

Techniques of Physics: 12

SEM
MICROCHARACTERIZATION
OF SEMICONDUCTORS

Edited by
D.B. Holt and D.C. Joy

Sem Microcharacterization Of Semiconductors

B.G. Yacobi

A decorative graphic consisting of a red circular shape with a white center, partially obscured by a white horizontal bar that extends from the left edge of the slide.

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SEM Microcharacterization of Semiconductors D. B. Holt, D. C. Joy, 2013-10-22 Applications of SEM techniques of microcharacterization have proliferated to cover every type of material and virtually every branch of science and technology. This book emphasizes the fundamental physical principles. The first section deals with the foundation of microcharacterization in electron beam instruments and the second deals with the interpretation of the information obtained in the main operating modes of a scanning electron microscope.

Optical Characterization of Semiconductors Sidney Perkowitz, 2012-12-02 This is the first book to explain, illustrate, and compare the most widely used methods in optics: photoluminescence, infrared spectroscopy, and Raman scattering. Written with non-experts in mind, the book develops the background needed to understand the why and how of each technique but does not require special knowledge of semiconductors or optics. Each method is illustrated with numerous case studies. Practical information drawn from the authors' experience is given to help establish optical facilities, including commercial sources for equipment and experimental details. For industrial scientists with specific problems in semiconducting materials, for academic scientists who wish to apply their spectroscopic methods to characterization problems, and for students in solid state physics, materials science, and engineering and semiconductor electronics and photonics, this book provides a unique overview bringing together these valuable techniques in a coherent way for the first time. Discusses and compares infrared, Raman, and photoluminescence methods. Enables readers to choose the best method for a given problem. Illustrates applications to help non-experts and industrial users with answers to selected common problems. Presents fundamentals with examples from the semiconductor literature without excessive abstract discussion. Features equipment lists and discussion of techniques to help establish characterization laboratories.

Characterization of Semiconductor Heterostructures and Nanostructures Lorenzo Rigutti, Maria Tchernycheva, 2013-04-11

Scanning Electron Microscopy and X-Ray Microanalysis Joseph Goldstein, Dale E. Newbury, David C. Joy, Charles E. Lyman, Patrick Echlin, Eric Lifshin, Linda Sawyer, J.R. Michael, 2012-12-06 In the decade since the publication of the second edition of *Scanning Electron Microscopy and X-Ray Microanalysis*, there has been a great expansion in the capabilities of the basic scanning electron microscope (SEM) and the x-ray spectrometers. The emergence of the variable pressure environmental SEM has enabled the observation of samples containing water or other liquids or vapor and has allowed for an entirely new class of dynamic experiments that of direct observation of chemical reactions in situ. Critical advances in electron detector technology and computer-aided analysis have enabled structural crystallographic analysis of specimens at the micrometer scale through electron backscatter diffraction (EBSD). Low voltage operation below 5 kV has improved x-ray spatial resolution by more than an order of magnitude and provided an effective route to minimizing sample charging. High resolution imaging has continued to develop with a more thorough understanding of how secondary electrons are generated. The field emission gun SEM with its high brightness, advanced electron optics which minimizes lens

aberrations to yield an effective nanometer scale beam and through the lens detector to enhance the measurement of primary beam excited secondary electrons has made high resolution imaging the rule rather than the exception. Methods of x ray analysis have evolved allowing for better measurement of specimens with complex morphology multiple thin layers of different compositions and rough specimens and particles. Digital mapping has transformed classic x ray area scanning a purely qualitative technique into fully quantitative compositional mapping.

Microanalysis of Solids B.G. Yacobi, L.L. Kazmerski, D.B. Holt, 2013-06-29. The main objective of this book is to systematically describe the basic principles of the most widely used techniques for the analysis of physical structural and compositional properties of solids with a spatial resolution of approximately 1 nm or less. Many books and reviews on a wide variety of microanalysis techniques have appeared in recent years and the purpose of this book is not to replace them. Rather the motivation for combining the descriptions of various microanalysis techniques in one comprehensive volume is the need for a reference source to help identify microanalysis techniques and their capabilities for obtaining particular information on solid state materials. In principle there are several possible ways to group the various microanalysis techniques. They can be distinguished by the means of excitation or the emitted species or whether they are surface or bulk sensitive techniques or on the basis of the information obtained. We have chosen to group them according to the means of excitation. Thus the major parts of the book are Electron Beam Techniques, Ion Beam Techniques, Photon Beam Techniques, Acoustic Wave Excitation and Tunneling of Electrons and Scanning Probe Microscopies. We hope that this book will be useful to students, final year undergraduates and graduates and researchers such as physicists, material scientists, electrical engineers and chemists working in a wide variety of fields in solid state sciences.

Characterization of Semiconductor Heterostructures and Nanostructures Giovanni Agostini, Carlo Lamberti, 2013-04-11. Characterization of Semiconductor Heterostructures and Nanostructures is structured so that each chapter is devoted to a specific characterization technique used in the understanding of the properties structural, physical, chemical, electrical, etc. of semiconductor quantum wells and superlattices. An additional chapter is devoted to ab initio modeling. The book has two basic aims. The first is educational, providing the basic concepts of each of the selected techniques with an approach understandable by advanced students in Physics, Chemistry, Material Science, Engineering, Nanotechnology. The second aim is to provide a selected set of examples from the recent literature of the TOP results obtained with the specific technique in understanding the properties of semiconductor heterostructures and nanostructures. Each chapter has this double structure: the first part devoted to explain the basic concepts and the second to the discussion of the most peculiar and innovative examples. The topic of quantum wells, wires and dots should be seen as a pretext of applying top level characterization techniques in understanding the structural, electronic, etc. properties of matter at the nanometer and even sub nanometer scale. In this respect it is an essential reference in the much broader and extremely hot field of Nanotechnology. Comprehensive collection of the most powerful characterization techniques for semiconductors.

heterostructures and nanostructures Most of the chapters are authored by scientists that are world wide among the top ten in publication ranking of the specific field Each chapter starts with a didactic introduction on the technique The second part of each chapters deals with a selection of top examples highlighting the power of the specific technique to analyse the properties of semiconductors heterostructures and nanostructures

Capacitance Spectroscopy of Semiconductors Jian V. Li, Giorgio Ferrari, 2018-07-06 Capacitance spectroscopy refers to techniques for characterizing the electrical properties of semiconductor materials junctions and interfaces all from the dependence of device capacitance on frequency time temperature and electric potential This book includes 15 chapters written by world recognized leading experts in the field academia national institutions and industry divided into four sections Physics Instrumentation Applications and Emerging Techniques The first section establishes the fundamental framework relating capacitance and its allied concepts of conductance admittance and impedance to the electrical and optical properties of semiconductors The second section reviews the electronic principles of capacitance measurements used by commercial products as well as custom apparatus The third section details the implementation in various scientific fields and industries such as photovoltaics and electronic and optoelectronic devices The last section presents the latest advances in capacitance based electrical characterization aimed at reaching nanometer scale resolution

Advanced Scanning Electron Microscopy and X-Ray Microanalysis Patrick Echlin, C.E. Fiori, Joseph Goldstein, David C. Joy, Dale E. Newbury, 2013-06-29 This book has its origins in the intensive short courses on scanning elec tron microscopy and x ray microanalysis which have been taught annually at Lehigh University since 1972 In order to provide a textbook containing the materials presented in the original course the lecturers collaborated to write the book Practical Scanning Electron Microscopy PSEM which was published by Plenum Press in 1975 The course con tinued to evolve and expand in the ensuing years until the volume of material to be covered necessitated the development of separate intro ductory and advanced courses In 1981 the lecturers undertook the project of rewriting the original textbook producing the volume Scan ning Electron Microscopy and X Ray Microanalysis SEMXM This vol ume contained substantial expansions of the treatment of such basic material as electron optics image formation energy dispersive x ray spectrometry and qualitative and quantitative analysis At the same time a number of chapters which had been included in the PSEM vol ume including those on magnetic contrast and electron channeling con trast had to be dropped for reasons of space Moreover these topics had naturally evolved into the basis of the advanced course In addition the evolution of the SEM and microanalysis fields had resulted in the devel opment of new topics such as digital image processing which by their nature became topics in the advanced course

Characterization in Compound Semiconductor Processing Yale Strausser, Gary E. McGuire, 2010 Characterization in Compound Semiconductor Processing is for scientists and engineers working with compound semiconductor materials and devices who are not characterization specialists Materials and processes typically used in R D and in the fabrication of GaAs GaAlAs InP and HgCdTe based

devices provide examples of common analytical problems The book discusses a variety of characterization techniques to provide insight into how each individually or in combination might be used in solving problems associated with these materials The book will help in the selection and application of the appropriate analytical techniques by its coverage of all stages of materials or device processing substrate preparation epitaxial growth dielectric film deposition contact formation and dopant introduction P 4 of cover

Semiconductor Materials B.G. Yacobi,2006-04-18 The technological progress is closely related to the developments of various materials and tools made of those materials Even the different ages have been defined in relation to the materials used Some of the major attributes of the present day age i e the electronic materials age are such common tools as computers and fiber optic telecommunication systems in which semiconductor materials provide vital components for various mic electronic and optoelectronic devices in applications such as computing memory storage and communication The field of semiconductors encompasses a variety of disciplines This book is not intended to provide a comprehensive description of a wide range of semiconductor properties or of a continually increasing number of the semiconductor device applications Rather the main purpose of this book is to provide an introductory perspective on the basic principles of semiconductor materials and their applications that are described in a relatively concise format in a single volume Thus this book should especially be suitable as an introductory text for a single course on semiconductor materials that may be taken by both undergraduate and graduate engineering students This book should also be useful as a concise reference on semiconductor materials for researchers working in a wide variety of fields in physical and engineering sciences

Springer Handbook of Microscopy Peter W. Hawkes,John C.H. Spence,2019-11-02 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

Handbook of Instrumentation and Techniques for Semiconductor Nanostructure Characterization Richard Haight,Frances M. Ross,James B. Hannon,2012 As we delve more

deeply into the physics and chemistry of functional materials and processes we are inexorably driven to the nanoscale And nowhere is the development of instrumentation and associated techniques more important to scientific progress than in the area of nanoscience The dramatic expansion of efforts to peer into nanoscale materials and processes has made it critical to capture and summarize the cutting edge instrumentation and techniques that have become indispensable for scientific investigation in this arena This Handbook is a key resource developed for scientists engineers and advanced graduate students in which eminent scientists present the forefront of instrumentation and techniques for the study of structural optical and electronic properties of semiconductor nanostructures

Compound Semiconductor Bulk Materials and Characterizations Osamu Oda, 2007 This book is concerned with compound semiconductor bulk materials and has been written for students researchers and engineers in material science and device fabrication It offers them the elementary and intermediate knowledge of compound semiconductor bulk materials necessary for entering this field In the first part the book describes the physical properties crystal growth technologies principles of crystal growth various defects in crystals characterization techniques and applications In the second and the third parts the book reviews various compound semiconductor materials including important industrial materials and the results of recent research

Microscopy of Semiconducting Materials A.G. Cullis, John L. Hutchison, 2006-08-25 The 14th conference in the series focused on the most recent advances in the study of the structural and electronic properties of semiconducting materials by the application of transmission and scanning electron microscopy The latest developments in the use of other important microcharacterisation techniques were also covered and included the latest work using scanning probe microscopy and also X ray topography and diffraction

Cathodoluminescence Microscopy of Inorganic Solids B.G. Yacobi, D.B. Holt, 2013-06-29

Microcharacterization of materials is a rapidly advancing field Among the many electron and ion probe techniques the cathodoluminescence mode of an electron probe instrument has reached a certain maturity which is reflected by an increasing number of publications in this field The rapid rate of progress in applications of cathodoluminescence techniques in characterizing inorganic solids has been especially noticeable in recent years The main purpose of the book is to outline the applications of cathodoluminescence techniques in the assessment of optical and electronic properties of inorganic solids such as semiconductors phosphors ceramics and minerals The assessment provides for example information on impurity levels derived from cathodoluminescence spectroscopy analysis of dopant concentrations at a level that in some cases is several orders of magnitude lower than that attainable by x ray microanalysis the mapping of defects and the determination of carrier lifetimes and the charge carrier capture cross sections of impurities In order to make the book self contained some basic concepts of solid state physics as well as various cathodoluminescence techniques and the processes leading to luminescence phenomena in inorganic solids are also described We hope that this book will be useful to both scientists and graduate students interested in microcharacterization of inorganic solids This book however was not intended as a definitive

account of cathodoluminescence analysis of inorganic solids In considering the results presented here readers should remember that many materials have properties that vary widely as a function of preparation conditions Semiconductor Materials Analysis and Fabrication Process Control G.M. Crean,R. Stuck,J.A. Woollam,2012-12-02 There is a growing awareness that the successful implementation of novel material systems and technology steps in the fabrication of microelectronic and optoelectronic devices is critically dependent on the understanding and control of the materials the process steps and their interactions The contributions in this volume demonstrate that characterisation and analysis techniques are an essential support mechanism for research in these fields Current major research themes are reviewed both in the development and application of diagnostic techniques for advanced materials analysis and fabrication process control Two distinct trends are elucidated the emergence and evaluation of sophisticated in situ optical diagnostic techniques such as photoreflectance and spectroellipsometry and the industrial application of ultra high sensitivity chemical analysis techniques for contamination monitoring The volume will serve as a useful and timely overview of this increasingly important field Optical Microstructural Characterization of Semiconductors: Volume 588 M. Selim Ünlü,2000-04-17 The MRS Symposium Proceeding series is an internationally recognised reference suitable for researchers and practitioners

Encyclopedia of Plasma Technology - Two Volume Set J. Leon Shohet,2016-12-12 Technical plasmas have a wide range of industrial applications The Encyclopedia of Plasma Technology covers all aspects of plasma technology from the fundamentals to a range of applications across a large number of industries and disciplines Topics covered include nanotechnology solar cell technology biomedical and clinical applications electronic materials sustainability and clean technologies The book bridges materials science industrial chemistry physics and engineering making it a must have for researchers in industry and academia as well as those working on application oriented plasma technologies Also Available Online This Taylor E mail e reference taylorandfrancis com International Tel 44 0 20 7017 6062 E mail online sales tandf co uk **Advanced Silicon Materials for Photovoltaic Applications** Sergio Pizzini,2012-06-07 Today the silicon feedstock for photovoltaic cells comes from processes which were originally developed for the microelectronic industry It covers almost 90% of the photovoltaic market with mass production volume at least one order of magnitude larger than those devoted to microelectronics However it is hard to imagine that this kind of feedstock extremely pure but heavily penalized by its high energy cost could remain the only source of silicon for a photovoltaic market which is in continuous expansion and which has a cumulative growth rate in excess of 30% in the last few years Even though reports suggest that the silicon share will slowly decrease in the next twenty years finding a way to manufacture a specific solar grade feedstock in large quantities at a low cost while maintaining the quality needed still remains a crucial issue Thin film and quantum confinement based silicon cells might be a complementary solution Advanced Silicon Materials for Photovoltaic Applications has been designed to describe the full potentialities of silicon as a multipurpose material and covers Physical chemical and structural properties of silicon

Production routes including the promise of low cost feedstock for PV applications Defect engineering and the role of impurities and defects Characterization techniques and advanced analytical techniques for metallic and non metallic impurities Thin film silicon and thin film solar cells Innovative quantum effects and 3rd generation solar cells With contributions from internationally recognized authorities this book gives a comprehensive analysis of the state of the art of process technologies and material properties essential for anyone interested in the application and development of photovoltaics

Extended Defects in Semiconductors D. B. Holt, B. G. Yacobi, 2007-04-12 The elucidation of the effects of structurally extended defects on electronic properties of materials is especially important in view of the current advances in electronic device development that involve defect control and engineering at the nanometer level This book surveys the properties effects roles and characterization of extended defects in semiconductors The basic properties of extended defects dislocations stacking faults grain boundaries and precipitates are outlined and their effect on the electronic properties of semiconductors their role in semiconductor devices and techniques for their characterization are discussed These topics are among the central issues in the investigation and applications of semiconductors and in the operation of semiconductor devices The authors preface their treatment with an introduction to semiconductor materials and conclude with a chapter on point defect maldistributions This text is suitable for advanced undergraduate and graduate students in materials science and engineering and for those studying semiconductor physics

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