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Book Reviews

Steven C. Gustafson, Book Reviews Editor

SR-16

Optoelectronic Technology and Lightwave Communications Systems

Chinlon Lin, ed., xviii + 766 pp., illus., index, references. ISBN 0-442-26050-4. Van Nostrand Reinhold, 115 Fifth Ave., New York, NY 10003 (1989) $64.95 hardbound.

Reviewed by Stuart D. Elby, Columbia University, Center for Telecommunications Research, New York, NY 10027.

The editor of this collection attempts to provide the reader with an "in-depth and working knowledge" of the foundations of optoelectronic technologies, key features and essential design parameters of some lightwave information systems, the future of optoelectronics and lightwave systems, and the social impact of these technologies and systems. The broad range of topics covered is indicative of the multidisciplinary audience for which this book is intended. Fortunately, each chapter, written by leading experts in their fields, is complete in itself, containing an introduction, conclusion, and an exhaustive list of primary references (mostly pre-1986). Almost all of the chapters are written at an advanced level and can be used as either a reference source for scientists and engineers actively working in the field or as a jumping-off point for readers with advanced technical degrees who wish to gain an understanding of an unfamiliar area. The book is divided into seven sections.

The first three sections ("Optical Fiber Waveguides," "Fiber-Joining Technology and Passive Optical Components," and "Semiconductor Laser Sources and Photodetectors") provide a detailed overview of the essential technologies relevant to fiber optic based system. The first section (Chaps. 1 through 5) covers fundamental fiber optic technology. Chapter 1 (F. P. Kapron) reviews the principles of fiber optic transmission and fiber fabrication. The second chapter (D. L. Philen) summarizes the characterization of optical fibers and provides useful examples of commonly employed measurement techniques. The third chapter (L. G. Cohen, W. L. Mammel, and W. A. Reed) presents advanced single mode fiber designs. These designs are presented as solutions to fiber transmission problems; this result-oriented motivation provides additional insight into this topic. The fourth chapter (T. Okoshi) covers aspects of polarization-maintaining fiber, including characteristics and fabrication. The fifth chapter (A. R. Chraplyvy) discusses the limitation imposed on fiber optic transmission by optical nonlinearities, including stimulated scattering (Raman and Brillouin) and the Kerr effect. Mention of doped-fiber amplifiers is notably absent from this section.

The next section, comprising Chaps. 6 and 7 (W. C. Young and G. -D. Khoe, respectively), describes fiber coupling techniques and passive optical components such as fiber coupling lenses and directional couplers. Primary consideration is given to optomechanical and packaging issues. The last "fundamental technology" section (Chaps. 8 through 14) covers semiconductor lasers and photodetectors. Chapter 8 (N. K. Dutta) provides a well-organized summary of basic semiconductor laser physics. Chapter 9 (P. J. Anthony) summarizes conventional fabrication processes and standard laser diode characterization tests. Laser reliability and failure modes are also described. Chapters 10 and 11 (K. Kobayashi and T. Ikegami, respectively) present design theory and fabrication approaches for transverse and longitudinal mode control. The discussion of transverse mode control does not discuss beam ellipticity or adequately address astigmatism. The clear presentation of DFB lasers is a highlight of these chapters. The presentation of semiconductor modulation properties in Chap. 12 (J. E. Bowers) is also superb. Chapter 13 (L. Figueroa) covers high-power semiconductor lasers and includes a brief overview of laser diode arrays. Chapter 14 (J. Campbell) is a well-organized discussion of PIN and APD photodetectors. Amplifier design and integration issues are also covered.

Section 4, "Optical Transmitters and Receivers," bridges the gap between the hardcore device technology covered in the first three sections and the systems-oriented issues presented in the following section. Comprising Chaps. 15 and 16 (P. W. Shumate and T. V. Muoi, respectively), this section present systems aspects of digital and analog fiber optic transmission links, including packaging, control circuitry, and noise considerations. Some of the theory presented is covered in much greater detail in the previous chapters, but the summary provided by this section may be a useful starting point for readers less familiar with optoelectronics technology.

Section 5, "Applications of Optoelectronics in Lightwave Systems," is much less diverse than its title implies. Fiber optic based communications systems are the primary focus (as per the title of the book), and Chaps. 17 through 19 are devoted to this topic. Chapter 17 (C. Lin) presents a clearly written account of fiber optic transmission link design trade-offs, performance, and limitations. Wavelength division multiplexing is also presented. Chapter 18 (N. Tokura and M. Koyama) attempts to cover fiber optic local area networks (LANs). Although a strong foundation is laid in terms of LAN topologies, media access protocols, and contention resolution schemes, optoelectronics and fiber optics are mentioned only as a means to provide point-to-point links between network nodes. The omission of a discussion of optical multiple access techniques and photonic switching architectures is a great disservice to this book and may reduce its appeal to the optical networks community. Chapter 19 (E. H. Hara) proposes future applications that require the wide bandwidth channels afforded by fiber optics. Topics presented include high-definition and digital TV, video access services, and ISDN.

Each of the remaining chapters in this section covers a particular optoelectronics based system. Although each system falls under the broad heading of an information system, the selection of topics seems quite arbitrary. A solid overview of free-space optical communications is presented in Chap. 20 (J. Katz). Chapter 21 (A. Dandridge, J. H. Cole, W. K. Burns, T. G. Giallorenzi, and J. A. Bucaro) presents a detailed summary of fiber optic sensors. Careful attention is paid to the underlying physics and the performance limitations of the various sensing architectures. Laser bar code and printer sys-

tems are described in Chap. 22 (Y. Ono and N. Nishida).

Section 6, "Future Optoelectronic Technology and Transmission Systems," examines optoelectronic integrated circuits (Chap. 23 by U. Koren) and coherent optical transmission techniques (Chap. 24 by I. W. Stanley and D. W. Smith). It is curious that Chap. 19, "Future Applications of Optical Fiber Networks," was not included in this section. The discussion of coherent optical transmission is excellent; enough theory is presented to afford the reader a working knowledge, but the emphasis is placed on the design complexity and performance trade-offs of the techniques.

The last section, "Impacts on the Information Society," is composed of a single chapter by C. K. Kao. This chapter attempts to place the sometimes isolated world of optoelectronic technology into a global socioeconomic framework. Although fascinating, the inclusion of this chapter into a book that otherwise is written at a technically advanced level seems forced.

In summary, the strong point of this book is optoelectronic technology and its application to fiber optic transmission links. However, issues relevant to lightwave communications systems other than point-to-point link based systems are not adequately covered. The disjointed nature of this collection makes it inappropriate as a primary textbook, but the self-contained nature of each chapter makes it ideal as a comprehensive reference book for the working scientist and engineer.

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Laser Microfabrication: Thin Film Processes and Lithography

Daniel J. Ehrlich and Jeffrey Y. Tsao, eds., xiii + 587 pp., illus., index, references. ISBN 0-12-233430-2. Academic Press, 1250 Sixth Ave., San Diego, CA 92101 (1989) $89.50 hardbound.

Reviewed by Lawrence H. Lin, Insystems, Inc., 1120 Ringwood Court, San Jose, CA 95131.

With contributions from 16 experts in this country and the United Kingdom, this book contains a great wealth of information, covering the wide field of laser microfabrication processes. The contributors not only provide detailed descriptions of the state-of-the-art technologies in Parts I and II, but also lay out an adequate theoretical ground in Part II. However, this reviewer is more familiar with the topics covered in Part I: Technology–sources, optics, and laser microfabrication systems for direct writing and projection lithography. The following comments pertain, therefore, to this part (pages 1 through 76) of the book only.

Both the style of writing and the organization of Part I, which contains only Chap. 1, are concise and yet informative. Acronyms are spelled out upon first usage when appropriate (e.g., SRS for stimulated Raman scattering) but left unexplained when unnecessary (e.g., UV, YAG, etc.). The author's last name and the publication date are given when a reference is cited in the text.

After a brief introduction, in Sec. 2 Y. S. Liu describes the characteristics of various lasers. Unfortunately, the He-Cd laser is neglected in this section and in the index. This is the only convenient low-power laser that can be used for photoresist exposures. (An example is indeed cited later in Sec. 3.9.3.) A very minor error was noted in Sec. 2.6.2 in the use of the symbols ν and ω for the same meaning. In Sec. 3 many practical optical considerations for direct-write applications are explained and useful formulas given. Several examples of laboratory and commercial direct-write systems are then described. Neglected, unfortunately, are laser applications for read-only or read-and-write optical disks, which are proliferating and becoming increasingly more important.

In Sec. 4, following the similar format of the last section, the author first introduces some pertinent fundamental concepts and parameters and then describes some examples of laser projection lithography systems. The matching of laser wavelength and power to the spectral sensitivity of available photoresists in projection systems is a very important practical consideration and would have been a good topic for this section.

Overall, this chapter, like the rest of the book, provides delightful and informative reading. It should be useful for both starting students and active researchers, as the editors state in the preface.

BOOKS RECEIVED

Semiconductor Material and Device Characterization, by Dieter K. Schroder. xv + 599 pp., illus., subject index, references and appendixes following each chapter, list of physical constants and conversion factors, table of selected properties of some semiconductors at T = 300 K, two appendixes that include a list of symbols and a list of abbreviations and acronyms. ISBN 0-471-51104-8. John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158 (1990) $59.95 hardbound. Covers electrical, optical, electron-beam, ion-beam, x-ray, and gamma-ray methods of modern semiconductor material and device characterization. Topics include resistivity, carrier and doping concentration, contact resistance and Schottky barrier height, series resistance, channel length, threshold voltage, mobility, oxide and interface trapped charge, deep-level impurities, carrier lifetime, and optical, chemical, and physical characterization.

Dye Laser Principles with Applications, edited by F. J. Duarte and Lloyd W. Hillman. xi + 456 pp., illus., subject index, references following each chapter, problems following some chapters, appendix on laser dyes. Part of a series on Quantum Electronics—Principles and Applications, Paul F. Liao and Paul L. Kelley, series editors. ISBN 0-12-222700-X. Academic Press, Inc., 1250 Sixth Ave., San Diego, CA 92101 (1990) $64.50 hardbound. Covers laser dynamics, femtosecond dye lasers, narrow-linewidth pulsed dye laser oscillators, CW dye lasers, photochemistry, industrial applications, dye-laser isotope separation, and dye lasers in medicine.

Handbook of Biological Confocal Microscopy, edited by James B. Pawley. xiii + 232 pp., illus., subject index, bibliography, references following each chapter. ISBN 0-306-43538-1. Plenum Publishing Corp., 233 Spring Street, New York, NY 10013-1578 (1990) $49.50 hardbound. Covers light microscopy, confocal imaging, practical photon efficiency, laser scanning confocal microscopy, pixelation, laser sources, nonlaser illumination, objective lenses, intermediate optics in Nipkow disk microscopes, three-dimensional imaging, photophysics, photochemistry, guiding principles of specimen preservation, optical sectioning methods, and photon detectors.

Theory of Coherent Atomic Excitation, Vols. One and Two, by Bruce W. Shore. xx + 1735 pp., illus., index, references following each chapter, list of tables, list of symbols, eight appendixes. ISBN 0-471-61398-3 (Vol. One) and ISBN 0-471-52416-6 (Vol. Two). John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10158-0012 (1990) $123.00 for two-volume set, hardbound. Discusses the nature of the coherent excitation produced in atoms by lasers, with details of the transient variation of excited-state populations with time and with such controllable parameters as laser frequency and intensity. Topics covered include elementary atoms, two-state atoms, pulsed excitation, photons and radiation, scattered field spectra, propagation, multistate atoms, angular momentum and complex atoms, continuum processes, linkage patterns and static interactions, transition rates, and incoherence.

Optical Computing in Japan, edited by S. Ishihara. vi + 525 pp., illus., subject index, references following each chapter. ISBN 0-941743-85-3. Nova Science Publishers, Inc., 283 Commack Road, Suite 300, Commack, NY 11725-3401 (1990) $85.00 hardbound. Discusses state-of-the-art research on optical computing from Japan. Topics covered include photon limit in optical computers, optical parallel array logic systems, neural networks for computation and optimization, optical systems for real-time multiplication of a multiple matrix, image coupling and amplifi-

cation by two-wave coupling, chip-to-chip guided-wave optical interconnections, optical functional devices using semiconductor lasers, and recent advances in organic nonlinear optical materials.

Microwave Engineering Using Microstrip Circuits, by E. H. Fooks and R. A. Zakarevicius. xiii + 333 pp., illus., subject index, references and exercises following each chapter, list of symbols, four appendixes. ISBN 0-13-691650-3. Prentice Hall, Inc., Englewood Cliffs, NJ 07632 (1990). Presents a thorough grounding in the basics of microstrip components and for interfacing them with transistors and diodes in active circuits; aimed at developing a practical understanding of microstrip components and systems. Covers transmission line theory, two-port parameters, microstrip transmission lines, discontinuities, the Smith chart and its uses, hybrid-line couplers, parallel-coupled lines and directional couplers, filters, miscellaneous components, active circuit characterization, microstrip circuits and subsystems, and microstrip line experiments.

Machine Vision and Digital Image Processing Fundamentals, by Louis J. Galbiati, Jr., xii + 164 pp., illus. (with three figures in color), subject index, glossary of terms, references and exercises following each chapter. ISBN 0-13-542044-X. Prentice Hall, Inc., Englewood Cliffs, NJ 07632 (1990). Designed for both the reader with no previous knowledge and for individuals in industry interested in industrial applications, with broad coverage of all aspects of machine vision as a system, and the review of basic principles of optics in a building block approach, as well as covering various aspects of vision technology that is encountered in the application of machine vision and digital imaging to an industrial process. Discusses vision and factory automation, human vision versus machine vision, system overview, image acquisition, fundamental concepts of image processing, image acquisition signal parameters, basic machine vision processing, edge enhancement, and bar coding.

Continuous and Discrete Signals and Systems, by Samir S. Soliman and Mandyam D. Srinath. xx + 503 pp., illus., subject index, bibliography, problems and checklist of important terms following each chapter, four appendixes. Part of the Prentice Hall Information and System Sciences Series. ISBN 0-13-171257-8. Prentice Hall, Inc., Englewood Cliffs, NJ 07632 (1990). Provides an introductory and complete treatment of the most widely used techniques of signal and system analysis. Mathematics is used in an engineering context to enhance physical and intuitive understanding of both continuous and discrete systems. Topics covered include signal representation, continuous-time systems, Fourier series, Laplace transform, discrete-time systems, Fourier analysis of discrete-time systems, Z-transform, discrete Fourier transform, and design of analog and digital filters.

The Fiber Optic LAN Handbook. xii + 233 pp., illus., references following each chapter, data sheets of new product information at end of book. ISBN 0-9626933-0-8. Codenoll Technology Corp., 1086 North Broadway, Yonkers, NY 10701 (1990) $17.95. Most papers contributed by members of Codenoll Technology Corp.'s engineering staff, along with contributors from Hoechst AG, Packard Electric Division of General Motors Corp., and Southwestern Bell Telephone Co. Discusses intersection of two major technologies: fiber optics and local area networks. Topics covered include components, data links, plastic optical fiber, ethernet transceivers, ethernet PC adapter cards, ethernet hubs, FDDI adapter cards, FDDI concentrators, and cable assemblies.

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.

September 1990—Rosemont, Ill.

These courses will be offered in conjunction with SPIE's Optical Engineering Midwest, sponsored by the Chicago Regional Chapter and SPIE, Sept. 27–28, Rosemont, Ill.

Basic Optical Engineering for Electrical Engineers, Glenn D. Boreman, Univ. of Central Florida, Thurs., 8:00 am-5:00 pm.

Fundamentals of Optomechanical Engineering, Daniel Vukobratovitch, Univ. of Arizona, Thurs., 8:00 am-5:00 pm.

Modern Optical Testing, James C. Wyant, Univ. of Arizona and WYKO Corp., Thurs., 8:00 am-noon.

A Primer in Optical Coating Technology, Michael Ray Jacobson, Univ. of Arizona, Thurs., 1:30-5:30 pm.

Optical Feature Extraction and Product Inspection, David P. Casasent, Carnegie Mellon Univ., Thurs., 1:30-5:30 pm.

Computer-Generated Holography, Sing H. Lee, Univ. of California/San Diego, Fri., 8:00 am-noon.

Basics of Fiber Optics, Walter E. Chapelle, Optical Engineering Corp., Fri., 8:00 am-noon.

Artificial Neural Networks, M. R. Sayeh, Southern Illinois Univ./Carbondale, Fri., 8:00 am-noon.

Introduction to 3-D Imaging in Medicine, Michael Vannier, Washington Univ., Fri., 1:00-5:00 pm.

Materials Processing with Lasers, John Ready, Honeywell, Inc., Fri., 1:00-5:00 pm.

September–October 1990—Santa Clara, Calif.

These courses will be offered in conjunction with SPIE's Technical Symposium on Microelectronic Processing Integration, Sept. 30-Oct. 5, Santa Clara, Calif.

Plasma Etching and Reactive Ion Etching, John W. Coburn, IBM/Almaden Research Ctr., Sun., 8:30 am-6:00 pm.

Introduction to Microelectronic Fabrication, Dennis L. Polla, Univ. of Minnesota, Sun., 8:30 am-6:00 pm.

Characterization of Semiconductors and Semiconductor Structures by Optical Techniques, David E. Aspnes, Bellcore, Mon., 2:00-6:00 pm.

Optical Diagnostic Techniques for Plasma Processing, Gary S. Selwyn, IBM/Thomas J. Watson Research Ctr., Thurs., 8:30 am-6:00 pm.

Scanning Tunneling Microscope and Atomic Force Microscope: Instruments for Analysis and Inspection of Surfaces on a Scale Varying from a Micrometer to an Angstrom, Yves Martin, IBM/Thomas J. Watson Research Ctr., Mon., 6:00-10:00 pm.

Semiconductor Process Control, Ralph K. Cavin III, North Carolina State Univ., Tues., 2:00-6:00 pm.

Characterization of Thin Dielectric Layers, Paul W. Bohn, Univ. of Illinois/Urbana-Champaign, Tues., 6:00-10:00 pm.

Langmuir Probes: A Practical Introduction, Noah Hershkowitz, Univ. of Wisconsin/Madison, Wed., 6:00-10:00 pm.

Statistical Analysis Methods for Ultraclean Environments, Thomas J. Bzik, Air Products and Chemicals, Inc., Fri., 8:00 am-noon.

Statistical Process Control in Semiconductor Manufacturing, Costas J. Spanos, Univ. of California/Berkeley, Thurs., 8:30 am-6:00 pm.

Introduction to Laser Deposition and Etching, Frances A. Houle, IBM/Almaden Research Ctr., Mon., 1:00-9:00 pm.

Excimer Laser Etching and Ablation of Microelec-