

B. A. Strukov
A. P. Levanyuk

Ferroelectric Phenomena in Crystals

Physical Foundations



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Ferroelectric Phenomena In Crystals Physical Foundations

Tatiana Correia, Qi Zhang



Ferroelectric Phenomena In Crystals Physical Foundations:

Ferroelectric Phenomena in Crystals Boris A. Strukov, Arkadi P. Levanyuk, 2012-12-06 The expansion of the application of ferroelectric crystals in engineering as well as of a number of fundamental problems of solid state physics which have not yet been solved and which bear a direct relation to ferroelectricity has lately stimulated much interest in the problem of ferroelectricity In courses of solid state physics ferroelectricity is studied today along with traditional disciplines such as magnetism superconductivity and semiconducting phenomena Moreover new specialities have been born concerned directly with the development and utilization of ferroelectric material in optics acoustics computer technology and capacitor engineering Special courses in the physics of ferroelectrics are read in a number of colleges and universities The study of the nature of ferroelectricity has currently reached such a level of development that we may speak of having gained a rather deep insight into the physical essence of a number of phenomena which contribute to the generation of a spontaneous electric polarization in crystals It is exactly at this level that it has become possible to single out that part of the problem the physical picture of which can be depicted in a rather unsophisticated manner and which is the foundation for the construction of a building of complete understanding **Nanostructures in Ferroelectric Films for Energy**

Applications Jun Ouyang, 2019-06-07 Nanostructures in Ferroelectric Films for Energy Applications Grains Domains Interfaces and Engineering Methods presents methods of engineering nanostructures in ferroelectric films to improve their performance in energy harvesting and conversion and storage Ferroelectric films which have broad applications including the emerging energy technology usually consist of nanoscale inhomogeneities For polycrystalline films the size and distribution of nano grains determines the macroscopic properties especially the field induced polarization response For epitaxial films the energy of internal long range electric and elastic fields during their growth are minimized by formation of self assembled nano domains This book is an accessible reference for both instructors in academia and R D professionals

Nanoscale Ferroelectrics and Multiferroics Miguel Alguero, J. Marty Gregg, Liliana Mitoseriu, 2016-03-21 Dieses Buch beleuchtet die wichtigsten Aspekte der Verarbeitung und Charakterisierung von Ferroelektrika und Multiferroika auf Nanoebene präsentiert eine umfassende Beschreibung der jeweiligen Eigenschaften und legt dabei den Schwerpunkt auf die Unterscheidung von Gr ineffekten bei extrinsischen Eigenschaften wie Rand oder Interface Effekte Eingegangen wird auch auf neuartige Nanoebene Das Fachbuch ist in drei Abschnitte unterteilt und beschreibt die Verarbeitung Nanostrukturierung Charakterisierung nanostrukturierter Materialien und Nanoeffekte Unter R ckgriff auf die Synergien zwischen Nano Ferroelektrika und Multiferroika werden Materialien behandelt die auf allen Ebenen einer Nanostrukturierung unterzogen werden von Technologien f r keramische Materialien wie ferroelektrische Nanopulver nanostrukturierte Keramiken und Dickschichten sowie magnetoelektrische Nanokomposit Materialien bis hin zu freistehenden Nanoobjekten mit spezifischen Geometrien wie Nanodrähte und Nanoröhren auf verschiedenen Entwicklungsstufen Grundlage des Buches ist die europäische

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Ferroelectrics Mickaël Lallart, 2011-08-23 Ferroelectric materials have been and still are widely used in many applications that have moved from sonar towards breakthrough technologies such as memories or optical devices This book is a part of a four volume collection covering material aspects physical effects characterization and modeling and applications and focuses on the underlying mechanisms of ferroelectric materials including general ferroelectric effect piezoelectricity optical properties and multiferroic and magnetoelectric devices The aim of this book is to provide an up to date review of recent scientific findings and recent advances in the field of ferroelectric systems allowing a deep understanding of the physical aspect of ferroelectricity

Strain Mechanisms in Lead-Free Ferroelectrics for Actuators Matias Acosta, 2016-01-27 This book addresses and analyzes the mechanisms responsible for functionality of two technologically relevant materials giving emphasis on the relationship between structural transitions and electromechanical properties The author investigates the atomic crystal structure and microstructure by means of thermal analysis as well as diffraction and microscopy techniques Electric field temperature and frequency dependent electromechanical properties are also described Apart from this correlation between structure and properties characterization was also performed to bridge between basic research and optimization of application oriented parameters required for technological implementation The author proposes guidelines to the reader in order to engineer functional properties in other piezoelectric systems as well as in other similar functional materials with the perovskite structure

Topological Structures in Ferroic Materials Jan Seidel, 2016-02-12 This book provides a state of the art overview of a highly interesting emerging research field in solid state physics nanomaterials science topological structures in ferroic materials Topological structures in ferroic materials have received strongly increasing attention in the last few years Such structures include domain walls skyrmions and vortices which can form in ferroelectric magnetic ferroelastic or multiferroic materials These topological structures can have completely different properties from the bulk material they form in They also can be controlled by external fields electrical magnetic strain or currents which makes them interesting from a fundamental research point of view as well as for potential novel nanomaterials applications To provide a comprehensive overview international leading researches in these fields contributed review like chapters about their own work and the work of other researchers to provide a current view of this highly interesting topic

The Science of Hysteresis Giorgio Bertotti, Isaak D. Mayergoyz, 2005-12-20 Volume 1 covers Mathematical models Differential equations Stochastic aspects of hysteresis Binary detection using hysteresis Models of unemployment in economics Volume 2 covers Physical models of magnetic hysteresis All aspects of magnetisation dynamics

Volume 3 covers Hysteresis phenomena in materials Over 2100 pages rich with supporting illustrations figures and equations Contains contributions from an international list of authors from a wide range of disciplines Covers all aspects of hysteresis from differential equations and binary detection to models of unemployment and magnetisation dynamics **The Science of Hysteresis: Hysteresis in materials** I. D. Mayergoyz, 2006 Volume 1 covers Mathematical models Differential equations Stochastic aspects of hysteresis Binary detection using hysteresis Models of unemployment in economics Volume 2 covers Physical models of magnetic hysteresis All aspects of magnetisation dynamics Volume 3 covers Hysteresis phenomena in materials Over 2100 pages rich with supporting illustrations figures and equations Contains contributions from an international list of authors from a wide range of disciplines Covers all aspects of hysteresis from differential equations and binary detection to models of unemployment and magnetisation dynamics **The Electrocaloric Effect** Andrei L. Kholkin, Oleg V. Pakhomov, Alexander A. Semenov, Alexander Tselev, 2023-02-16 The Electrocaloric Effect Materials and Applications reviews the fundamentals of the electrocaloric effect the most relevant electrocaloric materials and electrocaloric measurements and device applications The book introduces the electrocaloric effect along with modeling and simulations of this effect Then it addresses the latest advances in synthesis characterization and optimization of the most relevant electrocaloric materials including ferroelectric materials liquid materials lead free materials polymers and composites Finally there is a review of the latest techniques in measurement and applications in refrigeration and cooling and a discussion of the advantages challenges and perspectives of the future of electrocaloric refrigeration Provides a comprehensive introduction to the electrocaloric effect including experimental techniques to measure model and simulate the effect Reviews the most relevant electrocaloric materials such as composites polymers metal oxides ferroelectric materials and more Touches on the design and application of electrocaloric materials for devices with potential cooling and refrigeration applications **Electromagnetic Phenomena in Matter** Igor N. Toptygin, 2015-02-09 Modern electrodynamics in different media is a wide branch of electrodynamics which combines the exact theory of electromagnetic fields in the presence of electric charges and currents with statistical description of these fields in gases plasmas liquids and solids dielectrics conductors and superconductors It is widely used in physics and in other natural sciences such as astrophysics and geophysics biophysics ecology and evolution of terrestrial climate and in various technological applications radio electronics technology of artificial materials laser based technological processes propagation of bunches of charges particles linear and nonlinear electromagnetic waves etc Electrodynamics of matter is based on the exact fundamental microscopic electrodynamics but is supplemented with specific descriptions of electromagnetic fields in various media using the methods of statistical physics quantum mechanics physics of condensed matter including theory of superconductivity physical kinetics and plasma physics This book presents in one unique volume a systematic description of the main electrodynamic phenomena in matter A large variety of theoretical approaches used in describing various media Numerous

important manifestations of electrodynamics in matter magnetic materials superconductivity magnetic hydrodynamics holography radiation in crystals solitons etc A description of the applications used in different branches of physics and many other fields of natural sciences Describes the whole complexity of electrodynamics in matter including material at different levels Oriented towards 3 4 year bachelors masters and PhD students as well as lectures and engineers and scientists working in the field The reader will need a basic knowledge of general physics higher mathematics classical mechanics and microscopic fundamental electrodynamics at the standard university level All examples and problems are described in detail in the text to help the reader learn how to solve problems Advanced problems are marked with one asterisk and the most advanced ones with two asterisks Some problems are recommended to be solved first and are marked by filled dots they are more general and important or contain results used in other problems *Nanoferroics* M.D. Glinchuk,A.V.

Ragulya,Vladimir A. Stephanovich,2013-05-13 This book covers the physical properties of nanosized ferroics also called nanoferroics Nanoferroics are an important class of ceramic materials that substitute conventional ceramic ferroics in modern electronic devices They include ferroelectric ferroelastic magnetic and multiferroic nanostructured materials The phase transitions and properties of these nanostructured ferroics are strongly affected by the geometric confinement originating from surfaces and interfaces As a consequence these materials exhibit a behavior different from the corresponding bulk crystalline ceramic and powder ferroics This monograph offers comprehensive coverage of size and shape dependent effects at the nanoscale the specific properties that these materials have been shown to exhibit the theoretical approaches that have been successful in describing the size dependent effects observed experimentally and the technological aspects of many chemical and physico chemical nanofabrication methods relevant to making nanoferroic materials and composites The book will be of interest to an audience of condensed matter physicists material scientists and engineers working on ferroic nanostructured materials their fundamentals fabrication and device applications **The**

Science of Hysteresis Bozzano G Luisa,2005-12-20 The Science of Hysteresis Electrocaloric Materials Tatiana Correia,Qi Zhang,2013-11-29 Since the 1997 Kyoto protocol of reduction of greenhouse gas emissions the development of novel refrigerators has been a priority within the scientific community Although magnetocaloric materials are promising candidates they still need a large magnetic field to induce a giant T as well as powerful and costly magnets However in electrocaloric materials ECMs a temperature change may be achieved by applying or removing an electric field Since a giant electrocaloric effect on ferroelectric thin films was reported in Science in 2006 researchers have been inspired to explore such effect in different ferroelectric thin films This book reviews electrocaloric effects observed in bulk materials as well as recent promising advances in thin films with special emphasis on the ferroelectric antiferroelectric and relaxor nature of ECMs It reports a number of considerations about the future of ECMs as a means of achieving an efficient ecologically sustainable and low cost refrigerator **Modern Crystallography 2** Boris K. Vainshtein,Vladimir M. Fridkin,Vladimir L.

Indenbom,2012-12-06 Structure of Crystals describes the ideal and real atomic structure of crystals as well as the electronic structures The fundamentals of chemical bonding between atoms are given and the geometric representations in the theory of crystal structure and crystal chemistry as well as the lattice energy are considered The important classes of crystal structures in inorganic compounds as well as the structures of polymers liquid crystals biological crystals and macromolecules are treated This edition is complemented with recent data on many types of crystal structures e g the structure of fullerenes high temperature superconductors minerals and liquid crystals *The Physics of Solids* J. B.

Ketterson,2016-10-28 This comprehensive text covers the basic physics of the solid state starting at an elementary level suitable for undergraduates but then advancing in stages to a graduate and advanced graduate level In addition to treating the fundamental elastic electrical thermal magnetic structural electronic transport optical mechanical and compositional properties we also discuss topics like superfluidity and superconductivity along with special topics such as strongly correlated systems high temperature superconductors the quantum Hall effects and graphene Particular emphasis is given to so called first principles calculations utilizing modern density functional theory which for many systems now allow accurate calculations of the electronic magnetic and thermal properties **Functional Metal Oxides** Satishchandra Balkrishna

Ogale,T. Venky Venkatesan,Mark Blamire,2013-11-08 Functional oxides are used both as insulators and metallic conductors in key applications across all industrial sectors This makes them attractive candidates in modern technology they make solar cells cheaper computers more efficient and medical instrumentation more sensitive Based on recent research experts in the field describe novel materials their properties and applications for energy systems semiconductors electronics catalysts and thin films This monograph is divided into 6 parts which allows the reader to find their topic of interest quickly and efficiently Magnetic Oxides Dopants Defects and Ferromagnetism in Metal Oxides Ferroelectrics Multiferroics Interfaces and Magnetism Devices and Applications This book is a valuable asset to materials scientists solid state chemists solid state physicists as well as engineers in the electric and automotive industries *Materials Handbook* François

Cardarelli,2013-11-11 Despite the several comprehensive series available in Material Sciences and their related fields it is a hard task to find grouped properties of metals and alloys ceramics polymers minerals woods and building materials in a single volume source book Actually the scope of this practical handbook is to provide to scientists engineers professors technicians and students working in numerous scientific and technical fields ranging from nuclear to civil engineering easy and rapid access to the accurate physico chemical properties of all classes of materials Classes used to describe the materials are i metals and their alloys ii semiconductors iii superconductors iv magnetic materials v miscellaneous electrical materials e g dielectrics thermocouple and industrial electrode materials vi ceramics refractories and glasses vii polymers and elastomers viii minerals ores meteorites and rocks ix timbers and woods and finally x building materials Particular emphasis is placed on the properties of the most common industrial materials in each class Physical and chemical properties usually

listed for each material are i mechanical e g density elastic moduli Poisson s ratio yield and tensile strength hardness fracture toughness ii thermal e g melting point thermal conductivity specific heat capacity coefficient of linear thermal expansion spectral emissivities iii electrical e g resistivity dielectric permittivity loss tangent factor iv magnetic e g magnetic permeability remanence Hall constant v optical e g refractive indices reflective index vi electrochemical e g

Functional Thin Films and Functional Materials Donglu Shi, 2003 This book provides an up to date introduction to the field of functional thin films and materials encompassing newly developed technologies and fundamental new concepts The focus is on the critical areas of novel thin films such as sol gel synthesis of membrane ferroelectric thin films and devices functional nanostructured thin films micromechanical analysis of fiber reinforced composites and novel applications An important aspect of the book lies in its wide coverage of practical applications It introduces not only the cutting edge technologies in modern industry but also unique applications in many rapidly advancing fields This book is written for a wide readership including university students and researchers from diverse backgrounds such as physics materials science engineering and chemistry Both undergraduate and graduate students will find it a valuable reference book on key topics related to solid state and materials science

Liquid Interfaces In Chemical, Biological And Pharmaceutical Applications Alexander G. Volkov, 2001-01-30 Provides a comprehensive treatment of surface chemistry and its applications to chemical engineering biology and medicine Focuses on the chemical and physical structure of oil water interfaces and membrane surfaces Details interfacial potentials ion solvation and electrostatic instabilities in double layers

Nanostructured Multiferroics Raneesh Balakrishnan, P. M. Visakh, 2021-06-01 Explore the state of the art in multiferroic materials with this cutting edge resource Nanostructured Multiferroics delivers an overview of recent research developments in the area of nanostructured multiferroics along with their preparation characterization and applications Covering single phase and composite multiferroics nanomultiferroics and multiferroic composites the book explains their physical properties the underlying physical principles and the technology and application aspects of the materials including energy harvesting and spintronics With multiferroics undergoing a renaissance of renewed interest and development in the past few years and with promising new breakthroughs in areas like superconductivity spintronics and quantum computing Nanostructured Multiferroics offers both experienced scientists and young researchers inspirational and informative resources likely to spark ideas for further research Along with chapters discussing topics such as the specific heat and magnetocaloric properties of manganite based multiferroics for cryo cooling applications and the multiferroic properties of barium doped BiFeO₃ particles further topics are A comprehensive discussion about the physical properties of multiferroic nanocomposites An exploration of the basic theory underpinning a variety of multiferroic interactions An in depth analysis of the engineering functionality in nanomultiferroics An introduction to nanostructured multiferroics accompanied by discussions of their synthesis characterization and common applications A treatment of multiferroic materials as well as single phase and composite

multiferroics An examination of the use of nanostructured multiferroics in the field of spintronics Perfect for materials scientists Nanostructured Multiferroics will also earn a place in the libraries of solid state physicists and chemists who seek to improve their understanding of the fundamentals of and recent advances made in multiferroics The information contained within will inform anyone working in areas involving superconductivity quantum computing and spintronics

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