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Ellipsometry at the Nanoscale

Springer Science & Business Media **This book presents and introduces ellipsometry in nanoscience and nanotechnology making a bridge between the classical and nanoscale optical behaviour of materials. It delineates the role of the non-destructive and non-invasive optical diagnostics of ellipsometry in improving science and technology of nanomaterials and related processes by illustrating its exploitation, ranging from fundamental studies of the physics and chemistry of nanostructures to the ultimate goal of turnkey manufacturing control. This book is written for a broad readership: materials scientists, researchers, engineers, as well as students and nanotechnology operators who want to deepen their knowledge about both basics and applications of ellipsometry to nanoscale phenomena. It starts as a general introduction for people curious to enter the fields of ellipsometry and polarimetry applied to nanomaterials and progresses to articles by experts on specific fields that span from plasmonics, optics, to semiconductors and flexible electronics. The core belief reflected in this book is that ellipsometry applied at the nanoscale offers new ways of addressing many current needs. The book also explores forward-looking potential applications.**

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Thin metal films on weakly-interacting substrates

Nanoscale growth dynamics, stress generation, and morphology manipulation

Linköping University Electronic Press **Vapor-based growth of thin metal films with controlled morphology on weakly-interacting substrates (WIS), including oxides and van der Waals materials, is essential for the fabrication of multifunctional metal contacts in a wide array of optoelectronic devices. Achieving this entails a great challenge, since weak film/substrate interactions yield a pronounced and uncontrolled 3D morphology. Moreover, the far-from-equilibrium nature of vapor-based film growth often leads to generation of mechanical stress, which may further compromise device reliability and functionality. The objectives of this thesis are related to metal film growth on WIS and seek to: (i) contribute to the understanding of atomic-scale processes that control film morphological evolution; (ii) elucidate the dynamic competition between nanoscale processes that govern film stress generation and evolution; and (iii) develop methodologies for manipulating and controlling nanoscale film morphology between 2D and 3D. Investigations focus on magnetron sputter-deposited Ag and Cu films on SiO2 and amorphous carbon (a-C) substrates. Research is conducted by strategically combining of in situ and real-time film growth monitoring, ex situ chemical and (micro)-structural analysis, optical modelling, and deterministic growth simulations. In the first part, the scaling behavior of characteristic morphological transition thicknesses (i.e., percolation and continuous film formation thickness) during growth of Ag and Cu films on a-C are established as function of deposition rate and temperature. These data are interpreted using a theoretical framework based on the droplet growth theory and the kinetic freezing model for island coalescence, from which the diffusion rates of film forming species during Ag and Cu growth are estimated. By combining experimental data with ab initio molecular dynamics simulations, diffusion of multiatomic clusters, rather than monomers, is identified as the rate-limiting structure-forming process. In the second part, the effect of minority metallic or gaseous species (Cu, N2, O2) on Ag film morphological evolution on SiO2 is studied. By employing in situ spectroscopic ellipsometry, it is found that addition of minority species at the film growth front promotes 2D morphology, but also yields an increased continuous-layer resistivity. Ex situ analyses show that 2D morphology is favored because minority species hinder the rate of coalescence completion. Hence, a novel growth manipulation strategy is compiled in which minority species are deployed with high temporal precision to selectively target specific film growth stages and achieve 2D morphology, while retaining opto-electronic properties of pure Ag films. In the third part, the evolution of stress during Ag and Cu film growth on a-C and its dependence on growth kinetics (as determined by deposition rate, substrate temperature) is systematically investigated. A general trend toward smaller compressive stress magnitudes with increasing temperature/deposition rate is found, related to increasing grain size/decreasing adatom diffusion length. Exception to this trend is found for Cu films, in which oxygen incorporation from the residual growth atmosphere at low deposition rates inhibits adatom diffusivity and decreases the magnitude of compressive stress. The effect of N2 on stress type and magnitude in Ag films is also studied. While Ag grown in N2-free atmosphere exhibits a typical compressive-tensile-compressive stress evolution as function of thickness, addition of a few percent of N2 yields to a stress turnaround from compressive to tensile stress after film continuity which is attributed to giant grain growth and film roughening. The overall results of the thesis provide the foundation to: (i) determine diffusion rates over a wide range of WIS film/substrates systems; (ii) design non-invasive strategies for multifunctional contacts in optoelectronic devices; (iii) complete important missing pieces in the fundamental understanding of stress, which can be used to expand theoretical descriptions for predicting and tuning stress magnitude. La morphologie de films minces métalliques polycristallins élaborés par condensation d'une phase vapeur sur des substrats à faible interaction (SFI) possède un caractère 3D intrinsèque. De plus, la nature hors équilibre de la croissance du film depuis une phase vapeur conduit souvent à la génération de contraintes mécaniques, ce qui peut compromettre davantage la fiabilité et la fonctionnalité des dispositifs optoélectroniques. Les objectifs de cette thèse sont liés à la croissance de films métalliques sur SFI et visent à: (i) contribuer à une meilleure compréhension des processus à l'échelle atomique qui contrôlent l'évolution morphologique des films; (ii) élucider les processus dynamiques qui régissent la génération et l'évolution des contraintes en cours de croissance; et (iii) développer des méthodologies pour manipuler et contrôler la morphologie des films à l'échelle nanométrique. L'originalité de l'approche mise en œuvre consiste à suivre la croissance des films in situ et en temps réel par couplage de plusieurs diagnostics, complété par des analyses microstructurales ex situ. Les grandeurs mesurées sont confrontées à des modèles optiques et des simulations atomistiques. La première partie est consacrée à une étude de comportement d'échelonnement des épaisseurs de transition morphologiques caractéristiques, à savoir la percolation et la continuité du film, lors de la croissance de films polycristallins d'Ag et de Cu sur carbone amorphe (a-C). Ces grandeurs sont examinées de façon systématique en fonction de la vitesse de dépôt et de la température du substrat, et interprétées dans le cadre de la théorie de la croissance de gouttelettes suivant un modèle cinétique décrivant la coalescence d'îlots, à partir duquel les coefficients de diffusion des espèces métalliques sont estimés. En confrontant les données expérimentales à des simulations par dynamique moléculaire ab initio, la diffusion de clusters multiatomiques est identifiée comme l'étape limitante le processus de croissance. Dans la seconde partie, l'incorporation, et l'impact sur la morphologie, d'espèces métalliques ou gazeuses minoritaires (Cu, N2, O2) lors de la croissance de film Ag sur SiO2 est étudié. A partir de mesures ellipsométriques in situ, on constate que l'addition d'espèces minoritaires favorise une morphologie 2D, entravant le taux d'achèvement de la coalescence, mais donne également une résistivité accrue de la couche continue. Par conséquent, une stratégie de manipulation de la croissance est proposée dans laquelle des espèces minoritaires sont déployées avec une grande précision temporelle pour cibler sélectivement des stades de croissance de film spécifiques et obtenir une morphologie 2D, tout en conservant les propriétés optoélectroniques des films d'Ag pur. Dans la troisième partie, l'évolution des contraintes résiduelles lors de la croissance des films d'Ag et de Cu sur a-C et leur dépendance à la cinétique de croissance est systématiquement étudiée. On observe une tendance générale vers des amplitudes de contrainte de compression plus faibles avec une augmentation de la température/vitesse de dépôt, liée à l'augmentation de la taille des grains/à la diminution de la longueur de diffusion des adatomes. Également, l'ajout dans le plasma de N2 sur le type et l'amplitude des contraintes dans les films d'Ag est étudié. L'ajout de quelques pourcents de N2 en phase gaz donne lieu à un renversement de la contrainte de compression et une évolution en tension au-delà de la continuité du film. Cet effet est attribué à une croissance anormale des grains géants et le développement de rugosité de surface. L'ensemble des résultats obtenus dans cette thèse fournissent les bases pour: (i) déterminer les coefficients de diffusion sur une large gamme de systèmes films/SFI; (ii) concevoir des stratégies non invasives pour les contacts multifonctionnels dans les dispositifs optoélectroniques; (iii) apporter des éléments de compréhension à l'origine du développement de contrainte, qui permettent de prédire et contrôler le niveau de contrainte intrinsèque à la croissance de films minces polycristallins.**

Surface Science

Foundations of Catalysis and Nanoscience

John Wiley & Sons **An updated fourth edition of the text that provides an understanding of chemical transformations and the formation of structures at surfaces The revised and enhanced fourth edition of Surface Science covers all the essential techniques and phenomena that are relevant to the field. The text elucidates the structural, dynamical, thermodynamic and kinetic principles concentrating on gas/solid and liquid/solid interfaces. These principles allow for an understanding of how and why chemical transformations occur at surfaces. The author (a noted expert on in the field) combines the required chemistry, physics and mathematics to create a text that is accessible and comprehensive. The fourth edition incorporates new end-of-chapter exercises, the solutions to which are available on-line to demonstrate how problem solving that is relevant to surface science should be performed. Each chapter begins with simple principles and builds to more advanced ones. The advanced topics provide material beyond the introductory level and highlight some frontier areas of study. This updated new edition: Contains an expanded treatment of STM and AFM as well as super-resolution microscopy Reviews advances in the theoretical basis of catalysis and the use of activity descriptors for rational catalyst design Extends the discussion of two-dimensional solids to reflect remarkable advances in their growth and characterization Delves deeper into the surface science of electrochemistry and charge transfer reactions Updates the "Frontiers and Challenges" sections at the end of each chapter as well as the list of references Written for students, researchers and professionals, the fourth edition of Surface Science offers a revitalized text that contains the tools and a set of principles for understanding the field. Instructor support material, solutions and PPTs of figures, are available at http://booksupport.wiley.com**

Materials Fundamentals of Gate Dielectrics

Springer Science & Business Media **Materials Fundamentals of Dielectric Gates treats materials fundamentals of the novel gate dielectrics that are being introduced into semiconductor manufacturing to ensure the continuous scaling of the CMOS devices. This is a very fast evolving field of research so the focus is materials, mostly transition metal oxide, that determine performance in device applications. The complexity of the structure-property relations in TM oxides makes the use of the state-of-the-art first-principles calculations necessary. Several chapters give a detailed description of the modern theory of polarization, and heterojunction band discontinuity within the framework of the density functional theory. Experimental methods include oxide melt solution calorimetry and differential scanning calorimetry, Raman scattering and other optical characterization techniques, transmission electron microscopy, and x-rayphotoelectron spectroscopy. Since many of the problems encountered in the world of CMOS are also relevant for other semiconductors such as GaAs, a comprehensive review of recent developments in this field is thus also given**

Thermometry at the Nanoscale

Techniques and Selected Applications

Royal Society of Chemistry **Covers the fundamentals of measuring temperature at the nanoscale, luminescence-based and non-luminescence based thermometry techniques, and applications.**

Fundamentals of Friction and Wear on the Nanoscale

Springer **This book provides an updated review on the development of scanning probe microscopy and related techniques, and the availability of computational techniques not even imaginable a few decades ago. The 36 chapters cover instrumental aspects, theoretical models and selected experimental results, thus offering a broad panoramic view on fundamental issues in nanotribology which are currently being investigated. Compared to the first edition, several topics have been added, including triboluminescence, graphene mechanics, friction and wear in liquid environments, capillary condensation, and multiscale friction modeling. Particular care has been taken to avoid overlaps and guarantee the independence of the chapters. In this way, our book aims to become a key reference on this subject for the next five to ten years to come.**

Functional Polymer Films, 2 Volume Set

John Wiley & Sons **Very thin film materials have emerged as a highly interesting and useful quasi 2D-state functionality. They have given rise to numerous applications ranging from protective and smart coatings to electronics, sensors and display technology as well as serving biological, analytical and medical purposes. The tailoring of polymer film properties and functions has become a major research field. As opposed to the traditional treatise on polymer and resin-based coatings, this one-stop reference is the first to give readers a comprehensive view of the latest macromolecular and supramolecular film-based nanotechnology. Bringing together all the important facets and state-of-the-art research, the two well-structured volumes cover film assembly and depostion, functionality and patterning, and analysis and characterization. The result is an in-depth understanding of the phenomena, ordering, scale effects, fabrication, and analysis of polymer ultrathin films. This book will be a valuable addition for Materials Scientists, Polymer Chemists, Surface Scientists, Bioengineers, Coatings Specialists, Chemical Engineers, and Scientists working in this important research field and industry.**

Photon-based Nanoscience and Nanobiotechnology

Springer Science & Business Media **This book provides a set of articles reviewing state-of-the art research and recent advancements in the field of photon-matter interaction for micro/nanomaterials synthesis and manipulation of properties of biological and inorganic materials at the atomic level. Photon-based nanoscience and related technologies have created exciting opportunities for the fabrication and characterization of nano(bio)material devices and systems.**

Nanoscience and Nanoengineering

Advances and Applications

CRC Press **Reflecting the breadth of the field from research to manufacturing, Nanoscience and Nanoengineering: Advances and Applications delivers an in-depth survey of emerging, high-impact nanotechnologies. Written by a multidisciplinary team of scientists and engineers and edited by prestigious faculty of the Joint School of Nanoscience and Nanoengineering, this book focuses on important breakthroughs in nanoelectronics, nanobiology, nanomedicine, nanomodeling, nanolithography, nanofabrication, and nanosafety. This authoritative text: Addresses concerns regarding the use of nanomaterials Discusses the advantages of nanocomposites versus conventional materials Explores self-assembly and its potential for nanomanufacturing applications Covers compound semiconductors and their applications in communications Considers display technology and infrared optics in relation to nanoelectronics Explains how computational nanotechnology is critical to the design of process materials and nanobiotechnologies Describes the design and fabrication of nanoelectromechanical systems (NEMS) and their applications in nanomedicine By seamlessly integrating interdisciplinary foundational science with state-of-the-art engineering tools, Nanoscience and Nanoengineering: Advances and Applications offers a holistic approach to understanding the mechanisms underpinning the nanotechnology-based products we enjoy today, as well as those that will change our society in the near future.**

Ion Beams in Nanoscience and Technology

Springer Science & Business Media **Energetic ion beam irradiation is the basis of a wide plethora of powerful research- and fabrication-techniques for materials characterisation and processing on a nanometre scale. Materials with tailored optical, magnetic and electrical properties can be fabricated by synthesis of nanocrystals by ion implantation, focused ion beams can be used to machine away and deposit material on a scale of nanometres and the scattering of energetic ions is a unique and quantitative tool for process development in high speed electronics and 3-D nanostructures with extreme aspect radios for tissue engineering and nano-fluidics lab-on-a-chip may be machined using proton beams. This book will benefit practitioners, researchers and graduate students working in the field of ion beams and application and more generally everyone concerned with the broad field of nanoscience and technology.**

Nanoscale and Microscale Effects and Electromechanical Aspects for Design of Thin Films and Sensors

Advanced Experimental Methods for Noise Research in Nanoscale Electronic Devices

Springer Science & Business Media **A discussion of recently developed experimental methods for noise research in nanoscale electronic devices, conducted by specialists in transport and stochastic phenomena in nanoscale physics. The approach described is to create methods for experimental observations of noise sources, their localization and their frequency spectrum, voltage-current and thermal dependences. Our current knowledge of measurement methods for mesoscopic devices is summarized to identify directions for future research, related to downscaling effects. The directions for future research into fluctuation phenomena in quantum dot and quantum wire devices are specified. Nanoscale electronic devices will be the basic components for electronics of the 21st century. From this point of view the signal-to-noise ratio is a very important parameter for the device application. Since the noise is also a quality and reliability indicator, experimental methods will have a wide application in the future.**

Nanoscience

Colloidal and Interfacial Aspects

CRC Press **Bringing together a prominent roster of 42 leading investigators and their teams, this volume details the wide range of theoretical and experimental knowledge that can be successfully applied for investigating nanosystems. The book provides researchers with a full examination of nano-disperse colloids, homogeneous and heterogeneous nano-structured materials (and their properties), and shelf-organization at the nano-scale. It explores non-linear lectrokinetic phenomena in nano-sized dispersions and nano-sized biological systems. It discusses application aspects of technological processes in great detail, offering scientists and engineers across all fields authoritative commentary on colloid and interface science operating at the nanoscale.**

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Heat Transport in Micro- and Nanoscale Thin Films

Elsevier **Heat Transport in Micro- and Nanoscale Thin Films presents aspects and applications of the principle methods of heat transport in relation to nanoscale films. Small-scale parts and thin films are widely used in the electronics industry. However, the drastic change in the thermal conductivity with reducing device size and film thickness modifies the energy transport by heat-carrying phonons in the film. Energy transfer in small-sized devices and thin films deviate from the classical diffusion to radiative transport. This book deals with micro/nano scale heat transfer in small scale devices and the thin films, including interface properties of cross-plane transport. The book fills the gap between applications of the physical fundamentals and energy transport at the micro- and nano scale, which will be valuable for academics, researchers and students in the fields of materials science and energy transport Offers a specialist focus on nanoscale thin films, allowing the reader to create more efficient heat transfer systems Includes in-depth coverage of the formulation of transient energy transport for short durations of heating, which is valuable those working in electronics Focuses on applications and real-life case studies to clearly illustrate how the theories explained in the book can be used in industry**

Fundamentals of Materials Science

The Microstructure–Property Relationship Using Metals as Model Systems

Springer Science & Business Media **This book offers a strong introduction to fundamental concepts on the basis of materials science. It conveys the central issue of materials science, distinguishing it from merely solid state physics and solid state chemistry, namely to develop models that provide the relation between the microstructure and the properties. The book is meant to be used in the beginning of a materials science and engineering study as well as throughout an entire undergraduate and even graduate study as a solid background against which specialized texts can be studied. Topics dealt with are "crystallography", "lattice defects", "microstructural analysis", "phase equilibria and transformations" and "mechanical strength". After the basic chapters the coverage of topics occurs to an extent surpassing what can be offered in a freshman's course. About the author Prof. Mittemeijer is one of the top scientists in materials science, whose perceptiveness and insight have led to important achievements. This book witnesses of his knowledge and panoramic overview and profound understanding of the field. He is a director of the Max Planck Institute for Metals Research in Stuttgart.**

Advanced Nanomaterials

Synthesis, Properties, and Applications

CRC Press **A collection of highly selected, peer-reviewed chapters, this book showcases the research of an international roster of scientists. It covers nanomaterials with emphasis on synthesis, characterization, and applications. It also presents emerging developments in nanotechnology in areas as diverse as medicine, energy, electronics, and agriculture. In addition to engineering aspects, the book discusses the physics, chemistry and biotechnology behind the fabrication and device designing.**

Organic Nanostructured Thin Film Devices and Coatings for Clean Energy

CRC Press **Authored by leading experts from around the world, the three-volume Handbook of Nanostructured Thin Films and Coatings gives scientific researchers and product engineers a resource as dynamic and flexible as the field itself. The first two volumes cover the latest research and application of the mechanical and functional properties of thin films and coatings, while the third volume explores the cutting-edge organic nanostructured devices used to produce clean energy. This third volume, Organic Nanostructured Thin Film Devices and Coatings for Clean Energy, addresses various aspects of the processing and properties of organic thin films, devices, and coatings for clean energy applications. Topics covered include: Thin-film solar cells based on the use of polycrystalline thin-film materials Anodized titania nanotube array and its application in dye-sensitized solar cells Progress and challenges associated with photovoltaic applications of silicon nanocrystalline materials Semiconductive nanocomposite films for clean environment Thin-coating technologies and applications in high-temperature solid oxide fuel cells Nanoscale organic molecular thin films for information memory applications A complete resource, this handbook provides the detailed explanations that newcomers need, as well as the latest cutting-edge research and data for experts. Covering a wide range of mechanical and functional technologies, including those used in clean energy, these books also feature figures, tables, and images that will aid research and help professionals acquire and maintain a solid grasp of this burgeoning field. The Handbook of Nanostructured Thin Films and Coatings is composed of this volume and two others: Nanostructured Thin Films and Coatings, Functional Properties Nanostructured Thin Films and Coatings, Mechanical Properties**

Nanostructured Thin Films and Coatings

Functional Properties

CRC Press **Authored by leading experts from around the world, the three-volume Handbook of Nanostructured Thin Films and Coatings gives scientific researchers and product engineers a resource as dynamic and flexible as the field itself. The first two volumes cover the latest research and application of the mechanical and functional properties of thin films and coatings, while the third volume explores the cutting-edge organic nanostructured devices used to produce clean energy. This second volume, Nanostructured Thin Films and Coatings: Functional Properties, focuses on functional properties (i.e., optical, electronic, and electrical) and related devices and applications. It also addresses topics such as: Large-scale fabrication of functional thin films using nanoarchitecture via chemical routes Fabrication and characterization of SiC nanostructured/nanocomposite films Low-dimensional nanocomposite fabrication and its applications Optical and optoelectronic properties of silicon nanocrystals embedded in SiO2 matrix Electrical properties of silicon nanocrystals embedded in amorphous SiO2 matrix Optical aspects of properties and applications of sol-gel-derived nanostructured thin films Controllably micro/nanostructured films and devices Thin-film shape memory alloy for microsystem applications A complete resource, this handbook provides the detailed explanations that newcomers need, as well as the latest cutting-edge research and data for experts. Covering a wide range of mechanical and functional technologies, including those used in clean energy, these books also feature figures, tables, and images that will aid research and help professionals acquire and maintain a solid grasp of this burgeoning field. The Handbook of Nanostructured Thin Films and Coatings is composed of this volume and two others: Nanostructured Thin Films and Coatings: Mechanical Properties Organic Nanostructured Thin Film Devices and Coatings for Clean Energy**

Introduction to Nano

Basics to Nanoscience and Nanotechnology

Springer **This book covers the basics of nanotechnology and provides a solid understanding of the subject. Starting from a brush-up of the basic quantum mechanics and materials science, the book helps to gradually build up understanding of the various effects of quantum confinement, optical-electronic properties of nanoparticles and major nanomaterials. The book covers the various physical, chemical and hybrid methods of nanomaterial synthesis and nanofabrication as well as advanced characterization techniques. It includes chapters on the various applications of nanoscience and nanotechnology. It is written in a simple form, making it useful for students of physical and material sciences.**

Dekker Encyclopedia of Nanoscience and Nanotechnology

CRC Press

Annual Review of Nano Research

World Scientific **The second volume of the Annual Review of Nano Research focuses mainly on nanofabrication, nanomaterials and nanostructures, and energy application of nanomaterials. All of the review chapters are contributed by well-published scientists and bring the most recent advancements in selected topics to the readers. This review volume will perfectly serve dual purposes: either as an excellent introduction to scientists whose expertise lies in different fields but who are interested in learning about nanotechnology, or as a quick reference for experts active in the field of nanotechnology and nanoscience. Sample Chapter(s). Chapter 1: Optical and Dynamic Properties of Undoped and Doped Semiconductor Nanostructures (782 KB). Contents: Optical and Dynamic Properties of Undoped and Doped Semiconductor Nanostructures (J Z Zhang & C D Grant); Nanostructure Presented Chemiluminescence and Electrochemiluminescence (Z-P Wang & J Li); Excitons in Nanoscale Systems: Fundamentals and Applications (G D Scholes & G Rumbles); Silicon Nanocrystal Assemblies: Universal Spin-Flip Activators? (D Kovalev & M Fujii); DNA-Templated Nanowires: Context, Fabrication, Properties and Applications (Q Gu & D T Haynie); Solution-Based Synthesis of Oriented One-Dimensional Nanomaterials (J Liu & G-Z Cao); One- and Two-Dimensional Assemblies of Nanoparticles: Mechanisms of Formation and Functionality (N A Kotov & Z-Y Tang); Synthesis of Porous Polymers Using Supercritical Carbon Dioxide (C D Wood & A I Cooper); Hierarchical Macro-Mesoporous Oxides and Carbons: Towards New and More Efficient Hierarchical Catalysis (A L(r)onard et al.); Environmental Application of Nanotechnology (G A Mansoori et al.); Nanostructured Ionic and Mixed Conducting Oxides (X Guo & S Kim); Nanostructured Cathode Materials for Advanced Li-Ion Batteries (Y Wang & G-Z Cao); Nanostructured Materials for Solar Cells (T-Y Zeng et al.). Readership: Research scientists and engineers in academia, research institutes and industry, as well as graduate students and upper-level undergraduate students in the physical sciences and engineerin**

Molecular Beam Epitaxy

From Research to Mass Production

Elsevier **Molecular Beam Epitaxy (MBE): From Research to Mass Production, Second Edition, provides a comprehensive overview of the latest MBE research and applications in epitaxial growth, along with a detailed discussion and ‘how to’ on processing molecular or atomic beams that occur on the surface of a heated crystalline substrate in a vacuum. The techniques addressed in the book can be deployed wherever precise thin-film devices with enhanced and unique properties for computing, optics or photonics are required. It includes new semiconductor materials, new device structures that are commercially available, and many that are at the advanced research stage. This second edition covers the advances made by MBE, both in research and in the mass production of electronic and optoelectronic devices. Enhancements include new chapters on MBE growth of 2D materials, Si-Ge materials, AIN and GaN materials, and hybrid ferromagnet and semiconductor structures. Condenses the fundamental science of MBE into a modern reference, speeding up literature review Discusses new materials, novel applications and new device structures, grounding current commercial applications with modern understanding in industry and research Includes coverage of MBE as mass production epitaxial technology and how it**

enhances processing efficiency and throughput for the semiconductor industry and nanostructured semiconductor materials research community

Ultrananocrystalline Diamond Coatings for Next-Generation High-Tech and Medical Devices

Cambridge University Press **A comprehensive guide to the science of a transformational ultrananocrystalline-diamond (UNCDTM) thin film technology enabling a new generation of high-tech and external and implantable medical devices. Edited and co-authored by a co-originator and pioneer in the field, it describes the synthesis and material properties of UNCDTM coatings and multifunctional oxide/nitride thin films and nanoparticles, and how these technologies can be integrated into the development of implantable and external medical devices and treatments of human biological conditions. Bringing together contributions from experts around the world, it covers a range of clinical applications, including ocular implants, glaucoma treatment devices, implantable prostheses, scaffolds for stem cell growth and differentiation, Li-ion batteries for defibrillators and pacemakers, and drug delivery and sensor devices. Technology transfer and regulatory issues are also covered. This is essential reading for researchers, engineers and practitioners in the field of high-tech and medical device technologies across materials science and biomedical engineering.**

Nanoscale Devices - Fundamentals and Applications

Springer Science & Business Media **This book collects papers on the fundamentals and applications of nanoscale devices, first presented at the NATO Advanced Research Workshop on Nanoscale Devices – Fundamentals and Applications held in Kishinev, Moldova, in September 2004. The focus is on the synthesis and characterization of nanoscale magnetic materials; fundamental physics and materials aspects of solid-state nanostructures; development of novel device concepts and design principles for nanoscale devices; and on applications in electronics with emphasis on defence against the threat of terrorism.**

Non-equilibrium Evaporation and Condensation Processes

Analytical Solutions

Springer Nature **This present book is concerned with analytical approaches to statement and solution of problems of non-equilibrium evaporation and condensation. From analytical solutions, one is capable to understand and represent in a transparent form the principal laws, especially in the study of a new phenomenon or a process. This is why analytical methods are always employed on the first stage of mathematical modeling. Analytical solutions are also used as test models for validation of results numerical solutions. Non-equilibrium evaporation and condensation processes play an important role in a number of fundamental and applied problems: laser methods for processing of materials, depressurization of the protection cover of nuclear propulsion units, solar radiation on a comet surface, explosive boiling of superheated liquid, thermodynamic principles of superfluid helium. Analytical relations provide an adequate description of the essence of a physical phenomenon.**

Diffusion and Stresses

Trans Tech Publications Ltd **The question of the interrelationship between diffusion and stress is almost as old as the investigation of diffusion itself. Nowadays, the study of various diffusion and solid-state reaction processes in thin films and multilayers is a vital area of research activity in which, inevitably, diffusion-induced or thermal stresses are of primary importance. Volume is indexed by Thomson Reuters CPCI-S (WoS).**

Advances in Nanocomposites

Modeling, Characterization and Applications

Springer **This book introduces nanocomposite materials possessing a broad range of multifunctionality. It elucidates novel and highly original developments from recent research and development of these critical, new engineered materials. The collection examines multiscale modeling, molecular dynamics, atomistic based continuum, synthesis and characterization, condition health monitoring, spectroscopic characterization techniques, self-lubricating materials, and conducting polymers. The volume features the latest efforts of some of the most eminent researchers in the world. Providing a range of perspectives from the laboratory and the field, Advances in Nanocomposites: Modeling and Characterization is ideal for engineers, physicists, and materials scientists in academia and industry.**

Mechanical Stress on the Nanoscale

Simulation, Material Systems and Characterization Techniques

John Wiley & Sons **Bringing together experts from the various disciplines involved, this first comprehensive overview of the current level of stress engineering on the nanoscale is unique in combining the theoretical fundamentals with simulation methods, model systems and characterization techniques. Essential reading for researchers in microelectronics, optoelectronics, sensing, and photonics.**

Stanford Bulletin

21st Century Nanoscience

A Handbook (Ten-Volume Set)

CRC Press **This 21st Century Nanoscience Handbook will be the most comprehensive, up-to-date large reference work for the field of nanoscience. Handbook of Nanophysics, by the same editor, published in the fall of 2010, was embraced as the first comprehensive reference to consider both fundamental and applied aspects of nanophysics. This follow-up project has been conceived as a necessary expansion and full update that considers the significant advances made in the field since 2010. It goes well beyond the physics as warranted by recent developments in the field. Key Features: Provides the most comprehensive, up-to-date large reference work for the field. Chapters written by international experts in the field. Emphasises presentation and real results and applications. This handbook distinguishes itself from other works by its breadth of coverage, readability and timely topics. The intended readership is very broad, from students and instructors to engineers, physicists, chemists, biologists, biomedical researchers, industry professionals, governmental scientists, and others whose work is impacted by nanotechnology. It will be an indispensable resource in academic, government, and industry libraries worldwide. The fields impacted by nanoscience extend from materials science and engineering to**

biotechnology, biomedical engineering, medicine, electrical engineering, pharmaceutical science, computer technology, aerospace engineering, mechanical engineering, food science, and beyond.

Surface and Interface Characterization of Thin Film Energy Devices

Stanford University **Thin film devices for energy conversion have become a vital area of research to achieve high performance with low cost. As the surface-to-volume ratio becomes significant, the fundamental physics of the surface and interface microstructures and the reaction mechanisms are important to developing such energy devices or processes. My Ph.D. research is thus focus on surface and interface characterization of energy materials for thin film devices with engineered components fabricated by novel technologies. The first part of this dissertation discusses how surface microstructures influence fuel cell performance. According to the high resolution characterization of surface grain boundaries in solid oxide ion conductors, oxygen vacancy segregation at grain boundaries was observed, indicating that the grain boundaries can be more active sites for oxygen incorporation into the electrolyte. This preferred surface reaction at grain boundaries was verified by AC impedance spectroscopy. In addition, using atomic force microscopy, the local rearrangement of charged species on the oxide surface was investigated as a function of time and temperature to quantitatively analyze the diffusivity of oxygen vacancies on the surface. The second part discusses investigation of quantum confined structures that was aimed at contributing to the development of new solar cell architectures. The electronic properties of quantum confined structures, fabricated by atomic layer deposition (ALD), were characterized by scanning tunneling microscopy. In particular, the band gap of lead sulfide quantum well was tuned as a function of well thickness and potential barrier height. In addition, various nano-patterning techniques were developed to fabricate higher-order quantum confined structures, including area-selective ALD.**