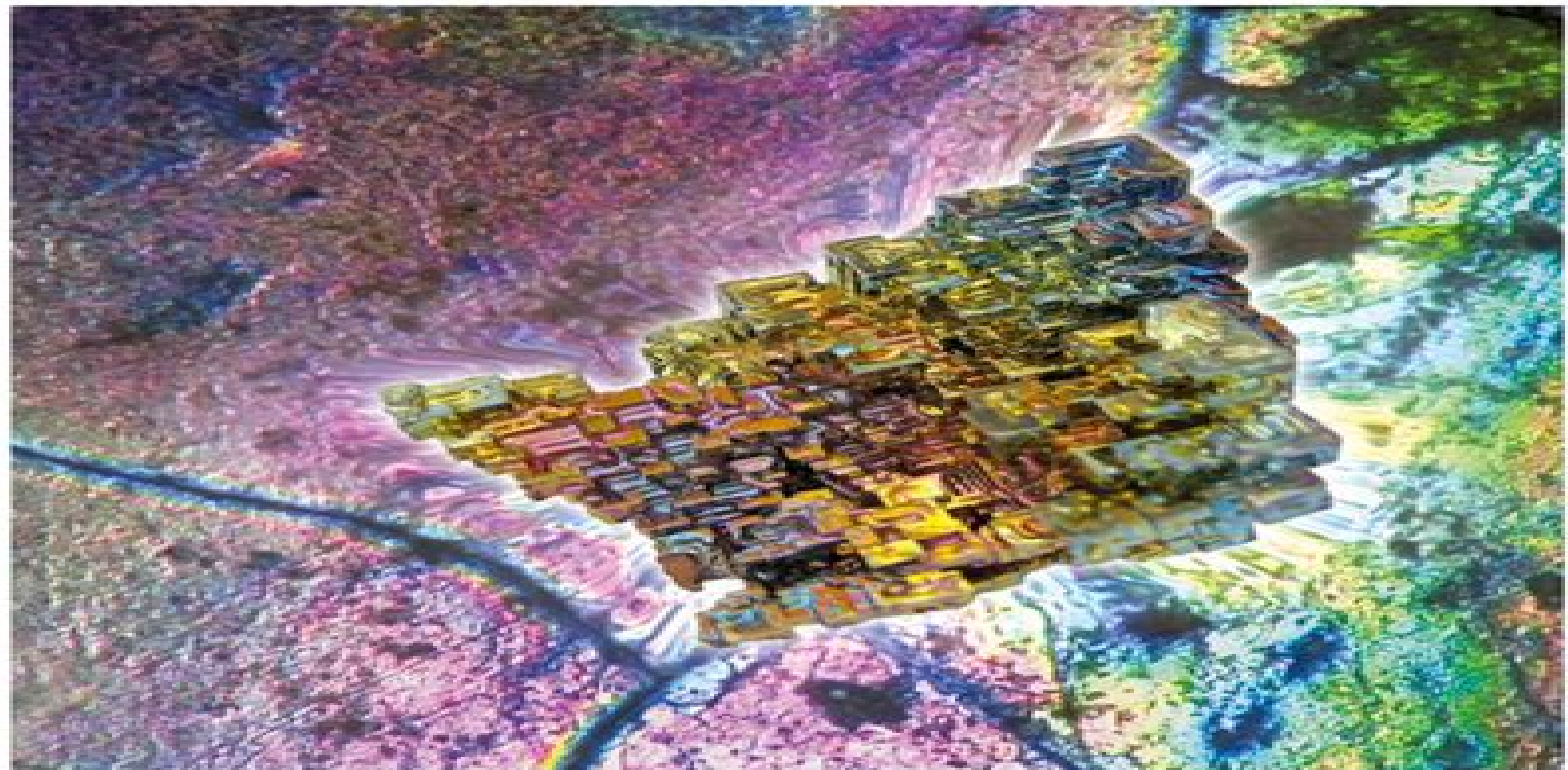


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# A Practical Guide to Optical Metrology for Thin Films



# A Practical Guide To Optical Metrology For Thin Films

**National Institute of Standards and  
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## **A Practical Guide To Optical Metrology For Thin Films:**

**A Practical Guide to Optical Metrology for Thin Films** Michael Quinten, 2012-09-24 A one stop concise guide on determining and measuring thin film thickness by optical methods This practical book covers the laws of electromagnetic radiation and interaction of light with matter as well as the theory and practice of thickness measurement and modern applications In so doing it shows the capabilities and opportunities of optical thickness determination and discusses the strengths and weaknesses of measurement devices along with their evaluation methods Following an introduction to the topic Chapter 2 presents the basics of the propagation of light and other electromagnetic radiation in space and matter The main topic of this book the determination of the thickness of a layer in a layer stack by measuring the spectral reflectance or transmittance is treated in the following three chapters The color of thin layers is discussed in chapter 6 Finally in chapter 7 the author discusses several industrial applications of the layer thickness measurement including high reflection and anti reflection coatings photolithographic structuring of semiconductors silicon on insulator transparent conductive films oxides and polymers thin film photovoltaics and heavily doped silicon Aimed at industrial and academic researchers engineers developers and manufacturers involved in all areas of optical layer and thin optical film measurement and metrology process control real time monitoring and applications

**A Practical Guide to Surface Metrology** Michael Quinten, 2020-01-01 This book offers a genuinely practical introduction to the most commonly encountered optical and non optical systems used for the metrology and characterization of surfaces including guidance on best practice calibration advantages and disadvantages and interpretation of results It enables the user to select the best approach in a given context Most methods in surface metrology are based upon the interaction of light or electromagnetic radiation UV NIR IR and different optical effects are utilized to get a certain optical response from the surface some of them record only the intensity reflected or scattered by the surface others use interference of EM waves to obtain a characteristic response from the surface The book covers techniques ranging from microscopy including confocal SNOM and digital holographic microscopy through interferometry including white light multi wavelength grazing incidence and shearing to spectral reflectometry and ellipsometry The non optical methods comprise tactile methods stylus tip AFM as well as capacitive and inductive methods capacitive sensors eddy current sensors The book provides Overview of the working principles Description of advantages and disadvantages Currently achievable numbers for resolutions repeatability and reproducibility Examples of real world applications A final chapter discusses examples where the combination of different surface metrology techniques in a multi sensor system can reasonably contribute to a better understanding of surface properties as well as a faster characterization of surfaces in industrial applications The book is aimed at scientists and engineers who use such methods for the measurement and characterization of surfaces across a wide range of fields and industries including electronics energy automotive and medical engineering

Quantum Metrology Ernst O. Göbel, Uwe Siegner, 2015-09-21 The International System of Units SI is the

world's most widely used system of measurement used every day in commerce and science and is the modern form of the metric system. It currently comprises the meter, the kilogram, the second, the ampere, the kelvin, the candela, and the mole. The system is changing though units and unit definitions are modified through international agreements as the technology of measurement progresses and as the precision of measurements improves. The SI is now being redefined based on constants of nature and their realization by quantum standards. Therefore the underlying physics and technologies will receive increasing interest and not only in the metrology community but in all fields of science. This book introduces and explains the applications of modern physics concepts to metrology, the science and the applications of measurements. A special focus is made on the use of quantum standards for the realization of the forthcoming new SI, the international system of units. The basic physical phenomena are introduced on a level which provides comprehensive information for the experienced reader but also provides a guide for a more intense study of these phenomena for students. *The Nano-Micro Interface, 2 Volumes* Marcel Van de Voorde, Matthias Werner, Hans-Jörg Fecht, 2015-03-09

Controlling the properties of materials by modifying their composition and by manipulating the arrangement of atoms and molecules is a dream that can be achieved by nanotechnology. As one of the fastest developing and innovative as well as well funded fields in science, nanotechnology has already significantly changed the research landscape in chemistry, materials science, and physics with numerous applications in consumer products such as sunscreens and water repellent clothes. It is also thanks to this multidisciplinary field that flat panel displays, highly efficient solar cells, and new biological imaging techniques have become reality. This second enlarged edition has been fully updated to address the rapid progress made within this field in recent years. Internationally recognized experts provide comprehensive first hand information resulting in an overview of the entire nano-micro world. In so doing they cover aspects of funding and commercialization, the manufacture and future applications of nanomaterials, the fundamentals of nanostructures leading to macroscale objects as well as the ongoing miniaturization toward the nanoscale domain. Along the way the authors explain the effects occurring at the nanoscale and the nanotechnological characterization techniques. An additional topic on the role of nanotechnology in energy and mobility covers the challenge of developing materials and devices such as electrodes and membrane materials for fuel cells and catalysts for sustainable transportation. Also new to this edition are the latest figures for funding, investments, and commercialization prospects as well as recent research programs and organizations. **Optical Characterization of Thin**

**Solid Films** Olaf Stenzel, Miloslav Ohlídal, 2018-03-09 This book is an up to date survey of the major optical characterization techniques for thin solid films. Emphasis is placed on practicability of the various approaches. Relevant fundamentals are briefly reviewed before demonstrating the application of these techniques to practically relevant research and development topics. The book is written by international top experts all of whom are involved in industrial research and development projects. *Practical Determination of Optical Constants from Spectral Measurements* Michael Quinten, 2018-03-15

constants are specific properties of condensed matter that allow to describe in a simple way the interaction of light or other electromagnetic radiation with matter. There is always a requirement for optical constants values for estimating colour reflection, internal total reflection, refraction, scattering, phase shifting, multilayer properties or thin film thickness. This book is concerned with the practical determination of optical constants from easily accomplishable reflectance or transmittance measurements with reflectometers or ellipsometers. It provides information on the basics of optical constants and a comprehensive overview on models for optical constants. A brief overview on methods of measurement and evaluation is followed by guidelines to the practical determination of optical constants mainly of thin films on a substrate. The main task is always to find the best suited model for the parametrization of the optical constants.

**Optische Schichtdickenmessung mit miniaturisierten Spektrometern** Michael Quinten, 2015-04-16. Dünne Schichten von transparenten oder halbrtransparenten Materialien spielen eine wichtige Rolle in unserem Leben. So wird einerseits eine Vielzahl von Farben in der Natur durch Interferenz von Licht hervorgerufen, das an dünnen transparenten Schichten reflektiert wird. Andererseits begegnen wir täglich meistens unbewusst einer Vielzahl technischer Anwendungen dünner Filme. Daher ist es in unserem Interesse so viel Information wie möglich über Schichten und Beschichtungen zu erhalten. Die optische Schichtdickenmessung mit miniaturisierten Spektrometern ist eine schnelle, zerstörungsfreie Methode zur Bestimmung der Dicke dünner Schichten, die sogar zur In-Prozess-Kontrolle von Schichtdicken verwendet werden kann. Dieses Buch führt in die optische Schichtdickenmessung mit miniaturisierten Spektrometern ein und beleuchtet die Einflüsse von Dispersion, Absorption und Substrat auf die Bestimmung der Schichtdicke. Desweiteren werden Messaufbau, Messgrößen, Berechnungsmodelle und Auswertemethoden vorgestellt und bewertet.

**The Nano-Micro Interface** Marcel Van de Voorde, Matthias Werner, Hans-Jörg Fecht, 2015-01-12. Controlling the properties of materials by modifying their composition and by manipulating the arrangement of atoms and molecules is a dream that can be achieved by nanotechnology. As one of the fastest developing and innovative as well as well funded fields in science, nanotechnology has already significantly changed the research landscape in chemistry, materials science and physics with numerous applications in consumer products such as sunscreens and water repellent clothes. It is also thanks to this multidisciplinary field that flat panel displays, highly efficient solar cells and new biological imaging techniques have become reality. This second enlarged edition has been fully updated to address the rapid progress made within this field in recent years. Internationally recognized experts provide comprehensive first hand information resulting in an overview of the entire nano-micro world. In so doing they cover aspects of funding and commercialization, the manufacture and future applications of nanomaterials, the fundamentals of nanostructures leading to macroscale objects as well as the ongoing miniaturization toward the nanoscale domain. Along the way the authors explain the effects occurring at the nanoscale and the nanotechnological characterization techniques. An additional topic on the role of nanotechnology in energy and mobility covers the challenge of developing materials and

devices such as electrodes and membrane materials for fuel cells and catalysts for sustainable transportation Also new to this edition are the latest figures for funding investments and commercialization prospects as well as recent research programs and organizations

**MEMS: A Practical Guide of Design, Analysis, and Applications** Jan Korvink, Oliver Paul, 2010-05-28 MEMS are rapidly moving from the research laboratory to the marketplace Many market studies indicate not only a tremendous market potential of MEMS devices year by year we see the actual market grow as the technology matures In fact these days many large silicon foundries have a MEMS group exploring this promising technology including such giants as INTEL and Motorola Yet MEMS are fundamentally different from microelectronics This means that companies with an established track record in these branches need to adapt their skills whereas companies that want to enter the miniaturization market need to establish an entirely new set of capabilities The same can be said of engineers with classical training who will also need to be educated toward their future professional activity in the MEMS field Here are some questions that a company or technologist may ask I have an existing product with miniaturization market potential Which technology should I adopt What are the manufacturing options available for miniaturization What are the qualitative differences How do we maintain a market lead for products based on MEMS Is there CAD support Can we outsource manufacturing Which skills in our current capability need only adaptation What skills need to be added Professors Jan Korvink and Oliver Paul have set out to answer these questions in a form that addresses the needs of companies commercial practitioners and technologists

Fringe 2009 Wolfgang Osten, Malgorzata Kujawinska, 2010-04-28 21 years ago it was a joint idea with Hans Rottenkolber to organize a workshop dedicated to the discussion of the latest results in the automatic processing of fringe patterns This idea was promoted by the insight that automatic and high precision phase measurement techniques will play a key role in all future industrial and scientific applications of optical metrology A couple of months later more than 50 specialists from East and West met in East Berlin the capital of the former GDR to spend 3 days with the discussion of new principles of fringe processing In the stimulating atmosphere the idea was born to repeat the workshop and to organize the meeting in an olympic schedule And thus meanwhile 20 years have been passed and we have today Fringe number six However such a workshop takes place in a dynamic environment Therefore the main topics of the previous events were always adapted to the most interesting subjects of the new period In 1993 the workshop took place in Bremen and was dedicated to new principles of optical shape measurement setup calibration phase unwrapping and nondestructive testing while in 1997 new approaches in multi sensor metrology active measurement strategies and hybrid processing technologies played a central role 2001 the first meeting in the 21st century was focused to optical methods for micrometrology hybrid measurement technologies and new sensor solutions for industrial inspection

Publications of the National Bureau of Standards United States. National Bureau of Standards, 1987

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*Catalog United States. National Bureau of Standards, 1988*      Publications of the National Institute of Standards and Technology ... Catalog National Institute of Standards and Technology (U.S.), 1988      *Handbook of Optical Metrology* Toru Yoshizawa, 2017-07-28 *Handbook of Optical Metrology Principles and Applications* 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 Moir 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      **The Optics Encyclopedia** Thomas Gordon Brown, 2004      Guide to NIST (National Institute of Standards and Technology) DIANE Publishing Company, 1997-07 Gathers in one place descriptions of NIST s many programs products services and research projects along with contact names phone numbers and e mail and World Wide Web addresses for further information It is divided into chapters covering each of NIST s major operating units In addition each chapter on laboratory programs includes subheadings for NIST organizational division or subject areas Covers electronics and electrical engineering manufacturing engineering chemical science and technology physics materials science and engineering building and fire research and information technology      *Optical Engineering* , 1998 Publishes papers reporting on research and development in optical science and engineering and the practical applications of known optical science engineering and technology      *Optical and Electrical Properties of Nanoscale Materials* Alain Diebold, Tino Hofmann, 2022-01-10 This book covers the optical and electrical properties of nanoscale materials with an emphasis on how new and unique material properties result from the special nature of their electronic band structure Beginning with a review of the optical and solid state physics needed for understanding optical and electrical properties the book then introduces the electronic band structure of solids and discusses the effect of spin orbit coupling on the valence band which is critical for understanding the optical properties of most nanoscale materials Excitonic effects and excitons are also presented along with their effect on optical absorption 2D materials such as graphene and transition metal dichalcogenides are host to unique electrical properties resulting from the electronic band structure This book devotes significant attention to the optical and electrical properties of 2D and topological materials with an emphasis on optical measurements electrical characterization of carrier transport and a discussion of the electronic band structures using a tight binding approach This book succinctly compiles useful fundamental and practical

information from one of the fastest growing research topics in materials science and is thus an essential compendium for both students and researchers in this rapidly moving field      *Guide to NIST* National Institute of Standards and Technology (U.S.),1996



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