Download Ebook Electromechanical Properties In Composites Based On Ferroelectrics Engineering Materials And Processes Read Pdf Free

Electromechanical Properties in Composites Based on Ferroelectrics Electrical Characterisation of Ferroelectric Field Effect Transistors based on Ferroelectric HfO2 Thin Films Electromechanical Properties in Composites Based on Ferroelectrics Ferroelectric Materials for Energy Harvesting and Storage Layered Materials for Energy Storage and Conversion Novel Devices Based on Relaxor Ferroelectric PMN-PT Single Crystals Development of HfO2-Based Ferroelectric Memories for Future CMOS Technology Nodes Formation of Ferroelectricity in Hafnium Oxide Based Thin Films Negative Capacitance in Ferroelectric Materials Handbook of Dielectric, Piezoelectric and Ferroelectric Materials Ferroelectric Materials for Energy Applications Logic Based Program Synthesis and Transformation Handbook of Advanced Dielectric, Piezoelectric and Ferroelectric Materials Ferroelectrics Explosive Ferroelectric Generators: From Physical Principles To Engineering Nanoscale Characterisation of Ferroelectric Materials Heterogeneous Ferroelectric Solid Solutions Ferroelectrics in Microwave Devices, Circuits and Systems Multifunctional Supramolecular Organic Ferroelectrics Heterogeneous Ferroelectric Solid Solutions Ferroelectric Materials Ferroelectrics Ferroelectrics Advances in Ferroelectrics Multifunctional Ferroelectric Materials Nanostructures in Ferroelectric Films for Energy Applications Piezo-Particulate Composites Ferroelectric Dielectrics Integrated on Silicon Magnetic, Ferroelectric, and Multiferroic Metal Oxides Metal Oxides for Non-volatile Memory Synthesis and Characterization of Ferroelectrics Ferroelectric-Gate Field Effect Transistor Memories Nanoscale Ferroelectrics and Multiferroics Ferroelectric Thin Films Multifunctional Polycrystalline Ferroelectric Materials Superatoms Electroceramic-Based MEMS Ferroelectricity in Doped Hafnium Oxide Ferroelectric Domain Walls Ferroelectric Semiconductors

Negative Capacitance in Ferroelectric Materials Feb 25 2022 This dissertation investigates the phenomenon of negative capacitance in ferroelectric materials, which is promising for overcoming the fundamental limits of energy efficiency in electronics. The focus of this dissertation is on negative capacitance in hafnium oxide based ferroelectrics and the impact of ferroelectric domain formation.

Electromechanical Properties in Composites Based on Ferroelectrics Sep 03 2022 "Electromechanical Properties in Composites Based on Ferroelectrics" investigates the problem of prediction and non-monotonicity of the effective electromechanical (piezoelectric, dielectric and elastic) properties in two- and three-component composites based on ferroelectric ceramics and relaxor-ferroelectric single crystals. The book analyzes the interrelations between the electromechanical constants of the components, and describes the different analytical schemes for averaging the properties of these materials with different connectivity and microgeometrical characteristics. The book highlights the advantages of different methods for predicting the electromechanical properties and choosing the optimum components, and demonstrates the non-trivial behavior of specific composite architectures and the parameters of value for engineering applications. The book is of benefit to all specialists looking to understand the detailed behavior and electromechanical response of advanced composite materials.

Ferroelectric Thin Films Jan 03 2020 Ferroelectric thin films continue to attract much attention due to their developing applications in memory devices, FeRAM, infrared sensors, piezoelectric sensors and actuators. This book, aimed at students, researchers and developers, gives detailed information about the basic properties of these materials and the associated device physics. The contributing authors are acknowledged experts in the field.

Metal Oxides for Non-volatile Memory May 07 2020 Metal Oxides for Non-volatile Memory: Materials, Technology and Applications covers the technology and applications of metal oxides (MOx) in non-volatile memory (NVM) technology. The book addresses all types of NVMs, including floating-gate memories, 3-D memories, charge-trapping memories, quantum-dot memories, resistance switching memories and memristors, Mott memories and transparent memories. Applications of MOx in DRAM technology where they play a crucial role to the DRAM evolution are also addressed. The book offers a broad scope, encompassing discussions of materials properties, deposition methods, design and fabrication, and circuit and system level applications of metal oxides to non-volatile memory. Finally, the book addresses one of the most promising materials that may lead to a solution to the challenges in chip size and capacity for memory technologies, particular for mobile applications and embedded systems. Systematically covers metal oxides materials and their properties with memory technology applications, including floating-gate memory, 3-D memory, memristors, and much more Provides an overview on the most relevant deposition methods, including sputtering, CVD, ALD and MBE Discusses the design and fabrication of metal oxides for wide breadth of non-volatile memory applications from 3-D flash technology, transparent memory and DRAM technology

Ferroelectric Semiconductors Jun 27 2019

Electromechanical Properties in Composites Based on Ferroelectrics Nov 05 2022 "Electromechanical Properties in Composites Based on Ferroelectrics" investigates the problem of prediction and non-monotonicity of the effective electromechanical (piezoelectric, dielectric and elastic) properties in two- and three-component composites based on ferroelectric ceramics and relaxor-ferroelectric single crystals. The book analyzes the interrelations between the electromechanical constants of the components, and describes the different analytical schemes for averaging the properties of these materials with different connectivity and microgeometrical characteristics. The book highlights the advantages of different methods for predicting the electromechanical properties and choosing the optimum components, and demonstrates the non-trivial behavior of specific composite architectures and the parameters of value for engineering applications. The book is of benefit to all specialists looking to understand the detailed behavior and electromechanical response of advanced composite materials.

Ferroelectrics Sep 22 2021 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 characterization of ferroelectric materials, including structural, electrical and multiphysic aspects, as well as innovative techniques for modeling and predicting the performance of these devices using phenomenological approaches and nonlinear methods. Hence, 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 system characterization and modeling, allowing a deep understanding of ferroelectricity.

Multifunctional Ferroelectric Materials Oct 12 2020 Ferroelectricity is a well-known phenomenon commonly used in scientific and industrial communities. Ferroelectric materials are the building blocks of different devices and technological innovations. This book presents an overview of the basic phenomenon of ferroelectricity and different ferroelectrics and ferroelectric devices, including their theoretical study, synthesis, characterization, and application. Chapters cover such topics as the basics of ferroelectricity, perovskite ferroelectrics and relaxor ferroelectrics, piezoelectricity, and more.

Ferroelectrics Dec 14 2020 Combining both fundamental principles and real-life applications in a single volume, this book discusses the latest research results in ferroelectrics, including many new ferroelectric materials for the latest technologies, such as capacitors, transducers and memories. The first two chapters introduce dielectrics and microscopic materials properties, while the following chapter discusses pyroelectricity and piezoelectricity. The larger part of the text is devoted to ferroelectricity and ferroelectric ceramics, with not only their fundamentals but also applications discussed. The book concludes with a look at the future for laser printed materials and applications. With over 600 references to recent publications on piezoelectric and ferroelectric materials, this is an invaluable reference for physicists, materials scientists and engineers.

Ferroelectrics in Microwave Devices, Circuits and Systems May 19 2021 Today's wireless communications and information systems are heavily based on microwave technology. Current trends indicate that in the future along with - crowaves, the millimeter wave and Terahertz technologies will be used to meet the growing bandwidth and overall performance requirements. Moreover, motivated by the needs of the society, new industry sectors are gaining ground; such as wi- less sensor networks, safety and security systems, automotive, medical, envir- mental/food monitoring, radio tags etc. Furthermore, the progress and the pr- lems in the modern society indicate that in the future these systems have to be more user/consumer friendly, i. e. adaptable, reconfigurable and cost effective. The mobile phone is a typical example which today is much more than just a phone; it includes a range of new functionalities such as Internet, GPS, TV, etc. To handle, in a cost effective way, all available and new future standards, the growing n- ber of the channels and bandwidth both the mobile handsets and the associated systems have to be agile (adaptable/reconfigurable). The complex societal needs have initiated considerable activities in the field of cognitive and software defined radios and triggered extensive research in adequate components and technology platforms. To meet the stringent requirements of these systems, especially in ag- ity and cost, new components with enhanced performances and new functionalities are needed. In this sense the components based on ferroelectrics have greater - tential and already are gaining ground.

Magnetic, Ferroelectric, and Multiferroic Metal Oxides Jun 07 2020 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

Novel Devices Based on Relaxor Ferroelectric PMN-PT Single Crystals May 31 2022 This book explores the applications of ferroelectric materials in information technology by developing several prototype devices based on Pb(Mg1/3Nb2/3)O3-PbTiO3 (PMN-PT) single crystals. It describes how an optothermal field-effect transistor (FET) was constructed on the PMN-26PT single crystal, using a MoS2 monolayer as the channel semiconductor material. This fusion of pyroelectric effect and the interface engineering of 2D materials provides an effective strategy for the 'photon revolution' of FET. An ultra-broadband photodetector (UV ~ THz) was monolithically integrated into a [111]-oriented PMN-28PT single crystal by using silver nanowires in the transparent top electrode. The photodetector showed a dramatic improvement in operation frequency up to 3 kHz: an order of magnitude higher than that of traditional pyroelectric photodetectors. A self-powered integrated module was demonstrated through the combination of a triboelectric nanogenerator and a ferroelectric FET. The stored information can easily be written in the memory system using mechanical energy, solving the power consumption problem with regard to information writing in ferroelectric nonvolatile memories. This book extends the applications of ferroelectric single crystals into areas other than piezoelectric devices, paving the way for exciting future developments.

Heterogeneous Ferroelectric Solid Solutions Mar 17 2021 The book deals with perovskite-type ferroelectric solid solutions for modern materials science and applications, solving problems of complicated heterophase/domain structures near the morphotropic phase boundary and applications to various systems with morphotropic phases. In this book domain state–interface diagrams are presented for the interpretation of heterophase states in perovskite-type ferroelectric solid solutions. It allows to describe the stress relief in the presence of polydomain phases, the behavior of unit-cell parameters of coexisting phases and the effect of external electric fields. The novelty of the book consists in (i) the first systematization of data about heterophase states and their evolution in ferroelectric solid solutions (ii) the general interpretation of heterophase and domain structures at changing temperature, composition or electric field (iii) the complete analysis of interconnection domain structures, unit-cell parameters changes, heterophase structures and stress relief.

Heterogeneous Ferroelectric Solid Solutions Jun 19 2021 This book systematizes data on the heterophase states and their evolution in perovskite-type ferroelectric solid solutions. It also provides a general interpretation of heterophase and domain structures on changing temperature, composition or electric field, as well as the complete analysis of interconnections domain structures, unit-cell parameters changes, heterophase structures and stress relief. The description of numerous examples of heterophase states in lead-free ferroelectric solid solutions is also included. Domain state–interface diagrams contribute to the interpretation of heterophase states in perovskite-type ferroelectric solid solutions and describe the stress relief in the presence of polydomain phases, the behavior of unit-cell parameters of coexisting phases, the effect of external electric field etc. This 2nd edition generalizes the results on the heterophase ferroelectric solid solutions and the stress relief and presents new results on heterophase/domain structures and phase contents in lead-free ferroelectric solid solutions.

Handbook of Advanced Dielectric, Piezoelectric and Ferroelectric Materials Oct 24 2021 This comprehensive book covers recent developments in advanced dielectric, piezoelectric and ferroelectric materials. Dielectric materials such as ceramics are used to manufacture microelectronic devices. Piezoelectric components have been used for many years in radioelectrics, time-keeping and, more recently, in microprocessor-based devices. Ferroelectric materials are widely used in various devices such as piezoelectric/electrostrictive transducers and actuators, pyroelectric infrared detectors, optical integrated circuits, optical data storage and display devices. The book is divided into eight parts under the general headings: High strain high performance piezo- and ferroelectric single crystals; Electric field-induced effects and domain engineering; Morphotropic phase boundary related phenomena; High power piezoelectric and microwave dielectric materials; Nanoscale piezo- and ferroelectrics; Piezo- and ferroelectric films; Novel processing and new materials; Novel properties of ferroelectrics and related materials. Each chapter looks at key recent research on these materials, their properties and potential applications. Advanced dielectric, piezoelectric and ferroelectric materials is an important reference tool for all those working in the area of electrical and electronic materials in general and dielectrics, piezoelectrics and ferroelectrics in particular. Covers the latest developments in advanced dielectric, piezoelectric and ferroelectric materials Includes topics such as high strain high performance piezo and ferroelectric single crystals Discusses novel processing and new materials, and novel properties of ferroelectrics and related materials

Logic Based Program Synthesis and Transformation Nov 24 2021 This book presents recent advances in the field of nanoscale characterization of ferroelectric materials using scanning probe microscopy (SPM). It addresses various imaging mechanisms of ferroelectric domains in SPM, quantitative analysis of the piezoresponse signals as well as basic physics of ferroelectrics at the nanoscale level, such as nanoscale switching, scaling effects, and transport behavior. This state-of-the-art review of theory and experiments on nanoscale polarization phenomena will be a useful reference for advanced readers as well for newcomers and graduate students interested in the SPM techniques. The non-specialists will obtain valuable information about different approaches to electrical characterization by SPM, while researchers in the ferroelectric field will be provided with details of SPM-based measurements of ferroelectrics.

Layered Materials for Energy Storage and Conversion Jul 01 2022 The considerable interest in graphene and 2D materials is sparking intense research on layered materials due to their unexpected physical, electronic, chemical, and optical properties. This book will provide a comprehensive overview of the recent and state-of-the-art research progress on layered materials for energy storage and other applications. With a brief introduction to layered materials, the chapters of this book gather various fascinating topics such as electrocatalysis for fuel cells, lithium-ion batteries, sodium-ion batteries, photovoltaic devices, thermoelectric devices, supercapacitors and water splitting. Unique aspects of layered materials in these fields, including novel synthesis and functionalization methods, particular physicochemical properties and consequently enhanced performance are addressed. Challenges and perspectives for layered materials in these fields will also be presented. With contributions from key researchers, Layered Materials for Energy Storage and Conversion will be of interest to students, researchers and engineers worldwide who want a basic overview of the latest progress and future directions.

Nanoscale Characterisation of Ferroelectric Materials Jul 21 2021 This book presents recent advances in the field of nanoscale characterization of ferroelectric materials using scanning probe microscopy (SPM). It addresses various imaging mechanisms of ferroelectric domains in SPM, quantitative analysis of the piezoresponse signals as well as basic physics of ferroelectrics at the nanoscale level, such as nanoscale switching, scaling effects, and transport behavior. This state-of-the-art review of theory and experiments on nanoscale polarization phenomena will be a useful reference for advanced readers as well for newcomers and graduate students interested in the SPM techniques. The non-specialists will obtain valuable information about different approaches to electrical characterization by SPM, while researchers in the ferroelectric field will be provided with details of SPM-based measurements of ferroelectrics.

Synthesis and Characterization of Ferroelectrics Apr 05 2020 The Special Issue on "Synthesis and Characterization of Ferroelectrics" reports on several physical properties of ferroelectric materials and their technological aspects. Different substitution mechanisms provide ideas toward future improvement of lead-free (Ba,Ca)(Zr,Ti)O3 piezoelectric ceramics, including the electrocaloric effect, fluorescence, and energy storage. It is established that axial and radial element segregation differently influences electrical properties of 0.68Pb(Mg1/3Nb2/3)0.32PbTiO3 (PMN-32PT for short) single crystals. While the electrical properties along the axial direction strongly depend on the PbTiO3 content, the electrical properties along the axial direction are mainly determined by the ratio of Nb and Mg. On the other hand, Fe-substitution of PMN-32PT crystals lead to an enhancement of the coercive field due to wall pinning induced by charged defect dipoles. It is also found, that capacitors based on Pt/Na0.5Bi0.5TiO3/La0.5Sr0.5CoO3 thin films display good fatigue resistance and retention. Another lead-free thin film capacitor fabricated from Ba0.3Sr0.7Zr0.18Ti0.82 features a low leakage current density and high breakdown strength. Such capacitors are essential for energy storage. Furthermore, an enhanced electrocaloric effect on 0.73Pb(Mg1/3Nb2/3)0.27PbTiO3 single crystals is demonstrated. This effect is promising for novel solid-state cooling systems.

Formation of Ferroelectricity in Hafnium Oxide Based Thin Films Mar 29 2022 In 2011, Böscke 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.

Nanoscale Ferroelectrics and Multiferroics Feb 02 2020 This two volume set reviews the key issues in processing and characterization of nanoscale ferroelectrics and multiferroics, and provides a comprehensive description of their properties, with an emphasis in differentiating size effects of extrinsic ones like boundary or interface effects. Recently described nanoscale novel phenomena are also addressed. Organized into three parts it

addresses key issues in processing (nanostructuring), characterization (of the nanostructured materials) and nanoscale effects. Taking full advantage of the synergies between nanoscale ferroelectrics and multiferroics, the text covers materials nanostructured at all levels, from ceramic technologies like ferroelectric nanopowders, bulk nanostructured ceramics and thick films, and magnetoelectric nanocomposites, to thin films, either polycrystalline layer heterostructures or epitaxial systems, and to nanoscale free standing objects with specific geometries, such as nanowires and tubes at different levels of development. This set is developed from the high level European scientific knowledge platform built within the COST (European Cooperation in Science and Technology) Action on Single and multiphase ferroics and multiferroics with restricted geometries (SIMUFER, ref. MP0904). Chapter contributors have been carefully selected, and have all made major contributions to knowledge of the respective topics, and overall, they are among most respected scientists in the field.

Piezo-Particulate Composites Aug 10 2020 This book provides an overview of the current state of the art in novel piezo-composites based on ferroelectrics. Covering aspects ranging from theoretical materials simulation and manufacturing and characterization methods, to the application and performance of these materials, it focuses on the optimization of the material parameters. Presenting the latest findings on modern composites and highlighting the applications of piezoelectric materials for sensors, transducers and hydro-acoustics, the book addresses an important gap in the physics of active dielectrics and materials science and describes new trends in the research on ferroelectric composites.

Ferroelectricity in Doped Hafnium Oxide Aug 29 2019 Ferroelectricity in Doped Hafnium Oxide: Materials, Properties and Devices covers all aspects relating to the structural and electrical properties of HfO2 and its implementation into semiconductor devices, including a comparison to standard ferroelectric materials. The ferroelectric and field-induced ferroelectric properties of HfO2-based films are considered promising for various applications, including non-volatile memories, negative capacitance field-effect-transistors, energy storage, harvesting, and solid-state cooling. Fundamentals of ferroelectric and piezoelectric properties, HfO2 processes, and the impact of dopants on ferroelectric properties are also extensively discussed in the book, 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 HFO2 and standard ferroelectric materials. Finally, HfO2 based devices are summarized. Explores all aspects of the structural and electrical properties of HfO2, including processes, modelling and implementation into semiconductor devices Considers potential applications including FeCaps, FeFETs, NCFETs, FTJs and more Provides comparison of an emerging ferroelectric material to conventional ferroelectric materials with insights to the problems of downscaling that conventional ferroelectrics face

Ferroelectric Domain Walls Jul 29 2019 Using the nano metric resolution of atomic force microscopy techniques, this work explores the rich fundamental physics and novel functionalities of domain walls in ferroelectric materials, the nano scale interfaces separating regions of differently oriented spontaneous polarization. Due to the local symmetry-breaking caused by the change in polarization, domain walls are found to possess an unexpected lateral piezoelectric response, even when this is symmetry-forbidden in the parent material. This has interesting potential applications in electromechanical devices based on ferroelectric domain patterning. Moreover, electrical conduction is shown to arise at domain walls in otherwise insulating lead zirconate titanate, the first such observation outside of multiferroic bismuth ferrite, due to the tendency of the walls to localize defects. The role of defects is then explored in the theoretical framework of disordered elastic interfaces possessing a characteristic roughness scaling and complex dynamic response. It is shown that the heterogeneous disorder landscape in ferroelectric thin films leads to a breakdown of the usual self-affine roughness, possibly related to strong pinning at individual defects. Finally, the roles of varying environmental conditions and defect densities in domain switching are explored and shown to be adequately modelled as a competition between screening effects and pinning.

Electrical Characterisation of Ferroelectric Field Effect Transistors based on Ferroelectric HfO2 Thin Films Oct 04 2022 Ferroelectric field effect transistor (FeFET) memories based on a new type of ferroelectric material (silicon doped hafnium oxide) were studied within the scope of the present work. Utilisation of silicon doped hafnium oxide (Si:HfO2 thin films instead of conventional perovskite ferroelectrics as a functional layer in FeFETs provides compatibility to the CMOS process as well as improved device scalability. The influence of different process parameters on the properties of Si:HfO2 thin films was analysed in order to gain better insight into the occurrence of ferroelectricity in this system. A subsequent examination of the potential of this material as well as its possible limitations with the respect to the application in non-volatile memories followed. The Si:HfO2-based ferroelectric transistors that were fully integrated into the state-of-the-art high-k metal gate CMOS technology were studied in this work for the first time. The memory performance of these devices scaled down to 28 nm gate length was investigated. Special attention was paid to the charge trapping phenomenon shown to significantly affect the device behaviour.

Advances in Ferroelectrics Nov 12 2020 Ferroelectricity is one of the most studied phenomena in the scientific community due the importance of ferroelectric materials in a wide range of applications including high dielectric constant capacitors, pyroelectric devices, transducers for medical diagnostic, piezoelectric sonars, electrooptic light valves, electromechanical transducers and ferroelectric random access memories. Actually the ferroelectricity at nanoscale receives a great attention to the development of new technologies. The demand for ferroelectric systems with specific applications enforced the in-depth research in addition to the improvement of processing and characterization techniques. This book contains twenty two chapters and offers an up-to-date view of recent research into ferroelectricity. The chapters cover various formulations, their forms (bulk, thin films, ferroelectric liquid crystals), fabrication, properties, theoretical topics and ferroelectricity at nanoscale.

Ferroelectric Materials for Energy Applications Dec 26 2021 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.

Ferroelectric Materials for Energy Harvesting and Storage Aug 02 2022 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

Multifunctional Polycrystalline Ferroelectric Materials Dec 02 2019 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 (ICMM-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.

Ferroelectric Dielectrics Integrated on Silicon Jul 09 2020 This book describes up-to-date technology applied to high-Kmaterials for More Than Moore applications, i.e. microsystemsapplied to microelectronics core technologies. After detailing the basic thermodynamic theory applied to high-Kdielectrics thin films including extrinsic effects, this bookemphasizes the specificity of thin films. Deposition and patterningtechnologies are then presented. A whole chapter is dedicated tothe major role played in the field by X-Ray Diffractioncharacterization, and other characterization techniques are alsodescribed such as Radio frequency characterization. An in-depthstudy of the influence of leakage currents is performed togetherwith reliability discussion. Three applicative chapters coverintegrated capacitors, variables capacitors and ferroelectricmemories. The final chapter deals with a reasonably new researchfield, multiferroic thin films.

Multifunctional Supramolecular Organic Ferroelectrics Apr 17 2021 Ferroelectric materials are known and valued for their multifunctionality arising from the possibility to perturb the remnant ferroelectric polarization by electric field, temperature and/or mechanical stimuli. While

inorganic ferroelectrics dominate the current market, their organic counterparts may provide highly desired properties like eco-friendliness, easy processability and flexibility, concomitantly opening unique opportunities to combine multiple functionalities into a single compound that facilitates unprecedented device concepts and designs. Supramolecular organic ferroelectrics of columnar discotic type, that are the topic of this thesis, offer additional advantages related to their strong hierarchical self-assembly and easy tunability by molecular structure modifications, allowing optimization of ferroelectric characteristics and their hybridization with, e.g., semiconductivity. This not only leads to textbook ferroelectric materials that can be used as model systems to understand the general behaviour of ferroics, but also gives rise to previously unobserved effects stemming from the interplay of different functionalities. The core-shell structure of the molecules under the scope enables multiple pathways forrational design by molecular structure modification. This was firstly pursued via peripheral tail engineering on an archetypal self-assembling ferroelectric trialkylbenzene-1,3,5-tricarboxamide (BTA). We found that by shortening the alkyl chain length all the ferroelectric properties can be continuously tuned. In particular, changing the tail from C18H37 to C6H13causes an increase in depolarization activation energy (~0.8 eV to ~1.55 eV), coercive field(~25 V/?m to ~50 V/?m) and remnant polarization (~20 mC/m2 to ~60 mC/m2). The combination of the mentioned characteristics resulted in a record polarization retention time of close to 3 months at room temperature for capacitor devices of the material having the shortest alkyl chain – BTA-C6, which at the time of writing was one of the best results for liquid-crystalline ferroelectrics. Taking one step further, we experimentally demonstrated how introduction of branched-tailsubstituents results in materials with a wide operating temperature range and a data retention time of more than 10 years in thin-film solution-processed capacitor devices already atelevated temperatures with no measurable depolarization at room temperature. The observed differences between linear- and branched-tail compounds were analysed using density functional theory (DFT) and molecular dynamics (MD) simulations. We concluded that morphological factors like improved packing quality and reduced disorder, rather than electrostatic interactions or intra/inter-columnar steric hindrance, underlay the superior properties of the branched-tailed BTAs. Synergistic effects upon blending of compounds with branched and linear sidechains were shown to further improve the materials' characteristics. Exploiting the excellent ferroelectric performance and the well-defined nanostructure of BTAs, we experimentally determined the Preisach (hysteron) distribution of BTA and confronted it to the one obtained for the semi-crystalline P(VDF:TrFE). This allowed to elucidate how the broadening of the Preisach distribution relates to the materials' morphology. We further connected the experimental Preisach distribution to the corresponding microscopic switching kinetics. We argue that the combination of the two underlays the macroscopic dispersive switching kinetics as commonly observed for practical ferroelectrics. These insights lead to guidelines for further advancement of ferroelectric materials both for conventional and multi-bit data storage applications. Although having strong differences in the Preisach distribution, BTA and P(VDF:TrFE) both demonstrate negative piezoelectricity – a rare anomalous phenomenon which is characteristic to two-phased materials and has never been observed in small-molecular ferroelectrics. We measured a pronounced negative piezoelectric effect in a whole family of BTAs and revealed its tunability by mesogenic tail substitution and structural disorder. While the large- and small-signal strain in highly ordered thin-film BTA capacitor devices are dominated by intrinsic contributions and originates from piezostriction, rising disorder introduces additional extrinsic factors that boost the large-signal d33 up to ?20 pm/V in short-tailed molecules. Interestingly, homologues with longer mesogenic tails show a large-signal electromechanical response that is dominated by the quadratic Maxwell strain with significant mechanical softening upon polarization switching, whereas the small-signal strain remains piezostrictive. Molecular dynamics and DFT calculations both predict a positive d33 for defect-free BTA stacks. Hence, the measured negative macroscopic d33 is attributed to the presence of structural defects that enable the dimensional effect to dominate the piezoelectric response of BTA thin films. The true multifunctionality of supramolecular discotics manifests when large semiconducting cores surrounded by field-switchable strongly polar moieties are introduced in the structure. We showed how the combination of switchable dipolar side groups and the semiconducting core of the newly synthetized C3-symmetric benzotristhiophene molecule (BTTTA) leads to an ordered columnar material showing continuous tunability from injection- to bulk-limited conductivity modulation. Both these resistive switching mechanisms may lead to the next-generation high-density non-volatile rewritable memory devices with high on/off ratios and non-destructive data readout – the element that has been desperately sought after to enablefully organic flexible electronics. Utbredd elektronisering och det högst aktuella fenomenet sakernas internet (Internet of Things) ställer höga krav på nästa generations elektroniska system. Produkterna ska vara lätta att framställa med miljövänliga metoder, låg kostnadsproduktion och skalbarhet (t. ex. tryckt elektronik), återvinningsbarhet eller biologisk nedbrytbarhet (gällande engångselektronik), mekanisk flexibilitet (formbara bärbara system), kemisk stabilitet, till och med biokompatibilitet (t. ex. implanterbara system) – dessa är bara några utmaningar som den kommande tekniken behöver övervinna. Organiska material kan åstadkomma alla dessa önskade egenskaper, samtidigt som man skapar unika möjligheter att kombinera flera funktionaliteter till en enda sammansättning som underlättar nydanande komponenter och design. Ferroelektriska material kännetecknas av pyroelektriska, piezoelektriska och dielektriska egenskaper. Denna mångsidighet möjliggör icke-flyktiga minnesenheter, temperatur- och taktila sensorer, olika transduktorer och manöverdon, som alla baseras på förändringar av den ferroelektriska restpolarisationen genom fält-, temperatur- och / eller mekaniska stimuleringar. Diskformade supramolekylära organiska ferroelektriska ämnen ger ytterligare fördelar tack vare deras modifierbara molekylstrukturer och starka hierarkiska självorganisation som staplar diskarna i kolumner. På detta sätt kan lättbearbetningsbara organiska ferroelektriska material med hög restpolarisering och extrem datalagring konstrueras molekylärt. På grund av deras väldefinierade nanostrukturer kan sådana material användas som modellsystem för att förstå det allmänna beteendet hos polykristallina ferroelektriska material. De uppvisar också ensällsynt negativ piezoelektricitet som är atypisk för små molekylära material och härrör från deras komplexa nanostruktur. Den verkliga multifunktionaliteten hos diskformade supramolekylära ämnen framträder när stora halvledande kärnor omgivna av starkt polära delar, som är växlingsbara via ett elektriskt fält, introduceras i strukturen. Oöverträffad resistiv omkoppling, inducerad av den asymmetriska laddningstransporten beroende på polarisationsriktningen med rekordhög datalagringstid, upptäcktes efter optimering av molekylstrukturen. Även en konceptuellt enklare resistiv omkopplingsmekanism bunden till en modulation av laddningsinjektionsbarriären genom gränssnittsdipolerna observerades. Båda dessa fenomen kan bidra till nästa generations icke-flyktiga överskrivningsbara minnesenheter med högdensitet, stora på av-förhållanden, och icke-destruktiv dataavläsning – vilket är kritiskt för att möjliggöra helt organisk flexibel elektronik.

***Development of HfO2-Based Ferroelectric Memories for Future CMOS Technology Nodes** Apr 29 2022 This thesis evaluates the viability of ferroelectric Si:HfO2 and its derived FeFET application for non-volatile data storage. At the beginning, the ferroelectric effect is explained briefly such that the applications that make use of it can be understood. Afterwards, the latest findings on ferroelectric HfO2 are reviewed and their potential impact on future applications is discussed. Experimental data is presented afterwards focusing on the ferroelectric material characteristics of Si:HfO2 that are most relevant for memory applications. Besides others, the stability of the ferroelectric switching effect could be demonstrated in a temperature range of almost 400 K. Moreover, nanosecond switching speed and endurance in the range of 1 million to 10 billion cycles could be proven. Retention and imprint characteristics have furthermore been analyzed and are shown to be stable for 1000 hours bake time at 125 oC. Derived from the ferroelectric effect in HfO2, a 28 nm FeFET memory cell is introduced as the central application of this thesis. Based on numerical simulations, the memory concept is explained and possible routes towards an optimized FeFET cell are discussed. Subsequently, the results from electrical characterization of FeFET multi-structures are presented and discussed. By using Si:HfO2 it was possible to realize the world's first 28 nm FeFET devices possessing i.a. 10k cycling endurance and an extrapolated 10 year data retention at room temperature. The next step towards a FeFET memory is represented by connecting several memory cells into matrix-type configurations. A cell concept study illustrates the different ways in which FeFET cells can be combined together to give high density memory arrays. For the proposed architectures, operational schemes are theoretically discussed and analyzed by both electrical characterization of FeFET multi-structures and numerical simulations. The thesis concludes with the electrical characterization of small FeFET memory arrays. First results show that a separation between memory states can be achieved by applying poling and incremental step pulse programming (ISPP) sequences. These results represent an important cornerstone for future studies on Si:HfO2 and its related applications.*

***Nanostructures in Ferroelectric Films for Energy Applications** Sep 10 2020 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. Provides the necessary components for the systematic study of the structure-property relationship in ferroelectric thin film materials using case studies in energy applications Written by leading experts in the research areas of piezoelectrics, electrocalorics, ferroelectric dielectrics (especially in capacitive energy storage), ferroelectric domains, and ferroelectric-Si technology Includes a well balanced mix of theoretical design and simulation, materials processing and integration, and dedicated characterization methods of the involved nanostructures*

***Ferroelectric Materials** Feb 13 2021 Ferroelectric materials receive great attention from the scientific international community because of the interesting phenomena they exhibit and their multiple applications such as transducers, capacitors, pyroelectric sensors, sonars, random access memories, etc. The demand for ferroelectric materials for technological applications enforced the in-depth research, in addition to the improvement of processing and characterization techniques. This book contains nine chapters and offers the results of several researches covering fabrication, properties, theoretical topics, and phenomena at the nanoscale.*

***Ferroelectric-Gate Field Effect Transistor Memories** Mar 05 2020 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.

Ferroelectrics Jan 15 2021 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.

Handbook of Dielectric, Piezoelectric and Ferroelectric Materials Jan 27 2022 This comprehensive volume covers the latest developments in advanced dielectric, piezoelectric, and ferroelectric materials. Divided into eight parts, it explores high strain high performance piezo- and ferroelectric single crystals, electric field-induced effects and domain engineering, morphotropic phase boundary-related phenomena, high power piezoelectric and microwave dielectric materials, nanoscale piezo- and ferroelectrics, piezo- and ferroelectric films, novel processing and materials, and novel properties of ferroelectrics and related materials. Each chapter looks at key recent research on these materials, their properties, and potential applications.

Electroceramic-Based MEMS Sep 30 2019 The book is focused on the use of functional oxide and nitride films to enlarge the application range of MEMS (microelectromechanical systems), including micro-sensors, micro-actuators, transducers, and electronic components for microwaves and optical communications systems. Applications, emerging applications, fabrication technology and functioning issues are presented and discussed. The book covers the following topics: Part A: Applications and devices with electroceramic-based MEMS: Chemical microsensors Microactuators based on thin films Micromachined ultrasonic transducers Thick-film piezoelectric and magnetostrictive devices Pyroelectric microsystems RF bulk acoustic wave resonators and filters High frequency tunable devices MEMS for optical functionality Part B: Materials, fabrication technology, and functionality: Ceramic thick films for MEMS Piezoelectric thin films for MEMS Materials and technology in thin films for tunable high frequency devices Permittivity, tunability and loss in ferroelectrics for reconfigurable high frequency electronics Microfabrication of piezoelectric MEMS Nano patterning methods for electroceramics Soft lithography emerging techniques The book is addressed to engineers, scientists and researchers of various disciplines, device engineers, materials engineers, chemists, physicists and microtechnologists who are working and/or interested in this fast growing and highly promising field. The publication of this book follows a Special Issue on electroceramic-based MEMS that was published in the Journal of Electroceramics at the beginning of 2004. The ten invited papers of that special issue were adapted by the authors into chapters of the present book and five additional chapters were added.

Superatoms Oct 31 2019 Explore the theory and applications of superatomic clusters and cluster assembled materials Superatoms: Principles, Synthesis and Applications delivers an insightful and exciting exploration of an emerging subfield in cluster science, superatomic clusters and cluster assembled materials. The book presents discussions of the fundamentals of superatom chemistry and their application in catalysis, energy, materials science, and biomedical sciences. Readers will discover the foundational significance of superatoms in science and technology and learn how they can serve as the building blocks of tailored materials, promising to usher in a new era in materials science. The book covers topics as varied as the thermal and thermoelectric properties of cluster-based materials and clusters for CO2 activation and conversion, before concluding with an incisive discussion of trends and directions likely to dominate the subject of superatoms in the coming years. Readers will also benefit from the inclusion of: A thorough introduction to the rational design of superatoms using electron-counting rules Explorations of superhalogens, endohedrally doped superatoms and assemblies, and magnetic superatoms A practical discussion of atomically precise synthesis of chemically modified superatoms A concise treatment of superatoms as the building blocks of 2D materials, as well as superatom-based ferroelectrics and cluster-based materials for energy harvesting and storage Perfect for academic researchers and industrial scientists working in cluster science, energy materials, thermoelectrics, 2D materials, and CO2 conversion, Superatoms: Principles, Synthesis and Applications will also earn a place in the libraries of interested professionals in chemistry, physics, materials science, and nanoscience.

Explosive Ferroelectric Generators: From Physical Principles To Engineering Aug 22 2021 'This book would appeal to those who are interested in pulse power technology and pulse power generation. The fascinating ability to be able to achieve such incredible power levels with such compact devices is astonishing and could open up many new applications using the methods described in this well-written book, that is loaded with a wealth of experimental data, technical background on ferroelectric materials, high explosives, references, and many design ideas for making compact FEG's.'IEEE Electrical Insulation MagazineExplosive Ferroelectric Generators: From Physical Principles to Engineering is an exciting new book that takes the readers inside the world of explosive ferroelectric generators guided by international expert, Dr Sergey I Shkuratov. It acquaints the reader with the principles of operation of ferroelectric generators and provides details on how to design, build and test the devices which are the most developed and the most near-term for practical applications. Containing a considerable amount of experimental data that has been obtained by the author and his team over a period of 20 years, this is the first book that provides key information on theory, performance and applications of ferroelectric generators. It is a fabulous reference for electrical and electronic engineers working with pulsed power systems, researchers, professors, postgraduate, graduate and undergraduate students.