \wedge a, a \wedge b$ [°]
$\Delta' H$	between max. and min. of the derivative of magnetic resonance curve [A m <sup>-1</sup> ]	$\beta_{ij}$	anisotropic temperature parameter [ $\text{\AA}^2$ ]
$h_{i\lambda}$	piezoelectric stress constant [N C <sup>-1</sup> ]	$\gamma$	gyromagnetic ratio [m A <sup>-1</sup> s <sup>-1</sup> ] or cubic thermal expansion coefficient [K <sup>-1</sup> ]
$I$	scattering intensity [J s <sup>-1</sup> ]	$\delta$	isomer shift [m s <sup>-1</sup> ]
$I_s$	switching current [A]	$\tan \delta$	dielectric loss tangent [numeral]
$k_{i\lambda}$	electromechanical coupling factor [numeral]	$\varepsilon$	permittivity [F m <sup>-1</sup> ]
$k_p, k_t$	planar, thickness coupling factor [numeral]	$\varepsilon_{ij}$	components of dielectric permittivity tensor [F m <sup>-1</sup> ]
$L_{\lambda\mu}$	quadratic electrooptic constant for $E$ [m <sup>2</sup> V <sup>-2</sup> ]	$\zeta, \xi$	coefficient of power series expansion of electric field strength [V m <sup>9</sup> C <sup>-5</sup> ] or reduced wave vector coordinate [numeral]
$\Delta l/l$	elongation per unit length m [m <sup>-1</sup> ]	$\eta$	asymmetry parameter [numeral]
$M$	molecular weight [numeral]	$\Theta, \Theta_{\text{II-I}}$	transition temperature, between phases II and I [K, °C]
$M_{\lambda\mu}$	quadratic electrooptic constant for $P$ [m <sup>4</sup> C <sup>-2</sup> ]	$\Theta_c, \Theta_f,$	superconducting, ferroelectric,
$n$	refractive index [numeral]	$\Theta_a, \Theta_p$	antiferroelectric, paraelectric transition temperature [K, °C]
$n, n_e, n_o$	refractive index, for extraordinary, ordinary light [numeral]	$\theta$	tilt angle [°]
$\Delta n$	birefringence [numeral]	$\kappa, \kappa', \kappa''$	dielectric constant, real and imaginary parts of complex dielectric constant [numeral]
$P, P_r,$	dielectric, remanent and spontaneous	$\lambda$	wave length [m] or thermal conductivity [J s <sup>-1</sup> m <sup>-1</sup> K <sup>-1</sup> ]
$P_s$	polarization [C m <sup>-2</sup> ]	$\nu$	frequency [Hz]
$p_i$	pyroelectric coefficient [C K <sup>-1</sup> m <sup>-2</sup> ]	$\Pi_{\lambda\mu}$	piezo-optic constant for $T$ [m <sup>2</sup> N <sup>-1</sup> ]
$p_{\lambda\mu}$	piezo-optic constant for $S$ [m m <sup>-1</sup> ]	$\rho, \rho_X$	density, X-ray density [kg m <sup>-3</sup> ]
$Q$	quality factor [numeral]	$\sigma$	conductivity [ $\Omega^{-1}$ m <sup>-1</sup> ] or surface conductivity [ $\Omega^{-1}$ ]
$\Delta Q_m$	transition heat per mole [J mol <sup>-1</sup> ]	$\chi, \chi_p$	electric, paraelectric susceptibility [F m <sup>-1</sup> ]
$Q_{\lambda\mu}$	electrostrictive constant for $P$ [m <sup>4</sup> C <sup>-2</sup> ]	$\chi_{\text{magn m}}$	molar magnetic susceptibility [m <sup>3</sup> mol <sup>-1</sup> ]
$q$	wave number ( $2\pi/\lambda$ ) [m <sup>-1</sup> ]	$\chi_{\text{magn } \rho}$	mass magnetic susceptibility, specific susceptibility [m <sup>3</sup> kg <sup>-1</sup> ]
$q$	wave number vector [m <sup>-1</sup> ]		
$R$	resistance [ $\Omega$ ] or reflectivity [numeral] or discrepancy index [numeral, %]		
$r_c$	$r_c = r_{33} - (n_o/n_e)^3 r_{13}$ [m V <sup>-1</sup> ]		
$r_{\lambda i}$	electro-optic constant for $E$ [m V <sup>-1</sup> ]		
$\Delta S_m$	transition entropy per mole [J K <sup>-1</sup> mol <sup>-1</sup> ]		

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Group III: Condensed Matter

Volume 36

# Ferroelectrics and Related Substances

Subvolume A1: Oxides

Perovskite-type oxides and  $\text{LiNbO}_3$  family

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Dedicated to our admired

Editor in Chief of Landolt-Börnstein 1950-1985

**PROF. DR. KARL-HEINZ HELLWEGE**

(\*1910 – †1999)

## Preface

A complete new edition on ferroelectrics, Landolt-Börnstein volume III/36, is required by the growing number of publications and increasing amount of valuable data after the publication of volume III/16 (1981) and its supplement III/28 (1990). The first part of the subvolume III/36A on oxides is presented herewith.

Volume III/36 contains revised, updated and extended information on ferroelectrics, antiferroelectrics and closely related substances. All reliable data on both pure compounds and solid solutions published between 1920 and 1995 (with some more recent data) are critically evaluated and included. Besides of the dielectric and ferroelectric behavior, a number of other properties relevant to the characterization of the substances are presented in tables and figures.

As the range of the compiled data is very extensive volume III/36 will be divided into two subvolumes titled

III/36A Oxides  
III/36B Non-oxides.

Each one of the two subvolumes will be published in at least two parts. The titles of the two parts of subvolume III/36A will be

III/36A1 Perovskite-type oxides and  $\text{LiNbO}_3$  family  
III/36A2 Other oxides.

Preliminary titles for two parts of subvolume III/36B are

III/36B1 Inorganic crystals other than oxides  
III/36B2 Ferroelectric organic crystals, liquid crystals and polymers.

The oxide ferroelectrics have a wide range of applications as dielectric, piezoelectric and pyroelectric materials. For these purposes they are mostly used in bulk. Thin films of oxide ferroelectrics during the last years have become very useful for memory devices in the information technology.

Unlike previous Landolt-Börnstein volumes on ferroelectrics, volume III/36 will be published in three different forms: printed, online and on CD-ROM. The internet address of Landolt-Boernstein online is

[www.landolt-boernstein.com](http://www.landolt-boernstein.com)

The CD-ROM will be offered together with the printed volume. The complete information of volume III/36 will be published online as well as on the CD-ROM. When printed the complete information of part III/36A1 alone would cover already about 1700 pages. Therefore, to keep things handy, the printed volumes will contain only a selection of the complete data, covering roughly one third of the complete data; the basic data, all figures and table captions and all references, however, will be included. Only the number of figures and the number of tables will be reduced in the printed volume.

The editors wish to thank all the authors for their competent and persistent work, the members of the Landolt-Börnstein office, especially Dr. R. Poerschke, Dr. T. Schneider and Mrs. Rathgeber-Manns for their nice cooperation and thoughtful help in the final preparation.

The Editors

August 2001

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