NANOSCALE PHENOMENA IN FERROELECTRIC THIN FILMS

Edited by
Seungbum Hong

Nanoscale Phenomena In Ferroelectric Thin Films

Miguel Alguero,J. Marty Gregg,Liliana Mitoseriu

Nanoscale Phenomena In Ferroelectric Thin Films:

Nanoscale Phenomena in Ferroelectric Thin Films Seungbum Hong,2013-11-27 This book presents the recent advances in the field of nanoscale science and engineering of ferroelectric thin films It comprises two main parts i e electrical characterization in nanoscale ferroelectric capacitor and nano domain manipulation and visualization in ferroelectric materials Well known le adingexperts both in relevant academia and industry over the world U S Japan Germany Switzerland Korea were invited to contribute to each chapter The first part under the title of electrical characterization in nanoscale ferroelectric capacitors starts with Chapter 1 Testing and characterization of ferroelectric thin film capacitors written by Dr I K Yoo The author provides a comprehensive review on basic concepts and terminologies of ferroelectric properties and their testing methods This chapter also covers reliability issues in FeRAMs that are crucial for commercialization of high density memory products In Chapter 2 Size effects in ferroelectric film capacitors role ofthe film thickness and capacitor size Dr I Stolichnov discusses the size effects both in in plane and out of plane dimensions of the ferroelectric thin film The author successfully relates the electric performance and domain dynamics with proposed models of charge injection and stress induced phase transition The author s findings present both a challenging problem and the clue to its solution of reliably predicting the switching properties for ultra thin ferroelectric capacitors In Chapter 3 Ferroelectric thin films for memory applications nanoscale characterization by scanning force microscopy Prof A *Nanoscale Phenomena in Ferroelectric Thin Films* Chandan S. Ganpule,2001 *Ferroelectric Random Access Memories* Hiroshi Ishiwara,Masanori Okuyama,Yoshihiro Arimoto,2004-04-16 The book consists of 5 parts 1 ferroelectric thin films 2 deposition and characterization methods 3 fabrication process and circuit design 4 advanced type memories and 5 applications and future prospects each part is further divided into several chapters Because of the wide range of topics discussed each chapter in this book was written by one of the best authors knowing the specific topic very well *Nanoscale Ferroelectrics and Multiferroics* Miguel Alguero,J. Marty Gregg,Liliana Mitoseriu,2016-05-31 Dieses Buch beleuchtet die wichtigsten Aspekte der Verarbeitung und Charakterisierung von Ferroelektrika und Multiferroika auf Nanoebene pr sentiert eine umfassende Beschreibung der jeweiligen Eigenschaften und legt dabei den Schwerpunkt auf die Unterscheidung von Gr eneffekten 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 Nanodr hte und Nanor hren auf verschiedenen Entwicklungsstufen Grundlage des Buches ist die europ ische Wissensplattform im Wissenschaftsbereich innerhalb der

Aktion von COST Europ ische Zusammenarbeit in Wissenschaft und Technik zu ein und mehrphasigen Ferroika und Multiferroika mit begrenzten Geometrien SIMUFER Ref MP0904 Die Autoren der Kapitelbeitr ge wurden sorgf ltig ausgew hlt haben allesamt ganz wesentlich zur Wissensbasis f r das jeweilige Thema beigetragen und geh ren vor allem zu den renommiertesten Wissenschaftlern des Fachgebiets *Nanoscale Characterisation of Ferroelectric Materials* Marin Alexe,Alexei Gruverman,2013-03-09 Among the main trends in our daily society is a drive for smaller faster cheaper smarter computers with ever increasing memories To sustain this drive the com puter industry is turning to nanotechnology as a source of new processes and func tional materials which can be used in high performance high density electronic systems Researchers and engineers have been focusing on ferroelectric materials for a long time due to their unique combination of physical properties The ability of ferroelectrics to transform electromagnetic thermal and mechanical energy into electrical charge has been used in a number of electronic applications most recently in nonvolatile computer memories Classical monographs such as Ferro electricity by E Fatuzzo and W J Mertz served as a comprehensive introduction into the field for several generations of scientists However to meet the challenges of the nano era a solid knowledge of the ferroelectric properties at the nano scale needs to be acquired While the science of ferroelectrics from micro to lar ger scale is well established the science of nanoscale ferroelectrics is still terra in cognita The properties of materials at the nanoscale show strong size dependence which makes it imperative to perform reliable characterization at this size range One of the most promising approaches is based on the use of scanning probe microscopy SPM which has revolutionized materials research over the last dec ade **Ferroelectric Thin Films** Masanori Okuyama,Yoshihiro Ishibashi,2005-02-22 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 **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 **Ferroelectrics** Ashim Kumar Bain,Prem Chand,2017-01-30 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 *Thin Films and Heterostructures for Oxide Electronics* Satishchandra B. Ogale,2005-11-21 Oxides form a broad subject area of research and technology development which encompasses different disciplines such as materials science solid state chemistry physics etc The aim of this book is to demonstrate the interplay of these fields and to provide an introduction to the techniques and methodologies involving film growth characterization and device processing The literature in this field is thus fairly scattered in different research journals covering one or the other aspect of the specific activity This situation calls for a book that will consolidate this information and thus enable a beginner as well as an expert to get an overall perspective of the field its foundations and its projected progress Nanoscale Ferroelectric-Multiferroic Materials for Energy Harvesting Applications Hideo Kimura,Zhenxiang Cheng,Tingting Jia,2019-02-22 Nanoscale Ferroelectric Multiferroic Materials for Energy Harvesting Applications presents the latest information in the emerging field of multiferroic materials research exploring applications in energy conversion and harvesting at the nanoscale The book covers crystal and microstructure ferroelectric piezoelectric and multiferroic physical properties along with their characterization Special attention is given to the design and tailoring of ferroelectric magnetic and multiferroic materials and their interaction among ferroics The fundamentals of energy conversion are incorporated along with the requirements of materials for this process Finally a range of applications is presented demonstrating the progression from fundamentals to applied science This essential resource describes the link between the basic physical properties of these materials and their applications in the field of energy harvest It will be a useful resource for graduate students early career researchers academics and industry professionals working in areas related to energy conversion Bridges the gap between the fundamentals and applications of ferroelectric and multiferroic materials for energy harvesting Demonstrates how a range of nanomaterials play an important role in the creation of efficient energy harvesting systems Provides new solutions for the fabrication of electronic devices for various applications

Handbook of Thin Film Deposition Dominic Schepis,Krishna Seshan,2024-10-08 Handbook of Thin Film Deposition Fifth Edition is a comprehensive reference focusing on thin film technologies and applications used in the semiconductor industry

When pursuing patents there is a phase called reduction to practice where the idea for a technology transitions from a concept to actual use The section Thin Film Reduction to Practice includes chapters that review the most relevant methods to fabricate thin films towards practical applications Then the latest applications of thin film deposition technologies are discussed Handbook of Thin Film Deposition 5th Edition is suitable for materials scientists and engineers in academia and working in semiconductor R D Offers a practical survey of thin film technologies including design fabrication and reliability Covers core processes and applications in the semiconductor industry and discusses latest advances in new thin film development Features new chapters that review methods on front end and back end thin films Graded Ferroelectrics, Transpacitors and Transponents Joseph V. Mantese,S. Pamir Alpay,2006-03-08 It has been more than 80 years since Valasek first recognized the existence of a dielectric analogue to ferromagnetism ferroelectricity in Rochelle salt Much as with semiconductor research the initial studies of ferroelectric materials focused on homogeneous materials Unlike semiconductor research however which rapidly expanded into n homogeneous structures and devices investigations of compositionally graded and layered ferroelectrics have been relatively recent endeavors Indeed many of the most significant results and analysis pertaining to polarization graded ferroelectrics have only appeared in publication within the last ten years Further extensions of these concepts to the general class of order parameter graded ferroic materials as depicted on the cover of this book have with one exception been totally lacking It was thus with a great deal of excitement that we assembled the manuscript for this book The primary focus of this study is directed toward polarization graded ferroelectrics and their active components transpacitors however the findings presented here are quite general The theory of graded 2 and 5 whereas much of the ferroics is put on a solid foundation in chapters introductory material relies more heavily upon analogy This was done so as to provide the reader with an intuitive approach to graded ferroics thereby enabling them to see heterogeneous ferroics as clearly logical extensions of passive semiconductor junction devices such as p n and n p diodes and their active manifestations transistors to transpacitors transductors translastics and ultimately to the general active ferroic elements transponents **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 **Frontiers of Ferroelectricity** Sidney B. Lang,Helen L.W. Chan,2007-12-31 The eld of ferroelectricity is a very active one Many hundreds of papers in this eld are published each year and a large number of local and international conferences are held We felt that it wouldbeappropriate at this time to publish a set of papers in a single journal describing some of the most active areas in the eld The Journal of Materials Science agreed to publish a special issue on ferroelectricity Accordingly we sent requests for papers to a number of research groups around the world It was diff culttoselect a small number of groups from among the many excellent ones in the eld and we apologize to those not included We received 24 manuscripts from groups in North America Asia and Europe each one of which was reviewed by two referees The papers include reviews and current research both experimental and theoretical It was especially satisfying that the authors included not only established researchers but also manyyounger people who are destined to continue in the eld in the future The special issue entitled Frontiers of Ferroelectricity appeared as Volume 41 Issue 1 of the Journal of Materials Science in January 2006 Because webelieved that many researchers and students would nd great value in having the complete set of papers on their bookshelf we suggested to the editors of Springer that Frontiers of Ferroelectricity shouldbe published in book form **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 establishedgroup 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 **Domains in Ferroic Crystals and Thin Films** Alexander Tagantsev,L. Eric Cross,Jan Fousek,2010-04-28 At present the marketplace for professionals researchers and graduate students in solid state physics and materials science lacks a book that presents a comprehensive discussion of ferroelectrics and related materials in a form that is suitable for experimentalists and engineers This book proposes to present a wide coverage of domain related issues concerning these

materials This coverage includes selected theoretical topics which are covered in the existing literature in addition to a plethora of experimental data which occupies over half of the book The book presents experimental findings and theoretical understanding of ferroic non magnetic domains developed during the past 60 years It addresses the situation by looking specifically at bulk crystals and thin films with a particular focus on recently developed microelectronic applications and methods for observations of domains with techniques such as scanning force microscopy polarized light microscopy scanning optical microscopy electron microscopy and surface decorating techniques Domains in Ferroic Crystals and Thin Films covers a large area of material properties and effects connected with static and dynamic properties of domains which are extremely relevant to materials referred to as ferroics In other textbooks on solid state physics one large group of ferroics is customarily covered those in which magnetic properties play a dominant role Numerous books are specifically devoted to magnetic ferroics and cover a wide spectrum of magnetic domain phenomena In contrast Domains in Ferroic Crystals and Thin Films concentrates on domain related phenomena in nonmagnetic ferroics These materials are still inadequately represented in solid state physics textbooks and monographs **Ferroelectric Thin Films** ,2005 **Raman Spectroscopy for Nanomaterials Characterization** Challa S. S. R. Kumar,2012-03-02 This handbook gives a comprehensive overview about Raman spectroscopy for the characterization of nanomaterials It is the first volume of a 40 volume series on nanoscience and nanotechnology edited by the renowned scientist Challa S S R Kumar *Ferroelectric Thin Films XII: Volume 784* ,2004-04-09 The MRS Symposium Proceeding series is an internationally recognised reference suitable for researchers and practitioners This book first published in 2004 offers scientific and technological information on ferroelectric thin films from an international mix of academia industry and government organizations *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 HfO2 and its implementation into semiconductor devices Fundamentals of ferroelectric and piezoelectric properties HfO2 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 HfO2 and standard ferroelectric materials Finally HfO2 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 HfO2 based materials for energy storage and pyroelectric piezoelectric and neuromorphic applications Explores all aspects of the structural and electrical properties of HfO2 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

Decoding **Nanoscale Phenomena In Ferroelectric Thin Films**: Revealing the Captivating Potential of Verbal Expression

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Table of Contents Nanoscale Phenomena In Ferroelectric Thin Films

Nanoscale Phenomena In Ferroelectric Thin Films Introduction

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