Symbols

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

A	solubility [kg kg^{-1}, kg m^{-3}, wt%]
B	isotropic temperature parameter [Å^2]
B_{ij}	anisotropic temperature parameter [numeral]
C	Curie-Weiss constant [K]
C_p, c_p	molar [J K^{-1} mol^{-1}], specific [J K^{-1} kg^{-1}] heat capacity at constant pressure
$c_{\lambda\mu}$	elastic stiffness [N m^{-2}]
$d_{i\lambda}$	piezoelectric strain constant [C N^{-1}]
$d_{i\lambda}$	susceptibility for second harmonic generation [m V^{-1}]
$\boldsymbol{E}$, E_{bias}	electric field strength, bias field [V m^{-1}]
E_c	coercive field [V m^{-1}]
$e_{i\lambda}$	piezoelectric stress constant [C m^{-2}]
e^2qQ/h	nuclear quadrupole coupling constant [Hz]
f, f_A, f_R	frequency, antiresonance, resonance frequency [Hz]
$f_{i\lambda}$	piezoelectric strain constant [m^2 C^{-1}]
g_i, g_{ij}	principal value or component of g-tensor [numeral]
$g_{i\lambda}$	piezoelectric strain constant [m^2 C^{-1}]
ΔH, $\Delta' H$	magnetic resonance half width, separation between max. and min. of the derivative of magnetic resonance curve [A m^{-1}]
$h_{i\lambda}$	piezoelectric stress constant [N C^{-1}]
I	scattering intensity [J s^{-1}]
I_s	switching current [A]
$k_{i\lambda}$	electromechanical coupling factor [numeral]
k_p, k_t	planar, thickness coupling factor [numeral]
$L_{\lambda\mu}$	quadratic electrooptic constant for $\boldsymbol{E}$ [m^2 V^{-2}]
$\Delta l/l$	elongation per unit length m [m^{-1}]
M	molecular weight [numeral]
$M_{\lambda\mu}$	quadratic electrooptic constant for $\boldsymbol{P}$ [m^4 C^{-2}]
n	refractive index [numeral]
n, n_e, n_o	refractive index, for extraordinary, ordinary light [numeral]
Δn	birefringence [numeral]
P, P_r, P_s	dielectric, remanent and spontaneous polarization [C m^{-2}]
p_i	pyroelectric coefficient [C K^{-1} m^{-2}]
$p_{\lambda\mu}$	piezooptic constant for $\mathbf{S}$ [m m^{-1}]
Q	qualify factor [numeral]
ΔQ_m	transition heat per mole [J mol^{-1}]
$Q_{\lambda\mu}$	electrostrictive constant for $\boldsymbol{P}$ [m^4 C^{-2}]
q	wave number ($2\pi/\lambda$) [m^{-1}]
$\boldsymbol{q}$	wave number vector [m^{-1}]
R	resistance [Ω] or reflectivity [numeral] or discrepancy index [numeral, %]
r_c	$r_c = r_{33} - (n_o/n_e)^3\, r_{13}$ [m V^{-1}]
$r_{\lambda i}$	electrooptic constant for $\boldsymbol{E}$ [m V^{-1}]
ΔS_m	transition entropy per mole [J K^{-1} mol^{-1}]
S_{ij}, S_λ	component of strain tensor: $S_\lambda = S_{ij}$ for i = j, $S_\lambda = 2S_{ij}$ for i ≠ j [m m^{-1}]
$s_{\lambda\mu}$	elastic compliance [m^2 N^{-1}]
T, T_{melt}	temperature, melting point [K, °C]
T_{ij}, T_λ	component of stress tensor: $T_\lambda = T_{ij}$ [N m^{-2}]
T_1	spin-lattice relaxation time [sec, s]
t, t_s, t_m	time, switching time, time for maximum switching current [sec, s]
U_{ij}	anisotropic temperature parameter [Å^2]
V	voltage [V] or 1/2 (optical axial angle) [° '] or volume of unit cell [Å^3]
υ	sound velocity [m s^{-1}]
υ_m	molar volume [m^3 mol^{-1}]
X, Y, Z	orthogonal coordinate system [Å, m]
x, y	molar fraction [numeral]
x, y, z	fractional coordinates of atoms in the unit cell [numeral]
Z	number of formula units per cell [numeral]
α	optical [m^{-1}] or acoustic absorption coefficient [m^{-1}, dB m^{-1}, neper m^{-1}]
α_{ij}	linear thermal expansion coefficient [K^{-1}]
α, β, γ	interaxial angles: $\boldsymbol{b} \wedge \boldsymbol{c}$, $\boldsymbol{c} \wedge \boldsymbol{a}$, $\boldsymbol{a} \wedge \boldsymbol{b}$ [° ']
β_{ij}	anisotropic temperature parameter [Å^2]
γ	gyromagnetic ratio [m A^{-1} s^{-1}] or cubic thermal expansion coefficient [K^{-1}]
δ	isomer shift [m s^{-1}]
tan δ	dielectric loss tangent [numeral]
ε	permittivity [F m^{-1}]
ε_{ij}	components of dielectric permittivity tensor [F m^{-1}]
ζ, ξ	coefficient of power series expansion of electric field strength [V m^9 C^{-5}] or reduced wave vector coordinate [numeral]
η	asymmetry parameter [numeral]
Θ, Θ_{II-I}	transition temperature, between phases II and I [K, °C]
Θ_c, Θ_f, Θ_a, Θ_p	superconducting, ferroelectric, antiferroelectric, paraelectric transition temperature [K,°C]
θ	tilt angle [°]
κ, κ', κ''	dielectric constant, real and imaginary parts of complex dielectric constant [numeral]
λ	wave length [m] or thermal conductivity [J s^{-1} m^{-1} K^{-1}]
ν	frequency [Hz]
$\Pi_{\lambda\mu}$	piezooptic constant for $\mathbf{T}$ [m^2 N^{-1}]
ρ, ρ_X	density, X-ray density [kg m^{-3}]
σ	conductivity [Ω^{-1} m^{-1}] or surface conductivity [Ω^{-1}]
χ, χ_p	electric, paraelectric susceptibility [F m^{-1}]
$\chi_{magn\,m}$	molar magnetic susceptibility [m^3 mol^{-1}]
$\chi_{magn\,\rho}$	mass magnetic susceptibility, specific susceptibility [m^3 kg^{-1}]

Back to Main Index

Landolt-Börnstein / New Series

Springer

Berlin
Heidelberg
New York
Barcelona
Budapest
Hong Kong
London
Milan
Paris
Singapore
Tokyo

Landolt-Börnstein

Numerical Data and Functional Relationships in Science and Technology

New Series
Editor in Chief: W. Martienssen

Units and Fundamental Constants in Physics and Chemistry

Elementary Particles, Nuclei and Atoms (Group I)
(Formerly: Nuclear and Particle Physics)

Molecules and Radicals (Group II)
(Formerly: Atomic and Molecular Physics)

Condensed Matter (Group III)
(Formerly: Solid State Physics)

Physical Chemistry (Group IV)
(Formerly: Macroscopic Properties of Matter)

Geophysics (Group V)

Astronomy and Astrophysics (Group VI)

Biophysics (Group VII)

Some of the group names have been changed according to a better description of their contents.

Landolt-Börnstein
Numerical Data and Functional Relationships in Science and Technology
New Series / Editor in Chief: W. Martienssen

Group III: Condensed Matter
Volume 36

Ferroelectrics and Related Substances

Subvolume A1: Oxides

Perovskite-type oxides and $LiNbO_3$ family

Editors: Y. Shiozaki, E. Nakamura, T. Mitsui

Authors:
M. Adachi, Y. Akishige, T. Asahi, K. Deguchi, K. Gesi, K. Hasebe,
T. Hikita, T. Ikeda, Y. Iwata, M. Komukae, T. Mitsui, E. Nakamura,
N. Nakatani, M. Okuyama, T. Osaka, A. Sakai, E. Sawaguchi, Y. Shiozaki,
T. Takenaka, K. Toyoda, T. Tsukamoto, T. Yagi

Springer

Back to Main Index

ISSN 1615-1925 (Condensed Matter)

ISBN 3-540-63274-3 Springer-Verlag Berlin Heidelberg New York

Library of Congress Cataloging in Publication Data:
Landolt-Börnstein: Numerical Data and Functional Relationships in Science and Technology, New Series.
Editor in Chief: W. Martienssen.
Group III, Volume 36: Ferroelectrics and Related Substances. Subvolume A: Oxides. Part 1: Perovskite-type oxides and $LiNbO_3$ family.
Edited by Y. Shiozaki, E. Nakamura and T. Mitsui.
Springer-Verlag, Berlin, Heidelberg, New York 2001.
Includes bibliographies.
1. Physics - Tables. 2. Chemistry - Tables. 3. Engineering - Tables.
I. Börnstein, Richard (1852-1913). II. Landolt, Hans (1831-1910).
QC 61.23 502'.12 62-53136

Typesetting and editorial office: Redaktion Landolt-Börnstein, Darmstadt
Printing: Computer to plate, Mercedes-Druck, Berlin
Binding: Lüderitz & Bauer, Berlin

SPIN: 1042 6842 63/3020- 5 4 3 2 1 0 – Printed on acid-free paper

Back to Main Index

Editors

Shiozaki, Yoichi
Hokkaido University, Sapporo, Japan

Nakamura, Eiji
Hiroshima University, Higashi-Hiroshima, Hiroshima-ken, Japan

Mitsui, Toshio
Meiji University, Kawasaki, Japan

Authors

Adachi, Masatoshi
Toyama Prefectural University, Kosugi, Toyama-ken, Japan

Akishige, Yukikuni
Shimane University, Matsue, Japan

Asahi, Takanao
Yamaguchi University, Yamaguchi, Japan

Deguchi, Kiyoshi
Shizuoka Institute of Science and Technology, Fukuroi, Shizuoka-ken, Japan

Gesi, Kazuo
Meisei University, Iwaki, Fukushima-ken, Japan

Hasebe, Katsuhiko
Yamaguchi University, Yamaguchi, Japan

Hikita, Tomoyuki
Tohoku University, Sendai, Japan

Ikeda, Takuro
Moriya, Ibaraki-ken, Japan

Iwata, Yutaka
Kyoto University, Kumatori, Osaka-fu, Japan

Komukae, Masaru
Science University of Tokyo, Tokyo, Japan

Mitsui, Toshio
Meiji University, Kawasaki, Japan

Nakamura, Eiji
Hiroshima University, Higashi-Hiroshima, Hiroshima-ken, Japan

Nakatani, Noriyuki
Toyama University, Toyama, Japan

Okuyama, Masanori
Osaka University, Toyonaka, Osaka-fu, Japan

Osaka, Tosio
Science University of Tokyo, Tokyo, Japan

Sakai, Akira
Muroran Institute of Technology, Muroran, Hokkaido, Japan

Sawaguchi, Etsuro
Agne Gijutsu Center, Tokyo, Japan

Shiozaki, Yoichi
Hokkaido University, Sapporo, Japan

Takenaka, Tadashi
Science University of Tokyo, Noda, Chiba-ken, Japan

Toyoda, Koichi
Shizuoka University, Hamamatsu, Shizuoka-ken, Japan

Tsukamoto, Takeyo
Science University of Tokyo, Tokyo, Japan

Yagi, Toshirou
Hokkaido University, Sapporo, Japan

Landolt-Börnstein

Editorial Office
Gagernstraße 8
D-64283 Darmstadt, Germany
fax: +49-(0)6151-171760
email: lb@springer.de

Internet
www.landolt-boernstein.com

Helpdesk
email: em-helpdesk@springer.de

Back to Main Index

Dedicated to our admired

Editor in Chief of Landolt-Börnstein 1950-1985

PROF. DR. KARL-HEINZ HELLWEGE

(*1910 – †1999)

Back to Main Index

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 devided 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 $LiNbO_3$ 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

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

Table of contents

Ferroelectrics and related substances

Subvolume A1: Oxides
Perovskite-type oxides and $LiNbO_3$ family