

characterisation of ferroelectric bulk materials and thin films springer series in measurement science and technology

[#ferroelectric materials characterization](#) [#thin film ferroelectrics](#) [#bulk ferroelectric properties](#) [#measurement science and technology](#) [#materials characterization techniques](#)

This authoritative text provides a comprehensive exploration into the characterisation of ferroelectric bulk materials and thin films. Delving into the latest advancements in measurement science and technology, it offers critical insights into the properties and analysis techniques essential for understanding these advanced ferroelectric materials, making it an invaluable resource for researchers and professionals.

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Characterisation of Ferroelectric Bulk Materials and Thin Films

This book presents a comprehensive review of the most important methods used in the characterisation of piezoelectric, ferroelectric and pyroelectric materials. It covers techniques for the analysis of bulk materials and thick and thin film materials and devices. There is a growing demand by industry to adapt and integrate piezoelectric materials into ever smaller devices and structures. Such applications development requires the joint development of reliable, robust, accurate and – most importantly – relevant and applicable measurement and characterisation methods and models. In the past few years there has been a rapid development of new techniques to model and measure the variety of properties that are deemed important for applications development engineers and scientists. The book has been written by the leaders in the field and many chapters represent established measurement best practice, with a strong emphasis on application of the methods via worked examples and detailed experimental procedural descriptions. Each chapter contains numerous diagrams, images, and measurement data, all of which are fully referenced and indexed. The book is intended to occupy space in the research or technical lab, and will be a valuable and practical resource for students, materials scientists, engineers, and lab technicians.

Advances in Nanotechnology and Its Applications

This book highlights current trends and research advances in nanotechnology and its applications. It discusses the synthesis and characterization of nanomaterials / nanocomposites for novel applications in environmental monitoring and sustainability, and presents new findings on wastewater treatment technologies using nanofiltration membranes.

Advanced Functional Piezoelectric Materials and Applications

The book reviews our current knowledge of piezoelectric materials, including their history, developments, properties, process design, and technical applications in such areas as sensors, actuators, power sources, motors, environmental and biomedical domains. Piezoelectric materials will play a crucial role in the development of sustainable energy systems. Keywords: Piezoelectric Materials, Piezo-crystals, Nanogenerators, Phototronics, Piezoelectric Composites, Biomedical Applications, Energy Harvesting, Piezoelectric Thin Films, Piezoelectric Perovskites, Sensor Applications, Piezoelectric Ceramics, Piezoelectric Semiconductors, Piezoelectric Polymers.

Advances in Heat Transfer

Advances in Heat Transfer, Volume 56, presents the latest in a serial that highlights new advances in the field, with this updated volume presenting interesting chapters written by an international board of authors. Provides the authority and expertise of leading contributors from an international board of authors Presents the latest release in Advances in Heat Transfer serials

A Flexible Multi-Functional Touch Panel for Multi-Dimensional Sensing in Interactive Displays

Touch screen panels (TSPs) have become an integral part of modern-day lifestyle. To enhance user experience, attributes such as form-factor flexibility, multi-dimensional sensing, low power consumption and low cost have become highly desirable. This Element addresses the design of multi-functional TSPs with integrated concurrent capture of ubiquitous capacitive touch signals and force information. It compares and contrasts interactive technologies and presents design considerations for multi-dimensional touch screens with high detection sensitivity, accuracy and resolution.

Power Ultrasonics

Power Ultrasonics: Applications of High-Intensity Ultrasound, Second Edition provides a comprehensive reference on the fundamentals, processing, engineering, medical, food and pharmaceutical applications of ultrasonic processing. Chapters cover the fundamentals of nonlinear propagation of ultrasonic waves in fluids and solids, discuss the materials and designs of power ultrasonic transducers and devices, identify applications of high power ultrasound in materials engineering and mechanical engineering, food processing technology, environmental monitoring and remediation and industrial and chemical processing (including pharmaceuticals), medicine and biotechnology, and cover developments in ultrasound therapy and surgery applications. The new edition also includes recent advances in modeling, characterization and measurement techniques, along with additive manufacturing and micromanufacturing. This is an invaluable reference for graduate students and researchers working in the disciplines of materials science and engineering. In addition, those working on the physics of acoustics, sound and ultrasound, sonochemistry, acoustic engineering and industrial process technology, R&D managers, production, and biomedical engineers will find it useful to their work. Covers the fundamentals of nonlinear propagation of ultrasonic waves in fluids and solids Discusses the materials and designs of power ultrasonic transducers and devices Considers state-of-the-art power sonic applications across a wide range of industries

Advanced Ceramic Coatings for Energy Applications

Smart ceramic coatings containing multifunctional components are now finding application in transportation and automotive industries, in electronics, and energy, sectors, in aerospace and defense, and in industrial goods and healthcare. Their wide application and stability in harsh environments are only possible due to the stability of the inorganic components that are used in ceramic coatings. Ceramic coatings are typically silicon nitride, chromia, hafnia, alumina, alumina-magnesia, silica, silicon carbide, titania, and zirconia-based compositions. The increased demand for these materials and their application in energy, transportation, and the automotive industry, are considered, to be the main

drivers. Advanced Ceramic Coatings for Energy Applications covers recent developments in conducting electrodes, photovoltaics, solar cells, battery applications, fuel cells, electrocatalysts, photocatalysts and supercapacitors. The book is one of four volumes that together provide a comprehensive resource in the field of Advanced Ceramic Coatings, also including titles covering: fundamentals, manufacturing, and classification; biomedical applications; and emerging applications. The books will be extremely useful for academic and industrial researchers and practicing engineers who need to find reliable and up-to-date information about recent progresses and new developments in the field of advanced ceramic coatings. It will also be of value to early career scientists providing background knowledge to the field. Includes comprehensive coverage of advanced ceramic coatings for energy applications Features the latest progress and recent technological developments Includes comparisons to other coatings types (e.g., polymers, metals, and enamel) to demonstrate potential, limitations, and differences Contains extensive case studies and worked examples

Handbook of Sol-Gel Science and Technology

This completely updated and expanded second edition stands as a comprehensive knowledgebase on both the fundamentals and applications of this important materials processing method. The diverse, international team of contributing authors of this reference clarify in extensive detail properties and applications of sol-gel science and technology as it pertains to the production of substances, active and non-active, including optical, electronic, chemical, sensor, bio- and structural materials. Essential to a wide range of manufacturing industries, the compilation divides into the three complementary sections: Sol-Gel Processing, devoted to general aspects of processing and recently developed materials such as organic-inorganic hybrids, photonic crystals, ferroelectric coatings, and photocatalysts; Characterization of Sol-Gel Materials and Products, presenting contributions that highlight the notion that useful materials are only produced when characterization is tied to processing, such as determination of structure by NMR, in-situ characterization of the sol-gel reaction process, determination of microstructure of oxide gels, characterization of porous structure of gels by the surface measurements, and characterization of organic-inorganic hybrid; and Applications of Sol-Gel Technology, covering applications such as the sol-gel method used in processing of bulk silica glasses, bulk porous gels prepared by sol-gel method, application of sol-gel method to fabrication of glass and ceramic fibers, reflective and antireflective coating films, application of sol-gel method to formation of photocatalytic coating films, and application of sol-gel method to bioactive coating films. The comprehensive scope and integrated treatment of topics make this reference volume ideal for R&D scientists and engineers across a wide range of disciplines and professional interests.

Nanoscale Phenomena in Ferroelectric Thin Films

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 leading experts 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 of the 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.

Electroceramic-Based MEMS

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.

Handbook of sol-gel science and technology. 2. Characterization and properties of sol-gel materials and products

In the history of humankind, the sea has always played a key role as a privileged medium for communication, commerce and contact among population centers. It constitutes an essential ecosystem, and an invaluable reservoir and source of food for all living beings. Therefore, its health is a critical challenge for the survival of all humanity, particularly as one of the most important environmental components targeted by global warming. Measuring and monitoring techniques are key tools for managing the marine environment and for supporting the Blue Economy. With this perspective, a series of annual international events, entitled Metrology for the Sea (MetroSea for short) was begun in 2017. Their increasing success inspired this book, which provides an anthology of tutorials dealing with a representative selection of topics of concern to a broad readership. The book covers two broad application areas, marine hydrography and meteorology, and then deals with instrumentation for measurement at sea. Typical metrological issues such as calibration and traceability, are considered, for both physical and chemical quantities. Key techniques, such as underwater acoustic investigation, remote sensing, measurement of waves and monitoring networks, are treated alongside marine geology and the monitoring of animal species. Economic and legal aspects of metrology for navigation are also discussed. Such an unparalleled wide vision of measurement for the sea will be of interest to a broad audience of scientists, engineers, economists, and their students.

Measurement for the Sea

The impetus for the rapid development of thin film technology, relative to that of bulk materials, is its application to a variety of microelectronic products. Many of the characteristics of thin film ferroelectric materials are utilized in the development of these products - namely, their nonvolatile memory and piezoelectric, pyroelectric, and electro-optic properties. It is befitting, therefore, that the first of a set of three complementary books with the general title Integrated Ferroelectric Devices and Technologies focuses on the synthesis of thin film ferroelectric materials and their basic properties. Because it is a basic introduction to the chemistry, materials science, processing, and physics of the materials from which integrated ferroelectrics are made, newcomers to this field as well as veterans will find this book self-contained and invaluable in acquiring the diverse elements requisite to success in their work in this area. It is directed at electronic engineers and physicists as well as process and system engineers, ceramicists, and chemists involved in the research, design, development, manufacturing, and utilization of thin film ferroelectric materials.

Ferroelectric Thin Films

Fourth volume of a 40-volume series on nano science and nanotechnology, edited by the renowned scientist Challa S.S.R. Kumar. This handbook gives a comprehensive overview about Surface Science Tools for Nanomaterials Characterization. Modern applications and state-of-the-art techniques are covered and make this volume an essential reading for research scientists in academia and industry.

Surface Science Tools for Nanomaterials Characterization

The tremendous impact of electronic devices on our lives is the result of continuous improvements of the billions of nanoelectronic components inside integrated circuits (ICs). However, ultra-scaled

semiconductor devices require nanometer control of the many parameters essential for their fabrication. Through the years, this created a strong alliance between microscopy techniques and IC manufacturing. This book reviews the latest progress in IC devices, with emphasis on the impact of electrical atomic force microscopy (AFM) techniques for their development. The operation principles of many techniques are introduced, and the associated metrology challenges described. Blending the expertise of industrial specialists and academic researchers, the chapters are dedicated to various AFM methods and their impact on the development of emerging nanoelectronic devices. The goal is to introduce the major electrical AFM methods, following the journey that has seen our lives changed by the advent of ubiquitous nanoelectronics devices, and has extended our capability to sense matter on a scale previously inaccessible.

Electrical Atomic Force Microscopy for Nanoelectronics

This book mainly focuses on the investigation of the electric-field control of magnetism and spin-dependent transportation based on a $\text{Co}_{40}\text{Fe}_{40}\text{B}_{20}(\text{CoFeB})/\text{Pb}(\text{Mg}_{1/3}\text{Nb}_{2/3})_{0.7}\text{Ti}_{0.3}\text{O}_3(\text{PMN-PT})$ multiferroic heterostructure. Methods of characterization and analysis of the multiferroic properties with in situ electric fields are induced to detect the direct magnetoelectric (ME) coupling. A switchable and non-volatile electric field control of magnetization in $\text{CoFeB}/\text{PMN-PT}(001)$ structures is observed at room temperature, and the mechanism of direct coupling between the ferroelectric domain and ferromagnetic film due to the combined action of 109° ferroelastic domain switching in PMN-PT and the absence of magnetocrystalline anisotropy in CoFeB is demonstrated. Moreover, the electric-field control of giant magnetoresistance is achieved in a CoFeB-based spin valve deposited on top of (011) oriented PMN-PT, which offers an avenue for implementing electric-writing and magnetic-reading random access memory at room temperature. Readers will learn the basic properties of multiferroic materials, many useful techniques related to characterizing multiferroics and the interesting ME effect in $\text{CoFeB}/\text{PMN-PT}$ structures, which is significant for applications.

Electric-Field Control of Magnetization and Electronic Transport in Ferromagnetic/Ferroelectric Heterostructures

This book presents theory, fundamentals and applications of ferroelectricity. 24 chapters gather reviews and research reports covering the spectrum of ferroelectricity. It describes the current levels of understanding of various aspects of ferroelectricity as presented by authorities in the field. Topics include relaxors, piezoelectrics, microscale and nanoscale studies, polymers and composites, unusual properties, and techniques and devices. The book is intended for physicists, engineers and materials scientists working with ferroelectric materials.

Frontiers of Ferroelectricity

One of the fascinating aspects of the field of ferroelectric ceramics is its interdisciplinary nature. This aspect is also a source of difficulty for the people working in the field. In a successful team of ferroelectricians the physics theoretician must understand the sintering technologist, the electrical engineer has to communicate with the crystallographer, the organic chemist will interact with the microelectronics engineer, the electron microscopist should collaborate with the systems engineer. It was the purpose of the summer school on ferroelectric ceramics that took place at the Centro Stefano Franscini (ETHZ), Monte Verità, Ascona, Switzerland, in September 1991 to help to build bridges between people from the different disciplines and to draw for them, in the form of tutorial lectures, some of the different facets of ferroelectrics. The book is a written version of this summer school. It contains the following subjects: ferroelectric materials, physics of ferroelectrics, thin films, processing of ferroelectrics and their applications. It represents a cross section of topics of current interest. Materials are presented (L. E. Cross) from the point of view of the user, i. e. the tailoring of materials for specific applications. Two reviews address the important topic of ferroelectric domains and domain walls (I. Fousek and H. Schmid). In the part devoted to theory, three subjects of current interest are presented: phase transition in thin films (D. R. Tilley), weak ferroelectrics (A. K. Tagantsev) and dielectric losses (A. K. Tagantsev).

Ferroelectric Ceramics

Nanostructures in Ferroelectric Films for Energy Applications: Grains, Domains, Interfaces and the 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.

Nanostructures in Ferroelectric Films for Energy Applications

A comprehensive collection of overview articles on novel microscopy methods for imaging magnetic structures on the nanoscale. Written by leading scientists in the field, the book covers synchrotron based methods, spin-polarized electron methods, and scanning probe techniques. It constitutes a valuable source of reference for graduate students and newcomers to the field.

Magnetic Microscopy of Nanostructures

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 application of ferroelectric devices to innovative systems. In particular, the use of these materials as varying capacitors, gyroscope, acoustics sensors and actuators, microgenerators and memory devices will be exposed, providing an up-to-date review of recent scientific findings and recent advances in the field of ferroelectric devices.

Ferroelectrics

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.

Ferroelectric Domain Walls

Introduction to Thin Film Transistors reviews the operation, application and technology of the main classes of thin film transistor (TFT) of current interest for large area electronics. The TFT materials covered include hydrogenated amorphous silicon (a-Si:H), poly-crystalline silicon (poly-Si), transparent amorphous oxide semiconductors (AOS), and organic semiconductors. The large scale manufacturing of a-Si:H TFTs forms the basis of the active matrix flat panel display industry. Poly-Si TFTs facilitate the integration of electronic circuits into portable active matrix liquid crystal displays, and are increasingly used in active matrix organic light emitting diode (AMOLED) displays for smart phones. The recently developed AOS TFTs are seen as an alternative option to poly-Si and a-Si:H for AMOLED TV and large AMLCD TV applications, respectively. The organic TFTs are regarded as a cost effective route into flexible electronics. As well as treating the highly divergent preparation and properties of these materials, the physics of the devices fabricated from them is also covered, with emphasis on performance features such as carrier mobility limitations, leakage currents and instability mechanisms.

The thin film transistors implemented with these materials are the conventional, insulated gate field effect transistors, and a further chapter describes a new thin film transistor structure: the source gated transistor, SGT. The driving force behind much of the development of TFTs has been their application to AMLCDs, and there is a chapter dealing with the operation of these displays, as well as of AMOLED and electrophoretic displays. A discussion of TFT and pixel layout issues is also included. For students and new-comers to the field, introductory chapters deal with basic semiconductor surface physics, and with classical MOSFET operation. These topics are handled analytically, so that the underlying device physics is clearly revealed. These treatments are then used as a reference point, from which the impact of additional band-gap states on TFT behaviour can be readily appreciated. This reference book, covering all the major TFT technologies, will be of interest to a wide range of scientists and engineers in the large area electronics industry. It will also be a broad introduction for research students and other scientists entering the field, as well as providing an accessible and comprehensive overview for undergraduate and postgraduate teaching programmes.

Introduction to Thin Film Transistors

Offering thorough coverage of atomic layer deposition (ALD), this book moves from basic chemistry of ALD and modeling of processes to examine ALD in memory, logic devices and machines. Reviews history, operating principles and ALD processes for each device.

Atomic Layer Deposition for Semiconductors

This book brings together an emerging consensus on our understanding of the complex functional materials including ferroics, perovskites, multiferroics, CMR and high-temperature superconductors. The common theme is the existence of many competing ground states and frustration as a collusion of spin, charge, orbital and lattice degrees of freedom in the presence of disorder and (both dipolar and elastic) long-range forces. An important consequence of the complex unit cell and the competing interactions is that the emergent materials properties are very sensitive to external fields thus rendering these materials with highly desirable, technologically important applications enabled by cross-response.

Disorder and Strain-Induced Complexity in Functional Materials

This book deals with the latest achievements in the field of ferroelectric domain engineering and characterization at micron- and nano-scale dimensions and periods. The book collects the results obtained in recent years by world renowned scientific leaders in the field, thus providing a valid and unique overview of the state-of-the-art. At the same time the book provides a view to future applications of those engineered materials in the field of photonics.

Ferroelectric Crystals for Photonic Applications

"Evaluating Measurement Accuracy, 2nd Edition" is intended for those who are concerned with measurements in any field of science or technology. It reflects the latest developments in metrology and offers new results, but is designed to be accessible to readers at different levels: scientists who advance the field of metrology, engineers and experimental scientists who use measurements as tool in their professions, students and graduate students in natural sciences and engineering, and, in parts describing practical recommendations, technicians performing mass measurements in industry, quality control, and trade. This book presents material from the practical perspective and offers solutions and recommendations for problems that arise in conducting real-life measurements. This new edition adds a method for estimating accuracy of indirect measurements with independent arguments, whose development Dr. Rabinovich was able to complete very recently. This method, which is called the Method of Enumeration, produces estimates that are no longer approximate, similar to the way the method of reduction described in the first edition removed approximation in estimating uncertainty of indirect measurements with dependent arguments. The method of enumeration completes addressing the range of problems whose solutions signify the emergence of the new theory of accuracy of measurements. A new method is added for building a composition of histograms, and this method forms a theoretical basis for the method of enumeration. Additionally, as a companion to this book, a concise practical guide that assembles simple step-by-step procedures for typical tasks the practitioners are likely to encounter in measurement accuracy estimation is available at SpringerLink.

Evaluating Measurement Accuracy

Ultrasound is currently used in a wide spectrum of applications ranging from medical imaging to metal cutting. This book is about using ultrasound in nondestructive evaluation (NDE) inspections. Ultrasonic NDE uses high-frequency acoustic/elastic waves to evaluate components without affecting their integrity or performance. This technique is commonly used in industry (particularly in aerospace and nuclear power) to inspect safety-critical parts for flaws during in-service use. Other important uses of ultrasonic NDE involve process control functions during manufacturing and fundamental materials characterization studies. It is not difficult to set up an ultrasonic NDE measurement system to launch waves into a component and monitor the waves received from defects, such as cracks, even when those defects are deep within the component. It is difficult however to interpret quantitatively the signals received in such an ultrasonic NDE measurement process. For example based on the ultrasonic signal received from a crack, what is the size, shape, and orientation of the crack producing the signal? Answering such questions requires evaluation procedures based on a detailed knowledge of the physics of the entire ultrasonic measurement process. One approach to obtaining such knowledge is to couple quantitative experiments closely with detailed models of the entire ultrasonic measurement system itself. We refer to such models here as ultrasonic NDE measurement models. In other areas of engineering, models have revolutionized how engineering is practiced. A classic example is the impact of the finite-element method on elastic stress analysis.

Fundamentals of Ultrasonic Nondestructive Evaluation

The past five years have witnessed some dramatic developments in the general area of ferroelectric thin films materials and devices. Ferroelectrics are not new materials by any stretch of imagination. Indeed, they have been known since the early part of this century and popular ferroelectric materials such as Barium Titanate have been in use since the second world war. In the late sixties and seventies, a considerable amount of research and development effort was made to create a solid state nonvolatile memory using ferroelectrics in a very simple matrix-addressed scheme. These attempts failed primarily due to problems associated with either the materials or due to device architectures. The early eighties saw the advent of new materials processing approaches, such as sol-gel processing, that enabled researchers to fabricate sub-micron thin films of ferroelectric materials on a silicon substrate. These pioneering developments signaled the onset of a revival in the area of ferroelectric thin films, especially ferroelectric nonvolatile memories. Research and development effort in ferroelectric materials and devices has now hit a feverish pitch. Many university laboratories, national laboratories and advanced R&D laboratories of large IC manufacturers are deeply involved in the pursuit of ferroelectric device technologies. Many companies worldwide are investing considerable manpower and resources into ferroelectric technologies. Some have already announced products ranging from embedded memories in micro controllers, low density stand-alone memories, microwave circuit elements, and RFID identification tags. There is now considerable optimism that ferroelectric devices and products will occupy a significant market-share in the new millennium.

Thin Film Ferroelectric Materials and Devices

This book summarizes the most recent and compelling experimental results for complex oxide interfaces. The results of this book were obtained with the cutting-edge photoemission technique at highest energy resolution. Due to their fascinating properties for new-generation electronic devices and the challenge of investigating buried regions, the book chiefly focuses on complex oxide interfaces. The crucial feature of exploring buried interfaces is the use of soft X-ray angle-resolved photoemission spectroscopy (ARPES) operating on the energy range of a few hundred eV to increase the photoelectron mean free path, enabling the photons to penetrate through the top layers – in contrast to conventional ultraviolet (UV)-ARPES techniques. The results presented here, achieved by different research groups around the world, are summarized in a clearly structured way and discussed in comparison with other photoemission spectroscopy techniques and other oxide materials. They are complemented and supported by the most recent theoretical calculations as well as results of complementary experimental techniques including electron transport and inelastic resonant X-ray scattering.

Spectroscopy of Complex Oxide Interfaces

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.

Ferroelectric Thin Films

This book delivers practical insight into a broad range of fields related to hard coatings, from their deposition and characterization up to the hardening and deformation mechanisms allowing the interpretation of results. The text examines relationships between structure/microstructure and mechanical properties from fundamental concepts, through types of coatings, to characterization techniques. The authors explore the search for coatings that can satisfy the criteria for successful implementation in real mechanical applications.

Nanostructured Coatings

Both an introductory course to broadband dielectric spectroscopy and a monograph describing recent dielectric contributions to current topics, this book is the first to cover the topic and has been hotly awaited by the scientific community.

Broadband Dielectric Spectroscopy

This book introduces novel developments in the field of electromagnetic non-destructive testing and evaluation (NDT/E). The topics include electromagnetic ultrasonic guided wave testing, pulsed eddy current testing, remote field eddy current testing, low frequency eddy current testing, metal magnetic memory testing, and magnetic flux leakage testing. Considering the increasing concern about the safety maintenance of critical structures in various industries and everyday life, these topics presented here will be of particular interest to the readers in the NDT/E field. This book covers both theoretical researches and the engineering applications of the electromagnetic NDT technology. It could serve as a valuable reference for college students and relevant NDT technicians. It is also a useful material for qualification training and higher learning for nondestructive testing professionals.

New Technologies in Electromagnetic Non-destructive Testing

Seven years have passed since the publication of the previous edition of this book. During that time, sensor technologies have made a remarkable leap forward. The sensitivity of the sensors became higher, the dimensions became smaller, the sensitivity became better, and the prices became lower. What have not changed are the fundamental principles of the sensor design. They are still governed by the laws of Nature. Arguably one of the greatest geniuses who ever lived, Leonardo Da Vinci, had his own peculiar way of praying. He was saying, "Oh Lord, thanks for Thou do not violate your own laws. " It is comforting indeed that the laws of Nature do not change as time goes by; it is just our appreciation of them that is being refined. Thus, this new edition examines the same good old laws of Nature that are employed in the designs of various sensors. This has not changed much since the previous edition. Yet, the sections that describe the practical designs are revised substantially. Recent ideas and developments have been added, and less important and nonessential designs were dropped. Probably the most dramatic recent progress in the sensor technologies relates to wide use of MEMS and MEOMS (micro-electro-mechanical systems and micro-electro-opto-mechanical systems). These are examined in this new edition with greater detail. This book is about devices commonly called sensors. The invention of a microprocessor has brought highly sophisticated instruments into our everyday lives.

Handbook of Modern Sensors

This book features reviews by leading experts on the methods and applications of modern forms of microscopy. The recent awards of Nobel Prizes awarded for super-resolution optical microscopy and cryo-electron microscopy have demonstrated the rich scientific opportunities for research in novel microscopies. Earlier Nobel Prizes for electron microscopy (the instrument itself and applications to biology), scanning probe microscopy and holography are a reminder of the central role of microscopy in modern science, from the study of nanostructures in materials science, physics and chemistry to structural biology. Separate chapters are devoted to confocal, fluorescent and related novel optical microscopies, coherent diffractive imaging, scanning probe microscopy, transmission electron microscopy in all its modes from aberration corrected and analytical to in-situ and time-resolved, low energy electron microscopy, photoelectron microscopy, cryo-electron microscopy in biology, and also ion microscopy. In addition to serving as an essential reference for researchers and teachers in the fields such as materials science, condensed matter physics, solid-state chemistry, structural biology and the molecular sciences generally, the Springer Handbook of Microscopy is a unified, coherent and pedagogically attractive text for advanced students who need an authoritative yet accessible guide to the science and practice of microscopy.

Springer Handbook of Microscopy

Modern materials science builds on knowledge from physics, chemistry, biology, mathematics, computer and data science, and engineering sciences to enable us to understand, control, and expand the material world. Although it is anchored in inquiry-based fundamental science, materials research is strongly focused on discovering and producing reliable and economically viable materials, from super alloys to polymer composites, that are used in a vast array of products essential to today's societies and economies. *Frontiers of Materials Research: A Decadal Survey* is aimed at documenting the status and promising future directions of materials research in the United States in the context of similar efforts worldwide. This third decadal survey in materials research reviews the progress and achievements in materials research and changes in the materials research landscape over the last decade; research opportunities for investment for the period 2020-2030; impacts that materials research has had and is expected to have on emerging technologies, national needs, and science; and challenges the enterprise may face over the next decade.

Frontiers of Materials Research

The transformation of vibrations into electric energy through the use of piezoelectric devices is an exciting and rapidly developing area of research with a widening range of applications constantly materialising. With *Piezoelectric Energy Harvesting*, world-leading researchers provide a timely and comprehensive coverage of the electromechanical modelling and applications of piezoelectric energy harvesters. They present principal modelling approaches, synthesizing fundamental material related to mechanical, aerospace, civil, electrical and materials engineering disciplines for vibration-based energy harvesting using piezoelectric transduction. *Piezoelectric Energy Harvesting* provides the first comprehensive treatment of distributed-parameter electromechanical modelling for piezoelectric energy harvesting with extensive case studies including experimental validations, and is the first book to address modelling of various forms of excitation in piezoelectric energy harvesting, ranging from airflow excitation to moving loads, thus ensuring its relevance to engineers in fields as disparate as aerospace engineering and civil engineering. Coverage includes: Analytical and approximate analytical distributed-parameter electromechanical models with illustrative theoretical case studies as well as extensive experimental validations Several problems of piezoelectric energy harvesting ranging from simple harmonic excitation to random vibrations Details of introducing and modelling piezoelectric coupling for various problems Modelling and exploiting nonlinear dynamics for performance enhancement, supported with experimental verifications Applications ranging from moving load excitation of slender bridges to airflow excitation of aeroelastic sections A review of standard nonlinear energy harvesting circuits with modelling aspects.

Piezoelectric Energy Harvesting

This book gathers, for the first time, an overview of nearly all of the magnetic sensors that exist today. The book is offering the readers a thorough and comprehensive knowledge from basics to state-of-the-art and is therefore suitable for both beginners and experts. From the more common

and popular AMR magnetometers and up to the recently developed NV center magnetometers, each chapter is describing a specific type of sensor and providing all the information that is necessary to understand the magnetometer behavior including theoretical background, noise model, materials, electronics, design and fabrication techniques, etc.

High Sensitivity Magnetometers

Measurement plays a fundamental role both in physical and behavioral sciences, as well as in engineering and technology: it is the link between abstract models and empirical reality and is a privileged method of gathering information from the real world. Is it possible to develop a single theory of measurement for the various domains of science and technology in which measurement is involved? This book takes the challenge by addressing the following main issues: What is the meaning of measurement? How do we measure? What can be measured? A theoretical framework that could truly be shared by scientists in different fields, ranging from physics and engineering to psychology is developed. The future in fact will require greater collaboration between science and technology and between different sciences. Measurement, which played a key role in the birth of modern science, can act as an essential interdisciplinary tool and language for this new scenario. A sound theoretical basis for addressing key problems in measurement is provided. These include perceptual measurement, the evaluation of uncertainty, the evaluation of inter-comparisons, the analysis of risks in decision-making and the characterization of dynamical measurement. Currently, increasing attention is paid to these issues due to their scientific, technical, economic and social impact. The book proposes a unified probabilistic approach to them which may allow more rational and effective solutions to be reached. Great care was taken to make the text as accessible as possible in several ways. Firstly, by giving preference to as interdisciplinary a terminology as possible; secondly, by carefully defining and discussing all key terms. This ensures that a wide readership, including people from different mathematical backgrounds and different understandings of measurement can all benefit from this work. Concerning mathematics, all the main results are preceded by intuitive discussions and illustrated by simple examples. Moreover, precise proofs are always included in order to enable the more demanding readers to make conscious and creative use of these ideas, and also to develop new ones. The book demonstrates that measurement, which is commonly understood to be a merely experimental matter, poses theoretical questions which are no less challenging than those arising in other, apparently more theoretical, disciplines.

Measurement and Probability