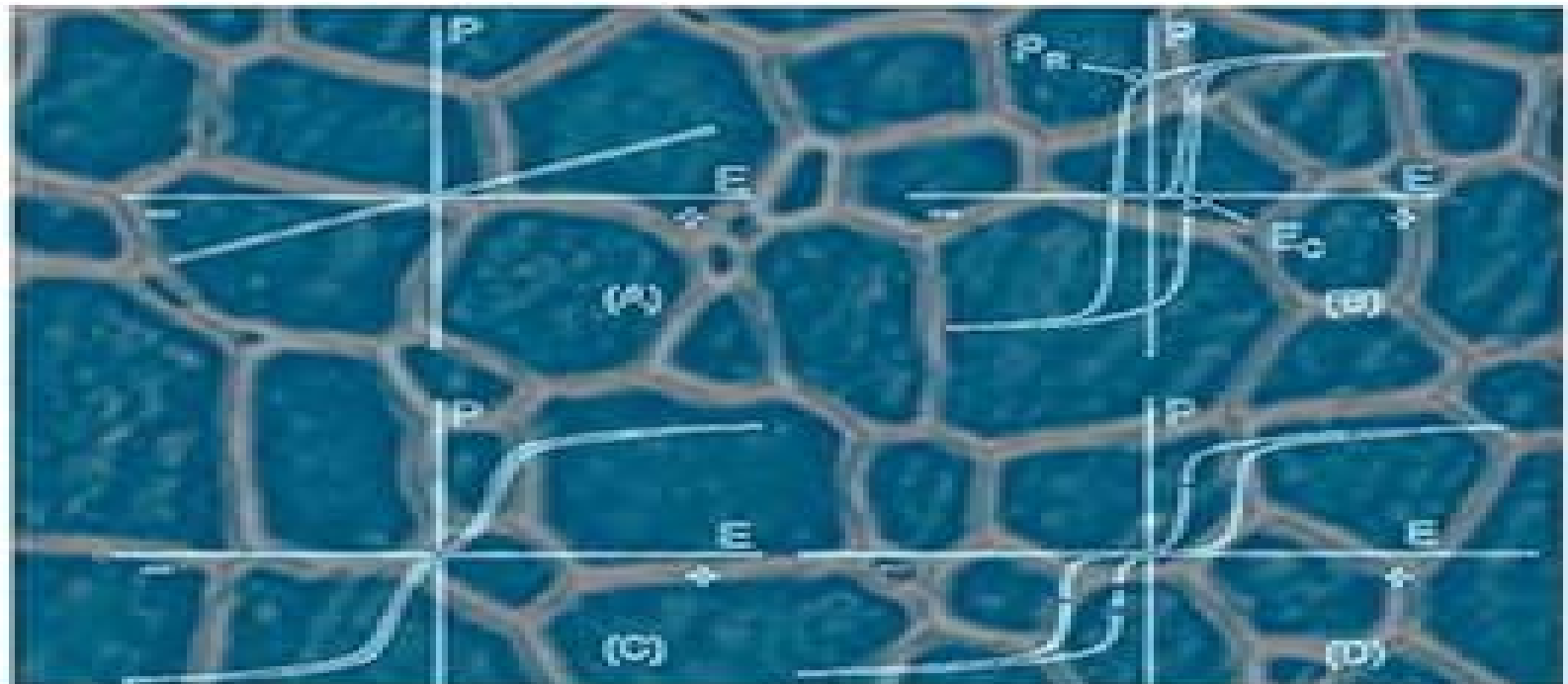


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# Ferroelectricity

The Fundamentals Collection



# Ferroelectricity The Fundamentals Collection

**Pietro Ferraro, Simonetta Grilli, Paolo  
De Natale**



## **Ferroelectricity The Fundamentals Collection:**

**Ferroelectricity** Julio A. Gonzalo, Basilio Jiménez, 2005 This indispensable collection of seminal papers on ferroelectricity provides an overview over almost a hundred years of basic and applied research Containing historic contributions from renowned authors this book presents developments in an area of science that is still rapidly growing Although primarily aimed at scientists and academics involved in research this will also be of use to students as well as newcomers to the field

**Ferroelectricity** Julio A. Gonzalo, Basilio Jiménez, 2008-09-26 This indispensable collection of seminal papers on ferroelectricity provides an overview over almost a hundred years of basic and applied research Containing historic contributions from renowned authors this book presents developments in an area of science that is still rapidly growing Although primarily aimed at scientists and academics involved in research this will also be of use to students as well as newcomers to the field

*Organic Ferroelectric Materials and Applications* Kamal Asadi, 2021-10-27 *Organic Ferroelectric Materials and Applications* aims to bring an up to date account of the field with discussion of recent findings This book presents an interdisciplinary resource for scientists from both academia and industry on the science and applications of molecular organic piezo and ferroelectric materials The book addresses the fundamental science of ferroelectric polymers molecular crystals supramolecular networks and other key and emerging organic materials systems It touches on important processing and characterization methods and provides an overview of current and emerging applications of organic piezoelectrics and ferroelectrics for electronics sensors energy harvesting and biomedical technologies *Organic Ferroelectric Materials and Applications* will be of special interest to those in academia or industry working in materials science engineering chemistry and physics Provides an overview of key physical properties of the emerging piezoelectric and ferroelectric molecular and supramolecular systems Discusses best practices of processing patterning and characterization methods and techniques Addresses current and emerging applications for electronics materials development sensors energy harvesting and biomedical technologies

**Ferroelectrics** Indrani Coondoo, 2010-12-14 Ferroelectric materials exhibit a wide spectrum of functional properties including switchable polarization piezoelectricity high non linear optical activity pyroelectricity and non linear dielectric behaviour These properties are crucial for application in electronic devices such as sensors microactuators infrared detectors microwave phase filters and non volatile memories This unique combination of properties of ferroelectric materials has attracted researchers and engineers for a long time This book reviews a wide range of diverse topics related to the phenomenon of ferroelectricity in the bulk as well as thin film form and provides a forum for scientists engineers and students working in this field The present book containing 24 chapters is a result of contributions of experts from international scientific community working in different aspects of ferroelectricity related to experimental and theoretical work aimed at the understanding of ferroelectricity and their utilization in devices It provides an up to date insightful coverage to the recent advances in the synthesis characterization functional properties and potential device

applications in specialized areas      Multifunctional Polycrystalline Ferroelectric Materials Lorena Pardo, Jesús Ricote, 2011-02-14 This book presents selected topics on processing and properties of ferroelectric materials that are currently the focus of attention in scientific and technical research Ferro piezoelectric ceramics are key materials in devices for many applications such as automotive healthcare and non destructive testing As they are polycrystalline non centrosymmetric materials their piezoelectricity is induced by the so called poling process This is based on the principle of polarization reversal by the action of an electric field that characterizes the ferroelectric materials This book was born with the aim of increasing the awareness of the multifunctionality of ferroelectric materials among different communities such as researchers electronic engineers end users and manufacturers working on and with ferro piezoelectric ceramic materials and devices which are based on them The initiative to write this book comes from a well established group of researchers at the Laboratories of Ferroelectric Materials Materials Science Institute of Madrid ICMN CSIC This group has been working in different areas concerning thin films and bulk ceramic materials since the mid 1980s It is a partner of the Network of Excellence on Multifunctional and Integrated Piezoelectric Devices MIND of the EC in which the European Institute of Piezoelectric Materials and Devices has its origin      **Piezoelectric Ceramic Resonators** Jiří Erhart, Petr Půlpán, Martin Pustka, 2016-10-24 This book helps the reader to understand the specific properties of piezoelectric ceramic resonators It provides their theoretical description by immitance and equivalent circuit method The nummerical modelling described is accompanied by examples of properties measured experimentally Piezoelectric ceramic transformers are also covered followed by a series of solved and unsolved problems prepared specially for students      *Ferroelectric Crystals for Photonic Applications* Pietro Ferraro, Simonetta Grilli, Paolo De Natale, 2013-11-20 This book deals with the latest achievements in the field of ferroelectric domain engineering and characterization at micro and nano scale dimensions and periods The book collects the results obtained in the last years by world scientific leaders in the field thus providing a valid and unique overview of the state of the art and also a view to future applications of those engineered and used materials in the field of photonics The second edition covers the major aspects of ferroelectric domain engineering and combines basic research and latest updated applications such as challenging results by introducing either new as well as extended chapters on Photonics Crystals based on Lithium Niobate and Lithium Tantalate crystals generation visualization and controlling of THz radiation latest achievements on Optical Parametric Oscillators for application in precise spectroscopy Further more recent advancements in characterization by probe scanning microscopy and optical methods with device and technological orientation A state of the art report on periodically poled processes and their characterization methods are provided on different materials LiNbO<sub>3</sub> KTP furnishing update research on ferroelectric crystal by extending materials research and applications      **Ferroic Materials-Based Technologies** Inamuddin, Tariq Altalhi, Mohammad Abu Jafar Mazumder, 2024-05-29 FERROIC MATERIALS BASED TECHNOLOGIES The book addresses the prospective relevant and

original research developments in the ferroelectric magnetic and multiferroic fields Ferroic materials have sparked widespread attention because they represent a broad spectrum of elementary physics and are employed in a plethora of fields including flexible memory enormous energy harvesting storage spintronic functionalities spin caloritronics and a large range of other multi functional devices With the application of new ferroic materials strong room temperature ferroelectricity with high saturation polarization may be established in ferroelectric materials and magnetism with significant magnetization can be accomplished in magnetic materials Furthermore magnetoelectric interaction between ferroelectric and magnetic orderings is high in multiferroic materials which could enable a wide range of innovative devices Magnetic ferroelectric and multiferroic 2D materials with ultrathin characteristics above ambient temperature are often expected to enable future miniaturization of electronics beyond Moore's law for energy efficient nanodevices This book addresses the prospective relevant and original research developments in the ferroelectric magnetic and multiferroic fields Audience The book will interest materials scientists physicists and engineers working in ferroic and multiferroic materials

**Ferroelectric Perovskites for High-Speed Memory** Taku Onishi, 2022-06-28 This book is intended for theoretical and experimental researchers who are interested in ferroelectrics and advanced memory After introducing readers to dielectric perovskites advanced memories and ferroelectric it explains quantum simulation Then using molecular orbital calculation results it explains the ferroelectric mechanism in perovskite titanium oxides in concrete terms Lastly the book examines the materials designed for high performance ferroelectrics and discusses the future of high speed memory

**Fundamental Physics of Ferroelectrics 2002** Ronald E. Cohen, 2002-08-14 This workshop continues an annual series held since 1990 covering the fundamental understanding of ferroelectrics and piezoelectrics using first principles theory and experiments Of particular interest this year are the new high strain single crystal piezoelectrics superlattices and complex solid solutions Also this year is growing interest in understanding dynamical properties of relaxors using theory and experiment particularly inelastic neutron scattering

**Magnetic, Ferroelectric, and Multiferroic Metal Oxides** Biljana Stojanovic, 2018-01-02 Magnetic Ferroelectric and Multiferroic Metal Oxides covers the fundamental and theoretical aspects of ferroics and magnetoelectrics their properties and important technological applications serving as the most comprehensive up to date reference on the subject Organized in four parts Dr Biljana Stojanovic leads expert contributors in providing the context to understand the material Part I Introduction the theoretical and practical aspects of ferroelectrics Part II Ferroelectrics From Theory Structure and Preparation to Application magnetic metal oxides Part III Magnetic Oxides Ferromagnetics Antiferromagnetics and Ferrimagnetics multiferroics Part IV Multiferroic Metal Oxides and future directions in research and application Part V Future of Metal Oxide Ferroics and Multiferroics As ferroelectric materials are used to make capacitors with high dielectric constant transducers and actuators and in sensors reed heads and memories based on giant magnetoresistive effects this book will provide an ideal source for the most updated information Addresses ferroelectrics ferromagnetics and

multiferroelectrics providing a one stop reference for researchers Provides fundamental theory and relevant important technological applications Highlights their use in capacitors with high dielectric constant transducers and actuators and in sensors reed heads and memories based on giant magnetoresistive effects     Formation of Ferroelectricity in Hafnium Oxide Based Thin Films Tony Schenk, 2017-03-15 In 2011 B scke et al reported the unexpected discovery of ferroelectric properties in hafnia based thin films which has since initiated many further studies and revitalized research on the topic of ferroelectric memories In spite of many efforts the unveiling of the fundamentals behind this surprising discovery has proven rather challenging In this work the originally claimed Pca21 phase is experimentally proven to be the root of the ferroelectric properties and the nature of this ferroelectricity is classified in the frame of existing concepts of ferroelectric materials Parameters to stabilize this polar phase are examined from a theoretical and fabrication point of view With these very basic questions addressed the application relevant electric field cycling behavior is studied The results of first order reversal curves impedance spectroscopy scanning transmission electron microscopy and piezoresponse force microscopy significantly advance the understanding of structural mechanisms underlying wake up fatigue and the novel phenomenon of split up merging of transient current peaks The impact of field cycling behavior on applications like ferroelectric memories is highlighted and routes to optimize it are derived These findings help to pave the road for a successful commercialization of hafnia based ferroelectrics     **Ferroelectric Devices** Kenji Uchino, 2018-09-03 Updating its bestselling predecessor Ferroelectric Devices Second Edition assesses the last decade of developments and setbacks in the commercialization of ferroelectricity Field pioneer and esteemed author Uchino provides insight into why this relatively nascent and interdisciplinary process has failed so far without a systematic accumulation of fundamental knowledge regarding materials and device development Filling the informational void this collection of information reviews state of the art research and development trends reflecting nano and optical technologies environmental regulation and alternative energy sources Like the first edition which became a standard in the field this volume provides a general introduction to ferroelectrics with theoretical background It then addresses practical design and device manufacturing including recently developed processes and applications Updating old data with a forecast of future developments the text analyzes improvements to original ferroelectric devices to aid the design process of new ones The second edition includes new sections on Pb free piezoelectrics Size effect on ferroelectricity Electrocaloric devices Micro mass sensor Piezoelectric energy harvesting Light valves and scanners Multi ferroic devices including magneto electric sensors Uchino provides a general introduction to the theoretical background of ferroelectric devices practical materials device designs drive control techniques and typical applications He presents frequently asked questions from students lab demonstrations for practical understanding and check point quizzes and model solutions to monitor understanding After a thorough exploration of ferroelectric devices and their past this book looks to the industry s future assessing market size and remaining reliability lifetime issues The author also unveils his

strategy for developing best selling ferroelectric devices      Physics of Ferroelectrics Karin M. Rabe, Charles H. Ahn, Jean-Marc Triscone, 2007-07-20 During the past two decades revolutionary breakthroughs have occurred in the understanding of ferroelectric materials both from the perspective of theory and experiment First principles approaches including the Berry phase formulation of ferroelectricity now allow accurate quantitative predictions of material properties and single crystalline thin films are now available for fundamental studies of these materials In addition the need for high dielectric constant insulators and nonvolatile memories in semiconductor applications has motivated a renaissance in the investigation of these materials This book addresses the paradigmatic shifts in understanding brought about by these breakthroughs including the consideration of novel fabrication methods and nanoscale applications of these materials and new theoretical methods such as the effective Hamiltonian approach and density functional theory      **Ferroelectric-Gate Field Effect Transistor Memories** Byung-Eun Park, Hiroshi Ishiwara, Masanori Okuyama, Shigeki Sakai, Sung-Min Yoon, 2020-03-23 This book provides comprehensive coverage of the materials characteristics process technologies and device operations for memory field effect transistors employing inorganic or organic ferroelectric thin films This transistor type ferroelectric memory has interesting fundamental device physics and potentially large industrial impact Among various applications of ferroelectric thin films the development of nonvolatile ferroelectric random access memory FeRAM has been most actively progressed since the late 1980s and reached modest mass production for specific application since 1995 There are two types of memory cells in ferroelectric nonvolatile memories One is the capacitor type FeRAM and the other is the field effect transistor FET type FeRAM Although the FET type FeRAM claims the ultimate scalability and nondestructive readout characteristics the capacitor type FeRAMs have been the main interest for the major semiconductor memory companies because the ferroelectric FET has fatal handicaps of cross talk for random accessibility and short retention time This book aims to provide the readers with development history technical issues fabrication methodologies and promising applications of FET type ferroelectric memory devices presenting a comprehensive review of past present and future technologies The topics discussed will lead to further advances in large area electronics implemented on glass plastic or paper substrates as well as in conventional Si electronics The book is composed of chapters written by leading researchers in ferroelectric materials and related device technologies including oxide and organic ferroelectric thin films      Ferroelectric Materials for Energy Applications Haitao Huang, James F. Scott, 2019-01-04 Provides a comprehensive overview of the emerging applications of ferroelectric materials in energy harvesting and storage Conventional ferroelectric materials are normally used in sensors and actuators memory devices and field effect transistors etc Recent progress in this area showed that ferroelectric materials can harvest energy from multiple sources including mechanical energy thermal fluctuations and light This book gives a complete summary of the novel energy related applications of ferroelectric materials and reviews both the recent advances as well as the future perspectives in this field Beginning with the fundamentals of ferroelectric materials

Ferroelectric Materials for Energy Applications offers in depth chapter coverage of piezoelectric energy generation ferroelectric photovoltaics organic inorganic hybrid perovskites for solar energy conversion ferroelectric ceramics and thin films in electric energy storage ferroelectric polymer composites in electric energy storage pyroelectric energy harvesting ferroelectrics in electrocaloric cooling ferroelectric in photocatalysis and first principles calculations on ferroelectrics for energy applications Covers a highly application oriented subject with great potential for energy conversion and storage applications Focused toward a large interdisciplinary group consisting of material scientists solid state physicists engineering scientists and industrial researchers Edited by the father of integrated ferroelectrics Ferroelectric Materials for Energy Applications is an excellent book for researchers working on ferroelectric materials and energy materials as well as engineers looking to broaden their view of the field

*Multicomponent and Multilayered Thin Films for Advanced Microtechnologies: Techniques, Fundamentals and Devices* O. Auciello, Jürgen Engemann, 2012-12-06 The synthesis of multicomponent multilayered superconducting conducting semiconducting and insulating thin films has become the subject of an intensive worldwide interdisciplinary research effort The development of deposition characterization techniques and the science and technology related to the synthesis of these films are critical for the successful evolution of this interdisciplinary field of research and the implementation of the new materials in a whole new generation of advanced microdevices This book contains the lectures and contributed papers on various scientific and technological aspects of multicomponent and multilayered thin films presented at a NATO ASI Compared to other recent books on thin films the distinctive character of this book is the interdisciplinary treatment of the various fields of research related to the different thin film materials mentioned above The wide range of topics discussed in this book include vacuum deposition techniques synthesis processing characterization and devices of multicomponent multilayered oxide high temperature superconducting ferroelectric electro optic optical metallic silicide and compound semiconductor thin films The book presents an unusual interdisciplinary exchange of ideas between researchers with cross disciplinary backgrounds and it will be useful to established investigators as well as postdoctoral and graduate students

**Ferroelectricity in Doped Hafnium Oxide** Uwe Schroeder, Cheol Seong Hwang, Hiroshi Funakubo, 2025-08-01 Ferroelectricity in Doped Hafnium Oxide Materials Properties and Devices Second Edition covers all aspects relating to the structural and electrical properties of  $\text{HfO}_2$  and its implementation into semiconductor devices Fundamentals of ferroelectric and piezoelectric properties  $\text{HfO}_2$  processes and the impact of dopants on ferroelectric properties are extensively discussed along with phase transition switching kinetics epitaxial growth thickness scaling and more Additional chapters consider the modeling of ferroelectric phase transformation structural characterization and the differences and similarities between  $\text{HfO}_2$  and standard ferroelectric materials Finally  $\text{HfO}_2$  based devices are summarized The new edition extends the first edition in the following areas Detailed discussion of the causes and dependencies for ferroelectric properties Broader coverage of all known deposition techniques Comparison of



ferroelectric with antiferroelectric piezoelectric and pyroelectric properties More aspects on switching and field cycling behavior Wider overview of simulation results Further applications of new HfO<sub>2</sub> based materials for energy storage and pyroelectric piezoelectric and neuromorphic applications Explores all aspects of the structural and electrical properties of HfO<sub>2</sub> including processes modeling and implementation into semiconductor devices Considers potential applications including FeCaps FeFETs FTJs energy storage pyroelectric piezoelectric and neuromorphic applications Provides a comparison of an emerging ferroelectric material to conventional ferroelectric materials with insights into the problems of downscaling that conventional ferroelectrics face

**Ferroelectric Materials for Energy Harvesting and Storage**

Deepam Maurya, Abhijit Pramanick, Dwight Viehland, 2020-10-14 The need to more efficiently harvest energy for electronics has spurred investigation into materials that can harvest energy from locally abundant sources Ferroelectric Materials for Energy Harvesting and Storage is the first book to bring together fundamental mechanisms for harvesting various abundant energy sources using ferroelectric and piezoelectric materials The authors discuss strategies of designing materials for efficiently harvesting energy sources like solar wind wave temperature fluctuations mechanical vibrations biomechanical motion and stray magnetic fields In addition concepts of the high density energy storage using ferroelectric materials is explored Ferroelectric Materials for Energy Harvesting and Storage is appropriate for those working in materials science and engineering physics chemistry and electrical engineering disciplines Reviews wide range of energy harvesting including solar wind biomechanical and more Discusses ferroelectric materials and their application to high energy density capacitors Includes review of fundamental mechanisms of energy harvesting and energy solutions their design and current applications and future trends and challenges

*Atomic-Scale Electronics Beyond CMOS* Mircea Dragoman, Daniela

Dragoman, 2020-11-16 This book explores emerging topics in atomic and nano scale electronics after the era of Moore's Law covering both the physical principles behind and technological implementations for many devices that are now expected to become key elements of the future of nanoelectronics beyond traditional complementary metal oxide semiconductors CMOS Moore's law is not a physical law itself but rather a visionary prediction that has worked well for more than 50 years but is rapidly coming to its end as the gate length of CMOS transistors approaches the length scale of only a few atoms Thus the key question here is What is the future for nanoelectronics beyond CMOS The possible answers are found in this book Introducing novel quantum devices such as atomic scale electronic devices ballistic devices memristors superconducting devices this book also presents the reader with the physical principles underlying new ways of computing as well as their practical implementation Topics such as quantum computing neuromorphic computing are highlighted here as some of the most promising candidates for ushering in a new era of atomic scale electronics beyond CMOS

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aujourd'hui il est commun de voir des tapis tissés à la fois en turquie ou en iran utilisant l'un ou l'autre des styles quand on compare des tapis la seule façon d'identifier le type de nœud utilisé est de plier le tapis contre lui-même et de regarder la base du nœud

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