

## Handbook Of Optical Dimensional Metrology

This book presents contributions from the joint event 8th INGEO International Conference on Engineering Surveying and 4th SIG Symposium on Engineering Geodesy, which was planned to be held in Dubrovnik, Croatia, on April 1-4, 2020 and was canceled due to COVID-19 pandemic situation. Editors, in cooperation with the Local Organisers, are decided to organize the Conference on-line at October 22-23, 2020. We would like to invite you to participation through <http://ingeo-sig2020.hgd1952.hr/index.php/2020/08/31/ingeosig2020-virtual-conference-october-22-23-2020/>. The event brought together professionals in the fields of civil engineering and engineering surveying to discuss new technologies, their applicability, and operability.

Working at the nano-scale demands an understanding of the high-precision measurement techniques that make nanotechnology and advanced manufacturing possible. Richard Leach introduces these techniques to a broad audience of engineers and scientists involved in nanotechnology and manufacturing applications and research. He also provides a routemap and toolkit for metrologists engaging with the rigor of measurement and data analysis at the nano-scale. Starting from the fundamentals of precision measurement, the author progresses into different measurement and characterization techniques. The focus on nanometrology in engineering contexts makes this book an essential guide for the emerging nanomanufacturing / nanofabrication sector, where measurement and standardization requirements are paramount both in product specification and quality assurance. This book provides engineers and scientists with the methods and understanding needed to design and produce high-performance, long-lived products while ensuring that compliance and public health requirements are met. Updated to cover new and emerging technologies, and recent developments in standards and regulatory frameworks, this second edition includes many new sections, e.g. new technologies in scanning probe and e-beam microscopy, recent developments in interferometry and advances in co-ordinate metrology. Demystifies nanometrology for a wide audience of engineers, scientists, and students involved in nanotech and advanced manufacturing applications and research Introduces metrologists to the specific techniques and equipment involved in measuring at the nano-scale or to nano-scale uncertainty Fully updated to cover the latest technological developments, standards, and regulations

Due to the development of microscale fabrication methods, microlenses are being used more and more in many unique applications, such as artificial implementations of compound eyes, optical communications, and labs-on-chips. Liquid microlenses, in particular, represent an important and growing research area yet there are no books devoted to this topic that summarize the research to date. Rectifying this deficiency, *Microlenses: Properties, Fabrication and Liquid Lenses* examines the recent progress in the emerging field of liquid-based microlenses. After describing how certain problems in optics can be solved by liquid microlenses, the book introduces the physics and fabrication methods involved in microlenses. It also details the facility and equipment requirements for general fabrication methods. The authors then present examples of various microlenses with non-tunable and tunable focal lengths based on different mechanisms, including: Non-tunable microlenses: Ge/SiO<sub>2</sub> core/shell nanolenses, glass lenses made by isotropic etching, self-assembled lenses and lens arrays, lenses fabricated by direct photo-induced polymerization, lenses formed by thermally reflowing photoresist, lenses formed from inkjet printing, arrays fabricated through molding processes, and injection-molded plastic lenses Electrically tuned microlenses: liquid crystal-based lenses and liquid lenses driven by electrostatic forces, dielectrophoretic forces, electrowetting, and electrochemical reactions Mechanically tunable microlenses: thin-membrane lenses with varying apertures, pressures, and surface shapes; swellable hydrogel lenses; liquid-liquid interface lenses actuated by environmentally stimuli-responsive hydrogels; and oscillating lens arrays driven by sound waves Horizontal microlenses: two-dimensional polymer lenses, tunable and movable liquid droplets as lenses, hydrodynamically tuned cylindrical lenses, liquid core and liquid cladding lenses, air-liquid interface lenses, and tunable liquid gradient refractive index lenses The book concludes by summarizing the importance of microlenses, shedding light on future microlens work, and exploring related challenges, such as the packaging of systems, effects of gravity, evaporation of liquids, aberrations, and integration with other optical components.

Reflecting the latest changes in standards and technology, market-leading *FUNDAMENTALS OF DIMENSIONAL METROLOGY*, 6e combines hands-on applications with authoritative, comprehensive coverage of the principles, techniques, and devices used within today's dimensional metrology field. The Sixth Edition has been thoroughly revised and updated in direct response to reviewer feedback. The new edition features an easier to understand presentation, a new lab manual/workbook, updated photos and illustrations and updated references to measurement standards.. The text continues to use both metric and imperial systems but emphasizes metric measurement devices and concepts in all examples for greater consistency with the latest industry trends. Important Notice: Media content referenced within the product description or the product text may not be available in the ebook version.

This text begins by describing the basic principles and diagnostic applications of optical techniques based on detecting and processing the scattering, fluorescence, FT IR, and Raman spectroscopic signals from various tissues, with an emphasis on blood, epithelial tissues, and human skin. The second half of the volume discusses specific imaging technologies, such as Doppler, laser speckle, optical coherence tomography (OCT), and fluorescence and photoacoustic imaging.

This book constitutes the refereed post-conference proceedings of the 8th IFIP WG 5.5 International Precision Assembly Seminar, IPAS 2018, held in Chamonix, France, in January 2018. The 20 revised full papers were carefully reviewed and selected from numerous submissions. The papers address topics such as machine vision and metrology for assembly operations, gripping and handling technologies, numerical methods and planning in assembly, digital technologies and Industry 4.0 applications, precision assembly methods, assembly systems and platforms and human cooperation, and machine learning. They are organized in the following topical sections: design and deployment of assembly systems; human robot cooperation and machine vision; assembly methods and models; digital technologies and industry 4.0 applications; and gripping and handling solutions in assembly.

Concise yet comprehensive, this highly acclaimed training manual and reference provides the many phases of inspection work and their application to today's manufacturing operations through a practical down-to-earth presentation. Discusses a range of manual and automatic measuring devices along with their specific functions and the specialized functions involved in their use. Analyzes the methods and duties of inspectors. Appropriate for use by inspection supervisors, plant managers, quality control engineers and subcontractors. Includes SPC and other data analysis methods for manufacturing applications. Provides detailed discussions of available measuring and quantitative systems. Compares important measuring and gaging systems.

Since John Bosch edited and published the first version of this book in 1995, the world of manufacturing and coordinate measuring machines (CMMs) and coordinate measuring systems (CMSs) has changed considerably. However, the basic physics of the machines has not changed in essence but have become more deeply understood. Completely revised and updat

Advances in engineering precision have tracked with technological progress for hundreds of years. Over the last few decades, precision engineering has been the specific focus of research on an international scale. The outcome of this effort has been the establishment of a broad range of engineering principles and techniques that form the foundation of precision design. Today's precision manufacturing machines and measuring instruments represent highly specialised processes that combine deterministic engineering with metrology. Spanning a broad range of technology applications, precision engineering principles frequently bring together scientific ideas drawn from mechanics, materials, optics, electronics, control, thermo-mechanics, dynamics, and software engineering. This book provides a collection of these principles in a single source. Each topic is presented at a level suitable for both undergraduate students and precision engineers in the

field. Also included is a wealth of references and example problems to consolidate ideas, and help guide the interested reader to more advanced literature on specific implementations.

Integrated circuits, and devices fabricated using the techniques developed for integrated circuits, have steadily gotten smaller, more complex, and more powerful. The rate of shrinking is astonishing – some components are now just a few dozen atoms wide. This book attempts to answer the questions, “What comes next?” and “How do we get there?” Nanolithography outlines the present state of the art in lithographic techniques, including optical projection in both deep and extreme ultraviolet, electron and ion beams, and imprinting. Special attention is paid to related issues, such as the resists used in lithography, the masks (or lack thereof), the metrology needed for nano-features, modeling, and the limitations caused by feature edge roughness. In addition emerging technologies are described, including the directed assembly of wafer features, nanostructures and devices, nano-photonics, and nano-fluidics. This book is intended as a guide to the researcher new to this field, reading related journals or facing the complexities of a technical conference. Its goal is to give enough background information to enable such a researcher to understand, and appreciate, new developments in nanolithography, and to go on to make advances of his/her own. Outlines the current state of the art in alternative nanolithography technologies in order to cope with the future reduction in size of semiconductor chips to nanoscale dimensions Covers lithographic techniques, including optical projection, extreme ultraviolet (EUV), nanoimprint, electron beam and ion beam lithography Describes the emerging applications of nanolithography in nanoelectronics, nanophotonics and microfluidics Diffractive Nanophotonics demonstrates the utility of the well-established methods of diffractive computer optics in solving nanophotonics tasks. It is concerned with peculiar properties of laser light diffraction by microoptics elements with nanoscale features and light confinement in subwavelength space regions. Written by recognized experts in this field, the book covers in detail a wide variety of advanced methods for the rigorous simulation of light diffraction. The authors apply their expertise to addressing cutting-edge problems in nanophotonics. Chapters consider the basic equations of diffractive nanophotonics and related transformations and numerical methods for solving diffraction problems under strict electromagnetic theory. They examine the diffraction of light on two-dimensional microscopic objects of arbitrary shape and present a numerical method for solving the problem of diffraction on periodic diffractive micro- and nanostructures. This method is used in modern trends in nanophotonics, such as plasmonics, metamaterials, and nanometrology. The book describes the simulation of electromagnetic waves in nanophotonic devices and discusses two methods of calculating the spatial modes of microstructured photonic crystal fibres—a relatively new class of optical fibres with the properties of photonic crystals. The book explains the theory of paraxial and non-paraxial laser beams with axial symmetry and an orbital angular momentum—called vortex beams—which are used for optical trapping and rotating micro- and nanoparticles in a ring in the cross-sectional plane of the beam. The final chapter discusses methods for calculating the force and torque exerted by the electromagnetic field focused onto the microparticle of arbitrary form, whose dimensions are comparable with the wavelength of light.

Containing more than 300 equations and nearly 500 drawings, photographs, and micrographs, this reference surveys key areas such as optical measurements and in-line calibration methods. It describes cleanroom-based measurement technology used during the manufacture of silicon integrated circuits and covers model-based, critical dimension, overlay

The confocal microscope is appropriate for imaging cells or the measurement of industrial artefacts. However, junior researchers and instrument users sometimes misuse imaging concepts and metrological characteristics, such as position resolution in industrial metrology and scale resolution in bio-imaging. And, metrological characteristics or influence factors in 3D measurement such as height assessment error caused by 3D coupling effect are so far not yet identified. In this book, the authors outline their practices by the working experiences on standardization and system design. This book assumes little previous knowledge of optics, but rich experience in engineering of industrial measurements, in particular with profile metrology or areal surface topography will be very helpful to understand the theoretical concerns and value of the technological advances. It should be useful for graduate students or researchers as extended reading material, as well as microscope users alongside their handbook.

"This engagingly written text provides a useful pedagogical introduction to an extensive class of geometrical phenomena in the optics of polarization and phase, including simple explanations of much of the underlying mathematics." —Michael Berry, University of Bristol, UK "The author covers a vast number of topics in great detail, with a unifying mathematical treatment. It will be a useful reference for both beginners and experts...." —Enrique Galvez, Charles A. Dana Professor of Physics and Astronomy, Colgate University "a firm and comprehensive grounding both for those looking to acquaint themselves with the field and those of us that need reminding of the things we thought we knew, but hitherto did not understand: an essential point of reference." —Miles Padgett, Kelvin Chair of Natural Philosophy and Vice Principal (Research), University of Glasgow This book focuses on the various forms of wavefield singularities, including optical vortices and polarization singularities, as well as orbital angular momentum and associated applications. It highlights how an understanding of singular optics provides a completely different way to look at light. Whereas traditional optics focuses on the shape and structure of the non-zero portions of the wavefield, singular optics describes a wave's properties from its null regions. The contents cover the three main areas of the field: the study of generic features of wavefields, determination of unusual properties of vortices and wavefields that contain singularities, and practical applications of vortices and other singularities.

The development of integrated silicon photonic circuits has recently been driven by the Internet and the push for high bandwidth as well as the need to reduce power dissipation induced by high data-rate signal transmission. To reach these goals, efficient passive and active silicon photonic devices, including waveguide, modulators, photodetectors, multiplexers, light sources, and various subsystems, have been developed that take advantage of state-of-the-art silicon technology. Suitable for both specialists and newcomers, Handbook of Silicon Photonics presents a coherent and comprehensive overview of this field from the fundamentals to integrated systems and applications. It covers a broad spectrum of materials and applications, emphasizing passive and active photonic devices, fabrication, integration, and the convergence with CMOS technology. The book's self-contained chapters are written by international experts from academia and various photonics-related industries. The handbook starts with the basics of silicon as an optical material. It then describes the building blocks needed to drive integrated silicon photonic circuits and explains how these building blocks are incorporated in complex photonic/electronic circuits. The book also presents applications of silicon photonics in numerous fields, including biophotonics and photovoltaics. With many illustrations, including some in color, this handbook provides an up-to-date reference to the broad and rapidly changing area of silicon photonics. It shows how basic science and innovative technological applications are pushing the field forward.

Nineteen Fact-Filled Charters that contain authoritative treatment of all aspects of dimensional measurement technology make Handbook of Dimensional Measurement the most readable and comprehensive guide available for engineers and technicians engaged in the various stages of industrial production. Design engineers, manufacturing engineers, tool and gage makers, quality control specialists, and reliability experts will find a wealth of practical data as well as complete coverage - both basic and advanced - of dimensional measurement techniques and equipment. The Third Edition of this classic book has been completely revised to include the computer and electronics revolution in metrology. Virtually every type of measurement instrument and machine, even the newest devices, can be found in these pages. Hundreds of changes, and additions and scores of new illustrations have been incorporated to assure that Handbook of Dimensional Measurement retains its status as the standard reference for the practitioner of dimensional measurement.

Due to their speed, data density, and versatility, optical metrology tools play important roles in today's high-speed industrial manufacturing applications. Handbook of Optical Dimensional Metrology provides useful background

information and practical examples to help readers understand and effectively use state-of-the-art optical metrology methods. The book first builds a foundation for evaluating optical measurement methods. It explores the many terms of optical metrology and compares it to other forms of metrology, such as mechanical gaging, highlighting the limitations and errors associated with each mode of measurement at a general level. This comparison is particularly helpful to current industry users who operate the most widely applied mechanical tools. The book then focuses on each application area of measurement, working down from large area to medium-sized to submicron measurements. It describes the measurement of large objects on the scale of buildings, the measurement of durable manufactured goods such as aircraft engines and appliances, and the measurement of fine features on the micron and nanometer scales. In each area, the book covers fast, coarse measures as well as the finest measurements possible. Best practices and practical examples for each technology aid readers in effectively using the methods. Requiring no prior expertise in optical dimensional metrology, this handbook helps engineers and quality specialists understand the capabilities and limitations of optical metrology methods. It also shows them how to successfully apply optical metrology to a vast array of current engineering and scientific problems.

Despite a number of books on biophotonics imaging for medical diagnostics and therapy, the field still lacks a comprehensive imaging book that describes state-of-the-art biophotonics imaging approaches intensively developed in recent years. Addressing this shortfall, *Advanced Biophotonics: Tissue Optical Sectioning* presents contemporary methods and applications of biophotonics imaging. Gathering research otherwise scattered in numerous physical, chemical, biophysical, and biomedical journals, the book helps researchers, bioengineers, and medical doctors understand major recent bioimaging technologies and the underlying biophotonics science. Well-known international experts explore a variety of "hot" biomedical optics and biophotonics problems, including the use of photoacoustic imaging to investigate the molecular and cellular processes in living systems. The book also covers Monte Carlo modeling, tissue optics and tissue optical clearing, nonlinear optical microscopy, various aspects of optical coherence tomography, multimodal tomography, adaptive optics, and signal imaging. With 58 color images, this book represents a valuable contribution to the biomedical and biophotonics literature. Designed for researchers and practitioners in biophotonics, the book is also a useful resource for scientists in laser physics and technology, fiber optics, spectroscopy, materials science, biology, and medicine as well as students studying biomedical physics and engineering, biomedical optics, and biophotonics.

With the ongoing release of 3D movies and the emergence of 3D TVs, 3D imaging technologies have penetrated our daily lives. Yet choosing from the numerous 3D vision methods available can be frustrating for scientists and engineers, especially without a comprehensive resource to consult. Filling this gap, *Handbook of 3D Machine Vision: Optical Metrology* begins by discussing key principles and techniques before exploring practical applications of optical metrology. Designed to provide beginners with an introduction to optical metrology without sacrificing academic rigor, this comprehensive text: Covers fundamentals of light sources, lenses, prisms, and mirrors, as well as optoelectronic sensors, optical devices, and optomechanical elements Addresses interferometry, holography, and speckle methods and applications Explains Moiré metrology and the optical heterodyne measurement method Delves into the specifics of diffraction, scattering, polarization, and near-field optics Considers applications for measuring length and size, displacement, straightness and parallelism, flatness, and three-dimensional shapes This new Second Edition is fully revised to reflect the latest developments. It also includes four new chapters—nearly 100 pages—on optical coherence tomography for industrial applications, interference microscopy for surface structure analysis, noncontact dimensional and profile metrology by video measurement, and optical metrology in manufacturing technology.

Optical science and engineering affect almost every aspect of our lives. Millions of miles of optical fiber carry voice and data signals around the world. Lasers are used in surgery of the retina, kidneys, and heart. New high-efficiency light sources promise dramatic reductions in electricity consumption. Night-vision equipment and satellite surveillance are changing how wars are fought. Industry uses optical methods in everything from the production of computer chips to the construction of tunnels. *Harnessing Light* surveys this multitude of applications, as well as the status of the optics industry and of research and education in optics, and identifies actions that could enhance the field's contributions to society and facilitate its continued technical development.

*An Up-to-Date Compendium on the Physics and Mathematics of Polarization Phenomena* Polarized Light and the Mueller Matrix Approach thoroughly and cohesively integrates basic concepts of polarization phenomena from the dual viewpoints of the states of polarization of electromagnetic waves and the transformations of these states by the action of material media. Through selected examples, it also illustrates actual and potential applications in materials science, biology, and optics technology. The book begins with the basic concepts related to two- and three-dimensional polarization states. It next describes the nondepolarizing linear transformations of the states of polarization through the Jones and Mueller–Jones approaches. The authors then discuss the forms and properties of the Jones and Mueller matrices associated with different types of nondepolarizing media, address the foundations of the Mueller matrix, and delve more deeply into the analysis of the physical parameters associated with Mueller matrices. The authors proceed to interpret arbitrary decomposition and other interesting parallel decompositions as well as compare the powerful serial decompositions of depolarizing Mueller matrix  $M$ . They also analyze the general formalism and specific algebraic quantities and notions related to the concept of differential Mueller matrix. The book concludes with useful approaches that provide a geometric point of view on the polarization effects exhibited by different types of media. Suitable for novices and more seasoned professionals, this book covers the main aspects of polarized radiation and polarization effects of material media. It expertly combines physical and mathematical concepts with important approaches for

representing media through equivalent systems composed of simple components.

Handbook of Optical Dimensional Metrology Taylor & Francis

New material on computerized optical processes, computerized ray tracing, and the fast Fourier transform, Bibre-Bragg sensors, and temporal phase unwrapping. \* New introductory sections to all chapters. \* Detailed discussion on lasers and laser principles, including an introduction to radiometry and photometry. \* Thorough coverage of the CCD camera.

The Handbook of Surface and Nanometrology explains and challenges current concepts in nanotechnology. It covers in great detail surface metrology and nanometrology and more importantly the areas where they overlap, thereby providing a quantitative means of controlling and predicting processes and performance. Trends and mechanisms are explained with

Optical Metrology is a rapidly expanding field in both its scientific foundations and technological developments, being of major concern to measurements, quality control, non-destructive testing and in fundamental research. In order to define the state-of-the-art, and to evaluate present accomplishments, whilst giving an appraisal of how each of the particular topics will evolve the Optical Metrology-anAdvancedStudy Institute was organized with a concourse of the world's acknowledged experts. Thus, the Institute provided a forum for tutorial reviews blended with topics of current research in the form of a progressive and comprehensive presentation of recent promising developments, leading techniques and instrumentation in incoherent and coherent optics for Metrology, Sensing and Control in Science, Industry and Biomedicine. Optical Metrology is a very broad field which is highly interdisciplinary in its applications, and in its scientific and technological background. It is related to such diverse disciplines as physical and chemical sciences, engineering, electronics, computer sciences, biological sciences and theoretical sciences, such as statistics. Although there was an emphasis on photomechanics and industrial applications, a marked diversity was reflected in the different background and interests of the participants. The vitality and viability of the discipline was enhanced not only by the encouraging number of young scientists and industrialists participating and authoring, but also by the remarkably promising prospects found in the practical applications supported by advanced electronic hybridization.

The measurement and characterisation of surface topography is crucial to modern manufacturing industry. The control of areal surface structure allows a manufacturer to radically alter the functionality of a part. Examples include structuring to effect fluidics, optics, tribology, aerodynamics and biology. To control such manufacturing methods requires measurement strategies. There is now a large range of new optical techniques on the market, or being developed in academia, that can measure areal surface topography. Each method has its strong points and limitations. The book starts with introductory chapters on optical instruments, their common language, generic features and limitations, and their calibration. Each type of modern optical instrument is described (in a common format) by an expert in the field. The book is intended for both industrial and academic scientists and engineers, and will be useful for undergraduate and postgraduate studies.

"The Measurement Quality Division, ASQ."

Optical Methods of Measurement: Wholefield Techniques, Second Edition provides a comprehensive collection of wholefield optical measurement techniques for engineering applications. Along with the reorganization of contents, this edition includes a new chapter on optical interference, new material on nondiffracting and singular beams and their applications, and updated bibliography and additional reading sections. The book explores the propagation of laser beams, metrological applications of phase-singular beams, various detectors such as CCD and CMOS devices, and recording materials. It also covers interference, diffraction, and digital fringe pattern measurement techniques, with special emphasis on phase measurement interferometry and algorithms. The remainder of the book focuses on theory, experimental arrangements, and applications of wholefield techniques. The author discusses digital hologram interferometry, digital speckle photography, digital speckle pattern interferometry, Talbot interferometry, and holophotoelasticity. This updated book compiles the major wholefield methods of measurement in one volume. It provides a solid understanding of the techniques by describing the physics behind them. In addition, the examples given illustrate how the techniques solve measurement problems.

Introduction to Optical Metrology examines the theory and practice of various measurement methodologies utilizing the wave nature of light. The book begins by introducing the subject of optics, and then addresses the propagation of laser beams through free space and optical systems. After explaining how a Gaussian beam propagates, how to set up a collimator to get a collimated beam for experimentation, and how to detect and record optical signals, the text: Discusses interferometry, speckle metrology, moiré phenomenon, photoelasticity, and microscopy Describes the different principles used to measure the refractive indices of solids, liquids, and gases Presents methods for measuring curvature, focal length, angle, thickness, velocity, pressure, and length Details techniques for optical testing as well as for making fiber optic- and MEMS-based measurements Depicts a wave propagating in the positive z-direction by  $e^{i(\omega t - kz)}$ , as opposed to  $e^{i(kz - \omega t)}$  Featuring exercise problems at the end of each chapter, Introduction to Optical Metrology provides an applied understanding of essential optical measurement concepts, techniques, and procedures.

This dedicated overview of optical compressive imaging addresses implementation aspects of the revolutionary theory of compressive sensing (CS) in the field of optical imaging and sensing. It overviews the technological opportunities and challenges involved in optical design and implementation, from basic theory to optical architectures and systems for compressive imaging in various spectral regimes, spectral and hyperspectral imaging, polarimetric sensing, three-dimensional imaging, super-resolution imaging, lens-free, on-chip microscopy, and phase sensing and retrieval. The reader will gain a complete introduction to theory, experiment, and practical use for reducing hardware, shortening image scanning time, and improving image resolution as well as other performance parameters. Optics practitioners and optical system designers, electrical and optical engineers, mathematicians, and signal processing professionals will all find the book a unique trove of information and practical guidance. Delivers the first book on compressed sensing dealing with system development for a wide variety of optical imaging and sensing applications. Covers the fundamentals of CS theory, including noise and algorithms, as well as basic design approaches for data acquisition in optics. Addresses the challenges of implementing compressed sensing theory in the context of different optical imaging designs, from 3D imaging to tomography and microscopy. Provides an essential resource for the design of new and improved devices with improved image quality and shorter acquisition times. Adrian Stern, PhD, is associate professor and head of the Electro-Optical Engineering Unit at Ben-Gurion University of the Negev, Israel. He is an elected Fellow of SPIE.

This handbook is a both a description of the current practice at the National Institute of Standards and Technology, and a compilation of the theory and lore of gauge block calibration. Most of the chapters are nearly self-contained so that the interested reader can, for example, get information on the cleaning and handling of gauge blocks without having to read the chapters on measurement schemes or process control, etc. This partitioning of the material has led to some unavoidable repetition of material between chapters. The basic structure of the handbook is from the theoretical to the practical. Chapter 1: basic concepts and definitions of length and units; Chapter 2: history of gauge blocks, appropriate definitions and a discussion of pertinent national and international standards; Chapter 3: physical characteristics of gauge blocks, including thermal, mechanical and optical properties; Chapter 4: a description of statistical process control (SPC) and measurement assurance (MA) concepts; and Chapters 5 and 6: details of the mechanical comparisons and interferometric techniques used for gauge block calibrations. Full discussions of the related uncertainties and corrections are included. Finally, the appendices cover in more detail some important topics in metrology and gauge block calibration.

A multidisciplinary reference of engineering measurement tools, techniques, and applications "When you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers,

your knowledge is of a meager and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of science." — Lord Kelvin Measurement is at the heart of any engineering and scientific discipline and job function. Whether engineers and scientists are attempting to state requirements quantitatively and demonstrate compliance; to track progress and predict results; or to analyze costs and benefits, they must use the right tools and techniques to produce meaningful data. The Handbook of Measurement in Science and Engineering is the most comprehensive, up-to-date reference set on engineering and scientific measurements—beyond anything on the market today. Encyclopedic in scope, Volume 3 covers measurements in physics, electrical engineering and chemistry: Laser Measurement Techniques Magnetic Force Images using Capacitive Coupling Effect Scanning Tunneling Microscopy Measurement of Light and Color The Detection and Measurement of Ionizing Radiation Measuring Time and Comparing Clocks Laboratory-Based Gravity Measurement Cryogenic Measurements Temperature-Dependent Fluorescence Measurements Voltage and Current Transducers for Power Systems Electric Power and Energy Measurement Chemometrics for the Engineering and Measurement Sciences Liquid Chromatography Mass Spectroscopy Measurements of Nitrotyrosine-Containing Proteins Fluorescence Spectroscopy X-Ray Absorption Spectroscopy Nuclear Magnetic Resonance (NMR) Spectroscopy Near Infrared (NIR) Spectroscopy Nanomaterials Properties Chemical Sensing Vital for engineers, scientists, and technical managers in industry and government, Handbook of Measurement in Science and Engineering will also prove ideal for academics and researchers at universities and laboratories.

Engineering Metrology and Measurements is a textbook designed for students of mechanical, production and allied disciplines to facilitate learning of various shop-floor measurement techniques and also understand the basics of mechanical measurements.

The aim of this handbook is to provide a comprehensive summary of sensing and measurement in precision manufacturing, which is essential for process and quality control. The importance of precision sensing and measurements lies not only in the ability to distinguish whether the manufactured part meets the assigned tolerances through inspection but also, in many cases, reduce the deviation of the manufactured part from the designed values through improvement of the process or compensation manufacturing based on the sensing and measurement results. The information provided in the book will be of interest to industrial practitioners and researchers in the field of precision manufacturing sensing and measurements. This volume is part of a handbook series that covers a comprehensive range of scientific and technological matters in 'Precision Manufacturing'.

This handbook gives readers a close look at the entire technology of printing very high resolution and high density integrated circuit (IC) patterns into thin resist process transfer coatings-- including optical lithography, electron beam, ion beam, and x-ray lithography. The book's main theme is the special printing process needed to achieve volume high density IC chip production, especially in the Dynamic Random Access Memory (DRAM) industry. The book leads off with a comparison of various lithography methods, covering the three major patterning parameters of line/space, resolution, line edge and pattern feature dimension control. The book's explanation of resist and resist process equipment technology may well be the first practical description of the relationship between the resist process and equipment parameters. The basics of resist technology are completely covered -- including an entire chapter on resist process defectivity and the potential yield limiting effect on device production. Each alternative lithographic technique and testing method is considered and evaluated: basic metrology including optical, scanning-electron-microscope (SEM) techniques and electrical test devices, along with explanations of actual printing tools and their design, construction and performance. The editor devotes an entire chapter to today's sophisticated, complex electron-beam printers, and to the emerging x-ray printing technology now used in high-density CMOS devices. Energetic ion particle printing is a controllable, steerable technology that does not rely on resist, and occupies a final section of the handbook.

The quantitative determination of the properties of micro- and nanostructures is essential in research and development. It is also a prerequisite in process control and quality assurance in industry. The knowledge of the geometrical dimensions of structures in most cases is the base, to which other physical and chemical properties are linked. Quantitative measurements require reliable and stable instruments, suitable measurement procedures as well as appropriate calibration artefacts and methods. The seminar "NanoScale 2004" (6th Seminar on Quantitative Microscopy and 2nd Seminar on Nanoscale Calibration Standards and Methods) at the National Metrology Institute (Physikalisch-Technische Bundesanstalt PTB), Braunschweig, Germany, continues the series of seminars on Quantitative Microscopy. The series stimulates the exchange of information between manufacturers of relevant hard- and software and the users in science and industry. Topics addressed in these proceedings are a) the application of quantitative measurements and measurement problems in: microelectronics, microsystems technology, nano/quantum/molecular electronics, chemistry, biology, medicine, environmental technology, materials science, surface processing b) calibration & correction methods: calibration methods, calibration standards, calibration procedures, traceable measurements, standardization, uncertainty of measurements c) instrumentation and methods: novel/improved instruments and methods, reproducible probe/sample positioning, position-measuring systems, novel/improved probe/detector systems, linearization methods, image processing

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