Electron Beam Interactions With Solids Application Of The Monte Carlo Method To Electron Scattering Problems Springer Tracts In Modern Physics


Cohesive Properties of Semiconductors under Laser Irradiation The conference "Laser Science and Technology" was held May 11-19, 1987 in Erice, Sicily. This was the 12th conference organized by the Internatio nal School of Quantum Electronics, under the auspices of the "Ettore Majorana" Center for Scientific Culture. This volume contains both the invited and contributed papers presented at the conference, covering current research work in two areas: new laser sources, and laser applications. The operation of the first laser by Dr. Theodore Maiman in 1960 initiated a decade of scientific exploration of new laser sources. This was followed by the decade of the 1970s, which was characterized by "technology push" in which the discoveries of the 1960s were seeking practical application. In the 1980s we are instead seeking "applications pull," in which the success and rapid maturing of laser applications provides both inspiration and financial resources to stimulate additional work both on laser sources and applications. The papers presented in these Proceedings attest to the great vitality of research in both these areas: New Laser Sources. The papers describe current developments in ultra violet excimer lasers, X-ray lasers, and free electron lasers. These new lasers share several characteristics: each is a potentially important coherent source; each is at a relatively short wavelength (below 1 micrometer); and each is receiving significant development attention today.

Laser Science and Technology Laser Annealing of Semiconductors deals with the materials science of surfaces that have been subjected to ultrafast heating by intense laser or electron beams. This book is organized into 13 chapters that specifically tackle transient annealing of compound semiconductors. After briefly dealing with an overview of laser annealing, this book goes on discussing the concepts of solidification and crystallization pertinent to the field. These topics are followed by discussions on the main mechanisms of interaction of photon and electron beams with condensed matter; the calculation of thermophysical properties of crystalline materials; and high-speed crystal growth by laser annealing of ion-implanted silicon. The subsequent chapters describe the microstructural and topographical properties of annealed semiconductor layers and the epitaxy of ion-implanted silicon irradiated with a laser or electron beam single pulse. This text also explores the electronic and surface properties and the continuous-wave beam processing of semiconductors. The concluding chapters cover various reactions in metal-semiconductor systems, such as fast and laser-induced melting, solidification, mixing, and quenching. Laser-induced interactions in metal-semiconductor systems and the factors involved in control of the heat treatment process are also discussed in these chapters. Materials scientists and researchers and device engineers will find this book invaluable.

Chemical Processing with Lasers

Laser Processing of Thin Films and Microstructures The European Microanalysis Society held its Fourth Workshop in Saint Malo in May 1995. This volume includes the revised presentations, 10 tutorial chapters and 50 brief articles, from leading experts in electron probe microanalysis, secondary mass spectroscopy, analytical electron microscopy, and related fields.

Laser Processing and Diagnostics Laser processing is now a rapidly increasing field with many real and potential applications in different areas of technology such as micromechanics, metallurgy, integrated optics, and semiconductor device fabrication. The necessity for such sophisticated light sources as 1 asers is based on the spatial coherence and the monochromaticity of laser light. The spatial coherence permits extreme focusing of the laser light resulting in the availability of high energy densities which can be used for strongly localized heat- and chemical-treatment of materials, with a resolution down to 1 esd than 1 Jlll. When us ng pul sed or scanned cw-l asers, 1 oca 1 i zat i on in time is also possible. Additionally, the monochromaticity of laser light allows for control of the depth of heat treatment and/or selective, nonthermal bond breaking
Physics

Carlo Method To Electron Scattering Problems Springer Tracts In Modern Physics

...within the surface of the material or within the molecules of the surrounding reactive atmosphere - simply by tuning the laser wavelength. These inherent advantages of laser light permit micromachining of materials (drilling, cutting, welding etc.) and also allow single-step controlled area processing of thin films and surfaces. Processes include structural transformation (removal of residual damage, grain growth in polycrystalline material, amorphization, surface hardening etc.), etching, doping, alloying, or deposition. In addition, laser processing is not limited to planar substrates.


Lithography for VLSI This book, written by a pioneer in surface physics and thin film research and the inventor of Low Energy Electron Microscopy (LEEM), Spin-Polarized Low Energy Electron Microscopy (SPELEEM) and Spectroscopic Photo Emission and Low Energy Electron Microscopy (SPELEEM), covers these and other techniques for the imaging of surfaces with low energy (slow) electrons. These techniques also include Photoemission Electron Microscopy (PEEM), X-ray Photoemission Electron Microscopy (XPEEM), and their combination with microdiffraction and microspectroscopy, all of which use cathode lenses and slow electrons. Of particular interest are the fundamentals and applications of LEEM, PEEM, and XPEEM because of their widespread use. Numerous illustrations illuminate the fundamental aspects of the electron optics, the experimental setup, and particularly the application results with these instruments. Surface Microscopy with Low Energy Electrons will give the reader a unified picture of the imaging, diffraction, and spectroscopy methods that are possible using low energy electron microscopes.

Electron-Beam Interactions with Solids Materials processing with lasers is a rapidly expanding field which is increasingly captivating the attention of scientists, engineers and manufacturers alike. The aspect of most interest to scientists is provided by the basic interaction mechanisms between the intense light of a laser and materials exposed to a chemically reactive or nonreactive surrounding medium. Engineers and manufacturers see in the laser a new tool which will not only make manufacturing cheaper, faster, cleaner and more accurate but which also opens up entirely new technologies and manufacturing methods that are simply not available using existing techniques. Actual and potential applications range from laser machining to laser-induced materials transformation, coating, patterning, etc., opening up the prospect of exciting new processing methods for micromechanics, metallurgy, integrated optics, semiconductor manufacture and chemical engineering. This book concentrates on the new and interdisciplinary field of laser-induced chemical process in material sciences. The techniques permit maskless single-step deposition of thin films of metals, semiconductors or insulators with lateral dimensions ranging from a few tenths of a micrometer up to several centimeters. Moreover, materials removal or synthesis, or surface modifications, such as oxidation, nitridation, reduction, metallisation and doping, are also possible within similar dimensions. This book is meant as an introduction. It attempts to cater for the very broad range of specific interests which different groups of readers will have, and this thinking underlies the way in which the material has been arranged.

Interfaces Under Laser Irradiation Laser-Assisted Microtechnology deals with laser applications to a wide variety of problems in microelectronic design and fabrication. It covers micromachining of thin films, microprocessing of materials, maskless laser micropatterning and laser-assisted synthesis of thin-film systems. The monograph describes fundamental aspects and practical details of the technological processes as well as the optimum conditions for their realization.

Charged Beam Interaction with Solids This book features reviews by leading experts on the methods and applications of modern forms of microscopy. The recent awards of Nobel Prizes 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 microscopes, 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.

Surface Modification and Alloying This volume contains invited and contributed papers at the conference on Microscopy of Semiconducting Materials which took place on 21/23 March 1983 in St Catherines College, Oxford. The conference was the third in the series devoted to advances in microscopical studies of semiconductors.

Fundamental Electron and Ion Beam Interactions with Solids for Microscopy, Microanalysis and Microlithography

Microlithography The interaction of an electron beam with a solid target has been studied since the early part of the past century. Since 1960, the electron-solid interaction has become a subject of numerous investigations and in Auger electron spectroscopy, in electron-beam lithography and in radiation damage. The interaction of an electron beam with a solid target has often been investigated theoretically by using the Monte Carlo method, a numerical procedure involving random numbers that is able to solve mathematical problems. This method is very useful for the study of electron penetration in matter. The probabilistic laws of the interaction of an individual electron with the atoms constituting the target are well known. Consequently, it is possible to compute the macroscopic characteristics of interaction processes by simulating a large number of real trajectories, and then...
averaging them. The aim of this book is to study the probabilistic laws of the interaction of individual electrons with atoms (elastic and inelastic cross-sections); to investigate selected aspects of electron interaction with matter (backscattering coefficients for bulk targets, absorption, backscattering and transmission for both supported and unsupported thin films, implantation processes, second electron emission, and so on); and to introduce the Monte Carlo method and its applications to compute the macroscopic characteristics of the interaction processes mentioned above. The book compares theory, computational simulations and experimental data in order to offer a more global vision.

Laser Annealing of Semiconductors Scanning Electron Microscopy provides a description of the physics of electron-probe formation and of electron-specimen interactions. The different imaging and analytical modes using secondary and backscattered electrons, electron-beam-induced currents, X-ray and Auger electrons, electron channelling effects, and cathodoluminescence are discussed to evaluate specific contrasts and to obtain quantitative information.

Semiconductors and Semimetals Semiconductors Probed by Ultrafast Laser Spectroscopy, Volume II discusses the use of ultrafast laser spectroscopy in studying fast physics in semiconductors. It reviews progress on the experimental and theoretical understanding of ultrafast events that occur on a picosecond and nanosecond time scale. This volume discusses electronic relaxation in amorphous semiconductor materials and the physical mechanisms during and after the interaction of an intense laser pulse with a semiconductor. It also covers the relaxation of carriers in semiconductors; transient optical pulse propagation; and methods of time-resolved spectroscopy. Scientists, engineers, and graduate students will find this book invaluable.

Materials Analysis by Ion Channeling VLSI Electronics Microstructure Science, Volume 16: Lithography for VLSI treats special topics from each branch of lithography, and also contains general discussion of some lithographic methods. This volume contains 8 chapters that discuss the various aspects of lithography. Chapters 1 and 2 are devoted to optical lithography. Chapter 3 covers electron lithography in general, and Chapter 4 discusses electron resist exposure modeling. Chapter 5 presents the fundamentals of ion-beam lithography. Mask/wafer alignment for x-ray proximity printing and for optical lithography is tackled in Chapter 6. Chapters 7 and 8 on metrology deal with the characterization of lithography by measurements of various types. Engineers, scientists, and technical managers in the semiconductor industry, and engineers and applied physics faculty and graduate students will find the text very useful.

Handbook of Charged Particle Optics Our intention has been to write a book that would be useful to people with a variety of levels of interest in this subject. Clearly it should be useful to both graduate students and workers in the field. We have attempted to bring together many of the concepts used in channeling beam analysis with an indication of the origin of the ideas within fundamental channeling theory. The level of the book is appropriate to senior undergraduate and graduate students who have had a modern physics course work in related areas of materials science and wish to learn more about the "channeling" probe, its strengths, weaknesses, and areas of further potential application. To them we hope we have explained this apparent paradox of using mega-electron volt ions to probe solid state phenomena that have characteristic energies of electron volts.

PFEFFERKORN CONFERENCE on ELECTRON BEAM INTERACTIONS with SOLIDS for MICROSCOPY, MICROANALYSIS, AND MICROLITHOGRAPHY(1982) This book collects recent topics of theoretical chemistry for advanced nanomaterials from the points of view of both computational and experimental chemistry. It is written for computational and experimental chemists, including undergraduate students, who are working with advanced nanomaterials, where collaboration and interplay between computation and experiment are essential. After the general introduction of nanomaterials, several computational approaches are explained in Part II. Each chapter presents not only calculation methods but also concrete calculation results for advanced nanomaterials. Hydride ion conducting nanomaterials, high-k dielectric nanomaterials, and organic electronics are focused on. In Part III, the interplay between computational and experimental approaches is explained. The chapters show calculation results, combined with corresponding experimental data. Dimensionality of nanomaterials, electronic structure of oligomers and nanorods, carbon nanomaterials, and the electronic structure of a nanosized sandwich cluster is looked at carefully. In Part IV, functionality analysis is explained from the point of view of the experimental approach. The emphasis is on the mechanism of photoluminescence and hydrogen generation using silicon nanopowder, the superionic conducting mechanism of glass ceramics, nanoclusters formation on the surface of metal oxides, and the magnetic property of an organic one-dimensional nanochannel. Finally, forthcoming theoretical methods for excited states and quantum dynamics are introduced in Part V.

Introduction to Focused Ion Beams Silicon Integrated Circuits, Part 2 covers some of the most promising approaches along with the new understanding of processing-related areas of physics and chemistry. The first chapter is about the transient thermal processing of silicon, including annealing with directed-energy beams and rapid isothermal annealing; adiabatic annealing with laser and electron beams; pulsed melting; thermal flux annealing; rapid isothermal annealing; and several applications stemming from rapid annealing and semiconductor processing with directed-energy beams. The second chapter is concerned with the use of electron cyclotron resonance plasmas in two important materials processing techniques: reactive ion-beam etching and plasma deposition. The last chapter of the book deals with the exploding area of very large scale integration processing and process simulation. Physicists, chemists, and engineers involved in silicon integrated circuits will find the book invaluable.

Laser and Electron-beam Interactions with Solids

Fundamental Electron and Ion Beam Interactions with Solids for Microscopy, Microanalysis, and Microlithography With the growing proliferation of nanotechnologies, powerful imaging technologies are being developed to operate at the sub-
 Silicon Integrated Circuits This book is an outcome of the NATO institute on surface modification which was held in Trevi, 1981. Surface modification and alloying by ion, electron or laser beams is proving to be one of the most burgeoning areas of materials science. The field covers such diverse areas as integrated circuit processing to fabricating wear and corrosion resistant surfaces on mechanical components. The common scientific questions of interest are the microstructures by the different energy deposition techniques. and associated physical properties produced The chapters constitute a critical review of the various subjects covered at Trevi. Each chapter author took responsibility for the overall review and used contributions from the many papers presented at the meeting; each participant gave a presentation. The contributors are listed at the start of each chapter. We took this approach to get some order in a large and diverse field. We are indebted to all the contributors, in particular the chapter authors for working the many papers into coherent packages; to Jim Mayer for hosting a workshop of chapter authors at Cornell and to Ian Bubb who did a sterling job in working over some of the manuscripts. Our special thanks are due to the text processing center at Bell Labs who took on the task of assembling the book. In particular Karen Lieb and Beverly Heravi typed the whole manuscript and had the entire book phototypeset using the Bell Laboratories UNIXTM system.

Semiconductors Probed by Ultrafast Laser Spectroscopy

Electron Beam Interactions with Solids for Microscopy, Microanalysis & Microlithography This text aims at providing a comprehensive and up to date treatment of the new and rapidly expanding field of laser processing of thin films, particularly, though by no means exclusively, of recent progress in the dielectrics area. The volume covers all the major aspects of laser processing technology in general, from the background and history to its many potential applications, and from the theory to the necessary experimental considerations. It highlights and compares the vast array of processing conditions now available with intense photon beams, as well as the properties of the films and microstructures produced. Separate chapters deal with the fundamentals of laser interactions with matter, and with experimental considerations. Detailed consideration is also given to film deposition, nucleation and growth, oxidation and annealing, as well as selective and localized. etching and ablation, not only in terms of the various photon-induced processes, but also with respect to traditional as well as other competing new technologies.

Atomic Collision Processes and Laser Beam Interactions with Solids

Microscopy of Semiconducting Materials 1983, Third Oxford Conference on Microscopy of Semiconducting Materials, St Catherines College, March 1983 Introduction to Focused Ion Beams is geared towards techniques and applications. This is the only text that discusses and presents the theory directly related to applications and the only one that discusses the vast applications and techniques used in FIBs and dual platform instruments.

Surface Microscopy with Low Energy Electrons

Electron-Beam Interactions with Solids The impact of Materials Science in our environment has probably never been as massive and decisive as it is today. In every aspect of our lives, progress has never been so dependent on the techniques involved in producing ever more sophisticated materials in ever larger quantities, nor so demanding for technologists to imagine novel processes and circumvent difficulties, or take up new challenges. Every technique is based on a physical process which is put into practice and optimized. The better we know that process, the better the optimization, and more powerful the technique. Laser processing of materials is inscribed in that context. As soon as powerful coherent light sources were made available, it was realized that such intense sources of energy could be used to "heat, melt and crystallize" materials, i.e., to promote phase transitions in atomic systems. As early as 1964, attempts in that direction were made but received very little (if any) attention. Reasons for this lack of interest were several. For one thing, laser technology was not fully developed, so that the process offered poor reliability and no versatility. Also, improving the existing techniques was believed to be sufficient to meet the needs of the time, and there was no real motivation to explore new ways. Finally, and more important, the fundamentals of the physics behind the scenes were, and continue to be, way out of the runni-g stream.

Laser and Electron-beam Interactions with Solids

Springer Handbook of Microscopy All solids are composed of atoms or molecules and in order to explain their behavior, experiments and theories came forward. Simultaneously, many new materials were synthetically and systematically developed in the laboratories, properties of which needed to be understood before deploying them in various technologies. It is known that there is a strong correlation between structure and properties of materials. Therefore, experiments on solids involve understanding their structure with diffraction techniques using X-rays, electrons or neutrons. The materials may be in different forms like bulk solid, thin films or powders and need to be observed using microscopes. Finally the properties can be correlated to electronic structure which can be deciphered through various spectroscopy techniques. Magnetic measurements give the insight in to electron-electron correlation. The advantages and limitations of the techniques are also spelled out. In
other words: this book takes into account the unaddressed needs of students and teachers associated with the experimental methods. Its relevance has increased manifold, as it addresses a wide scope of the topics in concise manner. Such as: improving signal-to-noise ratio, cryogenic methods, vacuum science, sources and detectors for electrons, photons (from infrared to gamma rays), error analysis, statistical handling of data, etc. Please note: This title is co-published with Capital Publishers, New Delhi. Taylor & Francis does not sell or distribute the Hardback in India, Pakistan, Nepal, Bhutan, Bangladesh and Sri Lanka.

Laser-Assisted Microtechnology

Electron-Beam Interactions with Solids

Laser and Electron-beam Interactions with Solids Semiconductors and Semimetals

VLSI Science and Technology/1982

Transport of Energetic Electrons in Solids Known and developed over the past twenty-five years, lasers have been experimentation in a variety of processes with an uneven success. Apart from fundamental physics experiments in which the various aspects of coherence are systematically exploited, applications in the field of Materials Science have been scattered recently over so many situations that it is apparently difficult today to conceive a comprehensive interpretation of all physical processes encountered. In some domains of research like photochemistry, development has been fast and rather self-supporting. In others, like solid-state processing, progress has been either very specific or deviated towards marginal applications, or else emerged as a joint-venture between physicists and chemists. This yielded a number of professional meetings, where day-to-day research activities are presented. In 1982, the Cargese ASI on "Cohesive properties of semiconductors under laser irradiation" was one of such meetings at which a prospective of the field was discussed at length in ebullient round-table sessions. Quoted from the proceedings, "the Institute helped to discern clearly the limits of existing theoretical approaches and the directions along which work is urgently needed within the next few years". Four years have passed and the field has literally exploded. It must be mentioned that some of the most striking developments over the past two years were accurately predicted at the Institute in Cargese.

Theoretical Chemistry for Advanced Nanomaterials The completely revised Third Edition to the bestselling Microlithography: Science and Technology provides a balanced treatment of theoretical and operational considerations, from fundamental principles to advanced topics of nanoscale lithography. The book is divided into chapters covering all important aspects related to the imaging, materials, and processes that have been necessary to drive semiconductor lithography toward nanometer-scale generations. Renowned experts from the world's leading academic and industrial organizations have provided in-depth coverage of the technologies involved in optical, deep-ultraviolet (DUV), immersion, multiple patterning, extreme ultraviolet (EUV), maskless, nanoimprint, and directed self-assembly lithography, together with comprehensive descriptions of the advanced materials and processes involved. New in the Third Edition In addition to the full revision of existing chapters, this new Third Edition features coverage of the technologies that have emerged over the past several years, including multiple patterning lithography, design for manufacturing, design process technology co-optimization, maskless lithography, and directed self-assembly. New advances in lithography modeling are covered as well as fully updated information detailing the new technologies, systems, materials, and processes for optical UV, DUV, immersion, and EUV lithography. The Third Edition of Microlithography: Science and Technology authoritatively covers the science and engineering involved in the latest generations of lithography and looks ahead to the future systems and technologies that will bring the next generations to fruition. Loaded with illustrations, equations, tables, and time-saving references to the most current technology, this book is the most comprehensive and reliable source for anyone, from student to seasoned professional, looking to better understand the complex world of microelectro-mechanical systems technology.


Laser and Electron-Beam Interactions with Solids, Proceedings of the Materials Research Society Annual Meeting, Boston, MA, November 16 - 19 1981 This book describes, as simply as possible, the mechanisms of scattering (both elastic and inelastic) of electrons with solid targets (electron/atom, electron/plasmon, and electron/phonon interactions). It also presents the main strategies of the Monte Carlo method, as well as numerous comparisons between simulation results and the experimental data available in the literature. Furthermore it provides readers with all the information they need in order to write their own Monte Carlo code and to compare the obtained results with the many numerical and experimental examples presented throughout the book. An extended and updated third edition of a work published in 2014 (first edition) and in 2017 (second edition) on the application of the Monte Carlo method to the transport of fast electrons in solids, this book includes, as novel topics, the theory of polarized electron beams (i.e. density matrix and spin-polarization), the study of elastic scattering by molecules, a classical treatment of the Bethe-Bloch stopping power, a simple derivation of the f- and ps-sum rules, the Vicanek and Urbassek formula for the calculation of the backscattering coefficient, the Wolff theory describing the secondary electron spectra, and fundamental aspects of the interactions between electrons beams and solid targets. Further, it describes a
completely analytical approach (the so-called multiple reflection method) for calculating the absorbed, backscattered, and transmitted fractions of electrons from unsupported and supported thin films. It also discusses recent applications of the Monte Carlo method.

Scanning Electron Microscopy The interaction of an electron beam with a solid target has been studied since the early part of the past century. Since 1960, the electron-solid interaction has become the subject of a number of investigators’ work owing to its fundamental role in scanning electron microscopy, in electron-probe microanalysis, in Auger electron spectroscopy, in electron-beam lithography and in radiation damage. The interaction of an electron beam with a solid target has often been investigated theoretically by using the Monte Carlo method, a numerical procedure involving random numbers that is able to solve mathematical problems. This method is very useful for the study of electron penetration in matter. The probabilistic laws of the interaction of an individual electron with the atoms constituting the target are well known. Consequently, it is possible to compute the macroscopic characteristics of interaction processes by simulating a large number of real trajectories, and then averaging them. The aim of this book is to study the probabilistic laws of the interaction of individual electrons with atoms (elastic and inelastic cross-sections); to investigate selected aspects of electron interaction with matter (backscattering coefficients for bulk targets, absorption, backscattering and transmission for both supported and unsupported thin films, implantation profiles, secondary electron emission, and so on); and to introduce the Monte Carlo method and its applications to compute the macroscopic characteristics of the interaction processes mentioned above. The book compares theory, computational simulations and experimental data in order to offer a more global vision.