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Book Reviews

Steven C. Gustafson, Book Reviews Editor

Optical Scattering: Measurement and Analysis

John C. Stover, xi + 238 pp., illus., index, bibliography, 3 appendixes. ISBN 0-07-061814-3. McGraw-Hill Optical and Electro-Optical Engineering Series, Robert E. Fischer and Warren J. Smith, series editors. McGraw-Hill, 11 West 19th St., New York, NY 10010 (1990), $44.95 hardbound.

Reviewed by Thomas A. Leonard, Science Services Inc., 42 Woodcroft Trail, Dayton, OH 45430-1980.

Optical scatter research and applications have grown rapidly to become a respected science, worthy of a dedicated SPIE conference each year. This book is the first compilation of the engineering knowledge necessary to allow a successful transition to the scatter world, or, as some already there would say, to become a scatter brain. The book is strongly oriented toward engineering knowledge and real world examples with actual scatter data. The analytical tools are also covered with sufficient detail to predict scatter and fully analyze the results. The book fulfills J. C. Stover's promise in the preface to provide the tools needed to make an engineer "the company scatter expert." Current and historical references are cited by author and year to provide the reader access to background information that until now could be found only in journals and conference proceedings.

There are nine chapters that seem to be disorganized in the sense that they alternate between theory and measurements, but they flow nicely from the standpoint of learning what optical scatter is all about. The first paragraph in each chapter discusses the purpose and background material needed for the chapter. The last paragraph ties the chapter to following chapters. Chapter 1, "Introduction to Light Scatter," gets off to an excellent start by noting that we see the world around us through scattered light. A specular world without scatter would indeed be a different existence. Scatter from typical surfaces is described, and the concepts of the bidirectional scatter distribution function (BSDF) and total integrated scatter (TIS) are introduced.

Chapter 2, "Surface Roughness," reviews common methods of surface roughness measurement and defines several terms used to quantify roughness, including the power spectral density (PSD) and autocovariance functions. A large part of the future of optical scatter work will be with characterization of machine-tooled surfaces; hence, Stover referenced the American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME) standard B46.1, which has a wealth of information on calculation of surface roughness parameters useful for machined, as opposed to polished, surfaces. The book does not include information on the various optical and mechanical instruments used to measure surface roughness. Spatial frequency coverage is directly related to the instrument, so this would be a very useful addition. The author does, however, make very clear the importance of spatial frequency limitations in roughness data. He also references the recent book *Introduction to Surface Roughness and Scattering,* which provides instrument-specific information.

Chapter 3, "Scatter Calculations and Diffraction Theory," outlines the elements of diffraction theory needed to calculate macroscopic scatter parameters. It abounds with physical references and real data so that the reader never loses the relationship with scattered light. The results are then used in Chap. 4, "Calculation of Surface Statistics from the BRDF." Care is taken to ensure that the reader realizes scatter can result from mechanisms other than surface roughness.

Polarization of scattered light is reviewed in Chap. 5. There are many "scatter brains" who do not appreciate the importance of polarization state to the resulting scatter. This is especially true for scatter from contaminants or features other than surface topography. Sufficient information is given to make the reader beware, but the references will have to be consulted for any serious understanding and analytical ability in the topic.

Scatter measurements and instrumentation are covered in Chap. 6 with the detail needed for an engineer to build his own instrument and understand its limitations. However, the section on measurement of incident power included only two of the four acceptable methods in the draft American Society of Testing and Materials (ASTM) BRDF standard. This "Standard Practice for Angle Resolved Optical Scatter Measurements on Specular and Diffuse Surfaces" written by Subcommittee E12.09 should soon be available from ASTM, 1916 Race Street, Philadelphia, PA 19103. Also, the section on raster scans could have included a reference to the extensive work on semiconductor wafers, such as "Nondestructive Measurements of Subsurface Structural Defects in Polished Single-Crystal Silicon" by R. M. Silva, F. D. Orazio, and J. M. Bennett in the February 1986 issue of *Optics News* (p. 10).

Chapter 7, "Scatter Predictions," discusses incident angle and wavelength scaling along with the caveats that must be understood before using these procedures. Actual data are used to demonstrate consistency of the PSD when the scatter results only from surface topography. BRDF data are also shown for typical diffuse white and black samples.

Scatter that results from other than surface topography is covered in Chap. 8, "Detection of Discrete Surface and Subsurface Defects." Techniques are presented for measurement of surface contaminants, bulk scatter, and subsurface defects. The use of depolarization in the scattered light is stressed as a method of enhancing signal-to-noise for nontopographic scatter. Discussion of MIL-STD-1246A, "Product Cleanliness Levels and Contamination Control Program," and the relationship to BRDF would have enhanced this chapter.

Chapter 9, "Scatter Specifications," uses examples such as a scatterometer mirror, laser rangefinder, and paper mill webs to demonstrate engineering specifications and process control. This topic is worthy of its own book, but the limited material covered here points the way for

the astute engineer. The vivid demonstration of the inability of TIS to predict BRDF is must reading for anyone who uses TIS or surface roughness as an engineering specification.

There are few typos and no major errors in the book. The use of "fee" in place of phi in Chap. 6 causes no confusion. There are omissions, such as minimal information on contaminant scatter and stray light analysis, that would have added to the usefulness and size of the book. Complete coverage of these topics is, however, beyond the author's stated intent. The book is recommended as an excellent reference for anyone involved in optical scatter work from building a scatterometer, to interpreting scatter data, to writing specifications. It will help to guide the future of optical scatter research and applications.

Laser Technology: Laser Driven Processes

Stjepan Lugomer, xiv + 449 pp., illus., index, references, appendixes. ISBN 0-13-523671-1. Prentice Hall, Englewood Cliffs, NJ 07632 (1990).

Reviewed by John A. Detrio, University of Dayton Research Institute, 300 College Park Ave., Dayton, OH 45469-0170.

Stjepan Lugomer's book provides a very useful introduction to the opportunities for laser processing for metallurgists and chemical engineers. The comprehensive treatment of applying lasers to chemical processing, material deposition, removal and cutting, surface treatment, and modification should be readily understood by the materials-trained reader. The 1990 copyright date is certainly current, but unfortunately, the most recent references are 1985, which accounts for the feeling of dated contents the reader may have. Minor proofreading and editing lapses are also a slight distraction.

The first four chapters are grouped by material technology: chemical, semiconductor, metals, and mechanical. Each application within the chapters is identified with a temporal and wavelength scale of the laser used.

Chapter 1, "Laser Chemical Technology," provides an introduction and classification of various chemical processes appropriate for laser-assisted reactions, depositions, and material removal. Specific topics covered include photolytic and photothermal deposition, laser ablation and etching, and laser-assisted oxidation. Topics not covered include isotope separation or gas phase processes used for chemical purification or the use of laser-generated powders (for example, high purity ceramic powder processing).

Chapter 2, "Laser Semiconductor Technology," addresses the use of lasers for "explosive recrystallization," laser annealing of ion implanted layers, laser doping, laser amorphization, and laser modification of properties. The presentation is reasonably comprehensive in surveying the wide range of processing options explored by the early researchers. The merits of laser processing are not critically assessed or compared to alternative technologies. There is a risk associated with making such judgments, but the reader should be aware of the limitations of laser processing—the laser is no panacea.

Chapter 4, "Laser Mechanical Technology," covers laser joining, drilling, and cutting. This is a very fruitful area of laser application and deserves complete and comprehensive treatment.

The treatment of the individual topics covers the state of technology up to 1985. Unfortunately, the recently recognized key role of polarization control for improved cutting and drilling is not included. Many of the references cited are to literature sources that may not be considered archival scientific journals; this could limit access through traditional library resources.

Chapter 5, on laser processing systems, is a more difficult challenge, and the presentation offers a sample of the wide variety of solutions and suppliers serving this market. Detailed requirements for a laser-based system should be developed in close cooperation with a vendor or with the aid of consultants.

The book would be complete even without Chap. 6 describing laser-based inertial confinement fusion (ICF). The scope of the treatment and level of presentation is in keeping with the balance of the book, but the specialized nature of ICF relative to the other laser-driven processing places it out of context with the dominant theme of the rest of the book.

An in-depth discussion of laser-generated surface artifacts completes the topics treated. This latter phenomena may be of some practical importance in limiting applications of lasers to certain sensitive systems or processing conditions.

In summary, *Laser Driven Processes* is a useful and comprehensive introductory treatment that should be of particular interest to readers who are familiar with the relevant materials science and engineering.

BOOKS RECEIVED

Practical Volume Holography, by R. R. A. Syms. ix + 399 pp., illus., subject index, references, two appendixes. Part of the Oxford Engineering Science Series. ISBN 0-19-856191-1. Oxford University Press, 2001 Evans Road, Cary, NC 27513 (1990). Topics covered include historical background, coupled wave theory, alternative theories, experimental holography, materials for volume holography, planar transmission and reflection holograms, superimposed holograms and multiple gratings, noise gratings, optical elements, pictorial holography, gratings in guided wave optics, and mass production.

Coulomb Interactions in Particle Beams, by G. H. Jansen. x + 546 pp., illus., subject index, references. Advances in Electronics and Electron Physics, Supplement 21. ISBN 0-12-014583-9. Academic Press, 1250 Sixth Ave., San Diego, CA 92101 (1990) $89.00 hardbound. Topics covered include historical notes, general beam properties, inverse square force law, two-particle dynamics, Boersch effect, statistical angular deflections, trajectory displacement effect, further investigations on statistical interactions, space charge effect in low-density particle beams, calculation of different spot- and edge-width measures, Monte Carlo simulation of particle beams, and summary for the one-minute designer.

Elements of Nonlinear Optics, by P. N. Butcher and D. Cotter. xiv + 344 pp., illus., subject index, bibliography, glossary of mathematical symbols, 10 appendixes. Cambridge Studies in Modern Optics 9. ISBN 0-521-34183-3. Cambridge University Press, 40 West 20th St., New York, NY 10011 (1990) $49.50 hardbound. Topics covered include the constitutive relation, review of quantum mechanics, susceptibility tensors, symmetry properties, resonant nonlinearities, wave propagation and processes in nonlinear media, dynamic optical nonlinearities in semiconductors, and optical properties of artificial materials.

Ethical Issues in Engineering, edited by Deborah G. Johnson. viii + 392 pp., subject index, references, bibliographies, notes following most chapters. ISBN 0-13-290578-7. Prentice Hall, Inc., Englewood Cliffs, NJ 07632 (1991). Topics covered include the Challenger disaster, the engineer and business, the role of professional codes of ethics, the engineer's responsibilities to society, engineering as social experimentation, the social and professional responsibility of engineers, obligations of loyalty to employer, obligations to clients and fair play in engineering, the role of the law in protecting scientific and technical dissent, trade secrets, morality and gift-giving, changing engineers and engineering, the phenomenon of international bribery, and engineering ethics and political imagination.

Computational Vision, by Harry Wechsler. xvii + 558 pp., illus., subject index, author index, references. ISBN 0-12-741245-X. Academic Press, 1250 Sixth Ave., San Diego, CA 92101 (1990) $64.50 hardbound. Develops an integrated theory of the workings and implementation of computational vision. Topics covered include computational complexity, distributed and multiscale representations, invariance, parallel and distributed processing, intrinsic representations, active perception, object recognition, intelligent systems, and parallel hardware architectures.

Converting Information for WORM Optical Storage, edited by Judith Paris Roth. xv + 284 pp., illus., subject index, references and bibliographies following some chapters, notes and directories of vendors following each chapter, list of trademarks, glossary of terms and acronyms, recommended readings, directory of firms and organizations involved with conversion, list of contributors. ISBN 0-88736-380-6. Meckler Publishing, 11 Ferry Lane West, Westport, CT 06880 (1990) $49.50 hardbound. Topics covered include electronic image information, optical disk technology, document conversion methodology, digital imaging research for archival application, biomedical document preservation by electronic imaging, image processing and the law environment, WORM optical archiving in radiology, converting engineering drawings to CAD, and the conversion and enhancement of archival photostatic deed records.

Science and Engineering of One- and Zero-Dimensional Semiconductors, edited by Steven P. Beaumont and Clivia M. Sotomayor Torres. From proceedings of a NATO Advanced Research Workshop on Science and Engineering of One- and Zero-Dimensional Semiconductors, held on March 29-April 1, 1989, in Cadiz, Spain, as part of the NATO Advanced Science Institutes Series B: Physics Volume 214. xi + 339 pp., illus., subject index, author index, and references following each chapter. ISBN 0-306-43417-2. Plenum Publishing Corp., 233 Spring St., New York, NY 10013 (1990) $75 hardbound. Topics covered include dry etching damage in nanostructures, ballistic electron transport in a gated constriction, one-dimensional electron transport in edge-channels studied with quantum point contacts, bound and resonant states in quantum wire structures, optical emission from quantum wires, resonant transverse magnetotunneling through double barrier systems, Raman scattering and photoluminescence of GaAs-based nanostructures, and radiative recombination in free standing quantum boxes.

Noninvasive Diagnostic Techniques in Ophthalmology, edited by Barry R. Masters. xxxii + 649 pp., illus., front section of color plates, subject index, references following each chapter, list of contributors and their affiliations, appendix of additional topics and resources. ISBN 0-387-96992-6. Springer-Verlag, 175 Fifth Ave., New York, NY 10010 (1990). Explores the special noninvasive tools that have been developed to function as diagnostic indicators to further the basic understanding of ocular function, with a collection of interdisciplinary chapters that cover a wide range of techniques. Topics covered include ophthalmic image processing, diagnostic ocular ultrasonography, wide-field specular microscopy, light scattering from cornea and corneal transparency, fluorometry of the anterior segment, fluorescence and Raman spectroscopy of the crystalline lens, retinal blood flow, laser Doppler velocimetry and blue field simulation technique, clinical visual psychophysics measurements, fundus imaging and diagnostic screening for public health, scanning laser tomography of the living human eye, digital image processing for ophthalmology, and image analysis of infrared choroidal angiography.

Short Courses

SPIE EDUCATIONAL PROGRAMS

SPIE short courses are organized to provide fundamental, practical instruction to scientists, engineers, and technical managers whose work focuses on, or is expanding into, optics, electro-optics, and integrated optoelectronics. Course lengths range from a half day (3 1/2 hours) to a full day (6 1/2 hours) to two days (12 hours) of instruction. For more information on SPIE short courses, contact SPIE's Educational Programs Department, P.O. Box 10, Bellingham, WA 98227-0010. 206/676-3290. Fax 206/647-1445. Telex 46-7053.

January 1991—Los Angeles, Calif.

These courses will be offered in conjunction with SPIE's OE/LASE '91, Optics, Electro-Optics and Laser Applications in Science and Engineering, Jan. 20-25, Los Angeles, Calif.

Laser Sources

Infrared Solid-State Lasers, Larry G. DeShazer, Solidlite Corp., Sun., 8:00 am-5:30 pm.

Design and Material Considerations for Second Harmonic Generation Laser Devices, Raymond G. Beausoleil and Larry G. DeShazer, Solidlite Corp., Mon., 8:00 am-5:30 pm.

Semiconductor Diode Lasers, Peter S. Zory, Univ. of Florida, Mon., 8:00 am-5:30 pm.

High Power Coherent Semiconductor Laser Arrays, James R. Leger, Massachusetts Inst. of Technology, Tues., 6:00-10:00 pm.

Applications of Laser Diodes, Chandrasekhar Roychoudhuri, United Technologies Research Ctr., Tues., 1:30-5:30 pm.

Principles of Polarized Light, Robert A. Fisher, RA Fisher Associates, Sun., 8:00 am-5:30 pm.

Laser Diagnostics

Diode Laser Testing, Thomas K. Plant, Oregon State Univ., Tues., 8:00 am-noon.

Gaussian Laser Beam Basics: Diameters, Divergence, and Waist Position, Gerald F. Marshall, Optical Design & Engineering, Sun., 1:30-5:30 pm.

High Energy Laser Wavefront Sensors, Joseph M. Geary, United Technologies Optical Systems, Mon., 1:30-5:30 pm.

Laser Systems

Fundamentals of Lasers and Laser Systems Design, Hugo Weichel, Nichols Research Corp., Tues. and Wed., 8:30 am-5:30 pm.

Laser Radar, Richard J. Becherer, Science Applications International Corp., Tues. and Wed., 8:30 am-5:30 pm.

Free Space Laser Communications: Introduction and Overview, James P. Hauck, Science Applications International Corp., Wed., 8:00 am-5:30 pm.

Wideband Receiver Design for Free Space Laser Communication, Stephen B. Alexander, Massachusetts Inst. of Technology, Sun., 1:30-5:30 pm.

Electro-Optical-Mechanical Design for Precision Stabilization and Laser Pointing Systems, Michael K. Masten, Texas Instruments Inc., and Larry A. Stockum, Battelle Memorial Inst., Thurs., 8:00 am-5:30 pm.

Sensor Systems

Sensor Systems Engineering, Richard J. Becherer, Science Applications International Corp., Sun. and Mon., 8:30 am-5:30 pm.

Advanced Sensors for Modern Defense Applications, Lawrence A. Klein, Hughes Aircraft Corp., Tues. and Wed., 8:30 am-5:30 pm.

Power Generation, Timothy T. Fong, Hughes Aircraft Co., Thurs., 8:00 am-noon.

Wavefront Correction

Atmospheric Propagation of Laser Beams, Hugo Weichel, Nichols Research Corp., Sun., 8:00 am-5:30 pm.

Laser Propagation Through Optical Turbulance, Jennifer C. Ricklin and Walter B. Miller, U.S. Army Atmospheric Sciences Lab., Sun., 8:00 am-5:30 pm.

Modern Aspects of Atmospheric Thermal Blooming, Peter B. Ulrich, W. J. Schafer Associates, Inc., Mon., 8:00 am-noon.

Introductory Nonlinear Optics of Gases, Liquids, and Solids, Robert A. Fisher, RA Fisher Associates, Tues., 8:00 am-5:30 pm.

Optical Phase Conjugation, Robert A. Fisher, RA Fisher Associates, Wed., 8:00 am-5:30 pm.

Optical Design

Introduction to Aberration Theory and Lens Design, Michael J. Kidger, Kidger Optics Ltd., Sun. and Mon., 8:30 am-5:30 pm.

Optical Design and Engineering: A Practical Introduction, Robert E. Fischer, OPTICS 1, Inc., Mon., 8:00 am-5:30 pm.