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Book Reviews

Steven C. Gustafson, Book Reviews Editor

Send books for review to the Managing Editor, Optical Engineering, P.O. Box 10, Bellingham, WA 98227-0010. Since there is not space to review all books received, the Book Reviews Editor will use his discretion in selecting those of most interest to the readership of this journal.

Optoelectronics, An Introduction (Second Edition)

J. Wilson and J. F. B. Hawkes, xiv + 470 pp., illus., index, bibliography, appendixes. Prentice Hall International Series in Optoelectronics. Prentice Hall, 66 Wood Lane End, Hemel Hempstead, Hertfordshire HP2 4RG, England (1989) $77.95 hardbound.

Reviewed by Gordon R. Little, University of Dayton, Dayton, OH 45469.

Optoelectronics has become increasingly important in the communication, consumer electronics, remote sensing, and defense fields. Consequently, there is a strong requirement for opto-electronic texts for undergraduate- and graduate-level courses. This book is intended to serve as an introduction to the field for final year undergraduate or first year graduate students. Since this is an introductory text, the authors have emphasized the fundamental principles underlying selected devices and systems. Consequently, rigorous theoretical treatments are not included.

The book being reviewed here is the second edition of a text published in 1983 that was used by the reviewer as the text in a first year graduate-level course in electro-optical devices and systems. The principal revisions include incorporation of a treatment of single mode optical fibers and addition of a chapter covering noncommunications applications of fiber optics.

The book includes 10 chapters, with Chaps. 1 and 2 reviewing elements of optical radiation and solid state physics, Chaps. 3 through 8 discussing selected devices and components, Chap. 9 covering communications systems, and Chap. 10 describing other applications of optical fibers. Numerical examples are included in the text, and a set of exercises and list of references follow each chapter. Among the seven appendixes are a description of birefringence, a tabulation of semiconductor physical constants, and a discussion of laser safety. Numerous well-chosen figures are used throughout to illustrate the phenomena and devices discussed.

The optics review in Chap. 1 is quite brief and serves mainly to refresh the reader on the rudiments of polarization, interference, diffraction, and blackbody radiation. Radiometry and photometry are discussed primarily by defining the fundamental radiometric and photometric parameters. It would have been useful to expand this section in view of the wide importance of radiometric analysis in optoelectronic systems. If an undergraduate-level course in optics is not a prerequisite for a course using this text, supplementary material would be needed.

The review of solid state physics in Chap. 2 is aimed at developing a general understanding of semiconductor materials and devices. It includes sections on energy bands, electrical conductivity, the work function, carrier transport, and junctions. This chapter is especially useful in highlighting those topics of solid state physics that are fundamental to understanding many optoelectronic devices.

Chapter 3 covers the modulation of light and discusses phenomenology, materials, and devices based on linear and quadratic electro-optic effects as well as the acousto-optic and magneto-optic effects. Some topics in nonlinear optics, including parametric oscillation, are also covered.

A wide variety of display devices are discussed in Chap. 4. The treatment emphasizes light emitting diodes and covers phenomenology, materials, construction, and associated electronics. Also described are cathode ray tube, plasma, and liquid crystal displays. The discussion is primarily from a device perspective; systems issues, such as modulation transfer function, are not addressed.

Laser sources are treated in Chaps. 5 and 6. The basic physics, including emission and absorption of radiation, the Einstein relations, population inversion, and optical feedback, are covered in Chap. 5 along with a discussion of laser modes. This chapter concludes with descriptions of doped insulator, semiconductor, gas, and liquid dye lasers. The more advanced topics of frequency stabilization, mode locking, and Q switching are covered in Chap. 6 along with some of the more important applications of laser radiation in distance measuring (both interferometric and ranging) and holography.

Chapter 7 is devoted to a discussion of several commonly used thermal and photon detectors. There is a general review of the physics of thermal detectors, followed by descriptions of thermoelectric, bolometric, pneumatic, and pyroelectric devices. Heavier emphasis is placed on photon detectors. Photoemissive, photomultiplier, and image intensifier devices are discussed in addition to photoconductor and junction detectors. The treatments include spectral and temporal response as well as noise sources. The chapter concludes with a discussion of detectivity and noise equivalent power.

Optical waveguides are discussed in Chap. 8. An analysis of planar dielectric waveguides serves to introduce the concept of guided modes, but the treatment emphasizes the step and graded index fiber waveguides commonly used in communications and sensing. New in the second edition are discussions of single mode fibers and measurement of fiber characteristics. Dispersion and loss mechanisms (intrinsic, bending, and jointing) and manufacturing techniques are also covered.

Chapter 9, devoted to optical communications systems, serves as a focal point for the earlier chapters in that it draws upon elements of modulation, radiation sources, propagation, and detection. While primary emphasis is placed on fiber optical systems, free space optical communication and integrated optics are also discussed.

The final chapter, which is entirely new in the second edition, discusses the two primary noncommunications applications of optical fibers, including optical fiber sensors and light guiding fibers. The treatment of interferometric sensors using single mode fibers is especially welcome.

In developing an introductory text for a new and rapidly developing field, it is perhaps impossible to satisfy all potential users, especially when the curriculum continues to evolve. In *Optoelectronics,* for instance, the examples and problems often involve straightforward application of formulas given in the text, and the use of supplementary problems would be advisable if the book is to be used as a graduate-level text. In addition, depending on the content of other courses in the curriculum, one might desire more extensive coverage of certain topics (e.g. radiometry), less emphasis on others, or inclusion of additional topics (e.g., imaging systems). Given that the

scope of an introductory text must be limited, the authors have been generally successful in topic selection and depth of coverage.

Optoelectronics is a good introductory text for the important and rapidly growing field of optoelectronics. The topics selected for exposition are well chosen and complete, and the emphasis on fundamental principles is appropriate and welcome. While many of the topics covered deserve (and are often given) full-course treatment, the introductory-level discussions provided in this text provide an excellent foundation for subsequent specialization.

Handbook of Solid-State Lasers

Peter K. Cheo, editor. Volume 18 in Marcel Dekker's Optical Engineering Series. xiv + 619 pp., illus, index, references. ISBN 0-8247-7857-X. Marcel Dekker, Inc., 270 Madison Ave., New York, NY 10016 (1989) $165 hardbound.

Reviewed by Roger J. Becker, University of Dayton Research Institute, Dayton, OH 45469-0001.

This is a source book on a set of emerging solid-state laser technologies. Each chapter is independently written by an eminent leader in the field. The book is aimed at potential users of the new lasers, such as systems engineers and second-year graduate students. It assumes throughout that the reader is familiar with the general principles of lasers. The title is somewhat misleading since, despite its considerable length, it does not attempt to be comprehensive. The first five chapters, each over 100 pages long, address new materials systems lasing chiefly in the infrared that have been developed to the point where they may be incorporated into systems. Naissant materials still in a basic research stage and established lasers such as YAG or ruby lasers are not addressed. The book concludes with a short discussion of slab laser amplifiers.

Chapter 1 discusses the physical principles of injection diode lasers. The introduction to this chapter gives a helpful review of the historical factors leading to the entry of these lasers into the market. In its attempt at completeness it is constrained to be terse, so the extensive use of mathematics will be slow going for the uninitiated. The following four chapters, covering in turn high-power lasers made from III-IV compounds and lead salt, alexandrite, and color-center lasers, are less mathematical. Each chapter is heavily illustrated and contains a lengthy list of references. Applications, especially in communications and spectroscopy, are mentioned throughout each chapter but are given relatively little space. The emphasis is on the factors affecting performance and the prospects for improvements.

Although there is considerable overlap in the material covered in the first two chapters, no explicit contact is made between them. Basic operating principles are given considerable attention in the first chapter and design is stressed in the second. While Chap. 2 makes profuse use of figures illustrating laser structure and performance, the explanation of the physics of the important problem of facet damage is left largely to a figure caption.

The chapter on lead salt lasers forms a bridge between the direct bandgap lasers and the broadly tunable electrovibronic lasers, if only by juxtaposition. Materials properties and the theory of operation are given the greatest attention. The mathematics is well complemented by a generous use of excellent illustrations. The consideration of applications, confined to spectroscopy, is easily the most extensive in the book.

The lucid treatment of alexandrite lasers has a nice balance between the underlying physics and laser engineering. Frequent comparisons are made with YAG and ruby lasers, which also provide high power in a similar wavelength region and are based on related physical mechanisms. The treatments of the coupling of electronic and vibronic excitations in lasing and the primary engineering tradeoffs are especially clear and informative. The coverage of color-center lasers is dominated by engineering considerations. Nearly half of the chapter discusses cavity optics. The approach to the laser physics is largely phenomenological. Some acquaintance with spectroscopic notation and group theory is assumed.

The book is in no way intended as a collection of monographs for research scientists and engineers. Neither is it recommended as a text, partly due to the unusual emphasis of its subject matter, but primarily because the chapters are disjointed. Common issues such as heat dissipation and lasing efficiency are not tied together. For example, alexandrite and color-center lasers share the use of vibronic transitions to generate a four-level excitation scheme leading to cw operation and tunability, but the commonality of this property is not mentioned. However, the book succeeds admirably at its intention of giving an overview of the individual fields and a convenient introduction and guide to the literature.

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. 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.

March 1990—San Jose, Calif.

These courses will be offered in conjunction with SPIE's 1990 Symposium on Microlithography, March 4-9, San Jose, Calif.

Introductory Microlithography

Microlithography Introduction: Resist Materials and Their Processing, Murrae Bowden, Bell Communications; Larry Thompson, AT&T Bell Labs.; C. Grant Willson, IBM Almaden Research Ctr., Sun., 8:00 am-5:00 pm.

Diffraction Limited Optics, Robert E. Fischer, Ernst Leitz Canada Ltd. and OPTICS 1, Inc., Sun., 8:00 am-noon.

Introduction to Focus and Alignment Subsystems, David Holbrook, MRS Technology, Inc., Sun., 1:30-5:30 pm.

Optics for Photolithography, Doug Goodman, IBM Thomas J. Watson Research Ctr., Mon., 8:00 am-5:00 pm.

Optical Lithography, Michael King, Summit Technology, Inc.; David Markle, Ultratech Stepper Corp., Tues., 8:00 am-5:00 pm.

Physics of Semiconductor Materials and Devices, Dennis Polla, Univ. of Minnesota, Thurs., 8:00 am-5:00 pm.

Advanced Microlithography

Theory and Techniques of Optical Lithography, Chris Mack, National Security Agency, Sun., 8:00 am-5:00 pm.

Applications of Optical Lithography Simulation with SAMPLE and PROLITH, Chris Mack, National Security Agency; Andrew Neureuther, Univ. of California/Berkeley, Tues., 8:00 am-noon.

Excimer Laser Beam Delivery Systems, Kenneth Harte, Image Micro Systems, Inc., Tues., 1:30-5:30 pm.

Excimer Laser Lithography, Kanti Jain, Raychem—Advanced Packaging Systems, Wed., 8:00 am-noon.

Excimer Lasers for Microlithography: Working Knowledge and Practical Considerations, Uday Sengupta, Cymer Laser Technologies, Thurs., 8:00 am-noon.

X-Ray Lithography, Henry Smith, Massachusetts Inst. of Technology, Sun., 8:00 am-noon.

Electron Beam Lithography: Principles and Applications, Donald Tennant, AT&T Bell Labs., Sun., 1:30-5:30 pm.

Focused Ion Beam Microfabrication, John Melngailis, Massachusetts Inst. of Technology, Fri., 8:00 am-noon.