

# DEPARTMENTS

## BOOK REVIEWS

### Optical Fiber Amplifiers: Design and System Applications

Anders Bjarklev, 392 pages, figures, references, subject index, and glossaries of acronyms and symbols. Artech House Optoelectronics Library. ISBN 0-89006-659-0. Artech House, Inc., 685 Canton Street, Norwood, MA 02062 (1993) \$88 hardbound.

Reviewed by **Behzad Moslehi**, Optivision, Inc., 4009 Miranda Avenue, Palo Alto, CA 94304

This book should fulfill the objective, stated in the introduction, of providing a practical and general working reference for engineers and researchers involved with optical fiber amplifiers (OFAs), as well as providing a guide to the subject for nonexperts. The level of detail is sufficient to gain an understanding of both the background and practical implementation of fiber amplifiers, while providing numerous references for the critical areas of interest in each chapter. However, the book does assume that the reader knows the basics of lasers and optical fiber technology. The breadth of coverage is substantial, spanning materials, fabrication, characterization, design, analysis, and system implications, including recent developments in the field.

This publication is significant in that to date very few books have been published on optical amplifiers, and those that have appeared, although more comprehensive as references regarding research in their domain, are more specialized.

The book is generally well organized. Nice summaries at the end of each chapter help to make it very readable. However, the subject index needs substantial improvement (for example, key words such as saturation intensity, relaxation oscillation, polarization, etc., do not appear), and an author index would have increased its usefulness as a reference work. For ease of reference, it would have also been useful to have the chapter title at the top of each page.

The book is divided into 12 chapters. After a succinct introduction in Chap. 1, which provides a nice summary and perspective of this rapidly expanding field, Chaps. 2, 3, and 4 consider the properties of rare-earth-doped fibers (manufacturing, materials, and characterization aspects); Chaps. 5 through 8 consider 1550-nm erbium-doped fiber amplifiers (EDFAs); Chap. 9 treats 1300-nm neodymium- and praseodymium-doped fiber amplifiers (NDFAs and PDFAs); and Chaps. 10, 11, and 12 deal with system applications.

In more detail, Chap. 2 discusses the manufacture of active fibers so as to provide an understanding of today's technological limitations. It considers the incorporation of rare-earth ions in silica glass hosts via the mainstream methods—modified chemical vapor deposition, vapor axial deposition, and outside vapor deposition—and via solution doping methods. Also discussed are the manufacture of active fibers using fluoride glass hosts, the performance of overcladding techniques or rod-in-tube methods, and new developments in optical fiber drawing techniques. Chapter 3 treats the properties of rare-earth ions in glass host materials. Chapter 4 considers characterization measurements for rare-earth-doped fibers.

Chapter 5 presents the basic theory of 1550-nm EDFAs. Chapter 6 deals with optimization of EDFAs, and in particular considers maximizing the gain coefficient by optimizing the erbium distribution, host glass choice, fiber index profile, numerical aperture, cutoff wavelength, etc. Although a useful introduction is provided, the gain optimization and modeling discussion and referencing could be more complete. Chapter 7 deals with the pump wavelength choice for 1550-nm EDFAs. Chapter 8 discusses EDFAs with improvements in gain, noise, or gain efficiency obtained via advanced configurations (using a filter or an isolator, etc.).

Chapter 9 considers 1300-nm NDFAs and PDFAs. This topic is of particular inter-

est in that, being a very recent development, an overview with perspective on 1300-nm applications is not found in other books.

Chapter 10 covers fiber amplifiers in digital direct detection systems. Chapter 11 deals with distributed optical amplifiers. The treatment of this topic is good and particularly valuable because the advantages of distributed (as opposed to lumped) OFAs in certain applications, such as wavelength-division-multiplexing systems, are not widely appreciated. Chapter 12 covers amplifiers for analog-modulated systems and in particular cable television (CATV). Although the established system applications (telecommunications and CATV) are well treated, emerging applications regarding sensors and optical measurements systems are omitted.

This book contains a large number of useful and clearly drawn figures (150 in total)—illustrations that support the text together with much plotted numerical data. A minor disappointment is that the figures reproduced on the cover of the book (which are rather arbitrary, specialized, and not very meaningful unless the book has already been read) could have been better chosen, e.g., to provide a more general illustration concerning the subject of optical fiber amplifiers.

Despite the large number of references (approximately 500 citations with some overlap between chapters), an enormous number of articles have been published over the last few years, and the author should point out that the references are representative but not all inclusive. In particular, because references are given at the end of each chapter, an author index at the end of the book would increase its value as a reference tool. A list of related books would also be useful.

This book is valuable in that someone who is interested in learning about OFAs does not have to find and go through numerous papers published in this area in the past few years. However, the field of fiber amplifiers is still rapidly changing, and thus it is probably too

soon to settle on a book as a long-term reference. An updated second edition within the next few years will certainly prove very valuable.

The book provides a very readable overview of this fast-moving field up to 1993. In scope this book, which covers the properties, design, and systems aspects of OFAs, stands between and nicely complements, on the one hand, general textbooks on optical fibers or lasers and, on the other hand, several edited books, collections of papers, and more complete but specialized references on EDFAs.<sup>1-4</sup>

This book provides an excellent review as well as a practical working reference for researchers and engineers involved with fiber amplifiers. The subject is too specialized for it to stand alone as a textbook, because it is about a single device type rather than a field. However, it would be excellent as recommended reading, for example, for courses on optical fiber technology or optical waveguide components. It would also be good as a first reference for those researchers or graduate students doing or planning to do research on this device type.

#### References

1. P. W. France, *Optical Fiber Lasers and Amplifiers*, CRC Press, Boca Raton, FL (1991).
2. M. J. F. Digonnet, Ed., *Selected Papers on Rare-Earth-Doped Fiber Laser Sources and Amplifiers*, SPIE Milestone Series, Vol. MS37, SPIE Optical Engineering Press, Bellingham, WA (1992).
3. M. J. F. Digonnet, Ed., *Rare-Earth Doped Fiber Lasers and Amplifiers*, Optical Engineering Series, Vol. 37, Marcel Dekker, New York (1993).
4. E. Dersurvire, *Erbium-Doped Fiber Amplifiers: Principles and Applications*, John Wiley & Sons, New York (1994).

### Testing and Evaluation of Infrared Imaging Systems

Gerald C. Holst, 351 pages, illus., index, and references. ISBN 0-9640000-0-8. JCD Publishing Co., 2932 Cove Trail, Winter Park, FL 32789; phone 407/629-5370 (1993) \$75 hardbound.

**Reviewed by Glenn D. Boreman**, University of Central Florida, Electrical Engineering Department, Center for Research in Electro-Optics and Lasers, Orlando, FL 32816.

This book treats the performance characterization of infrared imager systems and is written with the needs of the test engineer in mind. Detailed test procedures are included for the parameters of interest with the inherent assumptions of the test techniques clearly spelled out. Many sample calculations and associated data analysis procedures are included, along with up-to-date references to

the literature. The book contains a wealth of practical information. It includes such hard-to-find topics as test target fabrication, phasing effects in resolution testing, choice of a collimator, differences between ac- and dc-coupled systems, atmospheric transmission plots over laboratory-length paths, and the mean variance technique.

The first four chapters are introductory in nature; topics include the various subsystems comprising a typical infrared imager, image quality, general test methodology, and basic concepts in temperature and radiometry. Chapter 5 covers the topics of focusing and resolution measurement. Chapter 6 discusses characterizations of system responsivity, dynamic range, and linearity; including the signal transfer function, the aperiodic transfer function, and the slit response function. Chapter 7 covers noise and its impact on system performance, including a discussion of the three-dimensional noise metric and its relation to other performance measures such as fixed pattern noise, noise equivalent temperature difference, and noise equivalent flux density. Spatial-frequency transfer functions are covered in Chap. 8, including the modulation transfer function (MTF), phase transfer function, and contrast transfer function (CTF). Details on sampling requirements, signal processing, CTF-to-MTF conversion, and impact of slit width are included. Chapter 9 treats issues of distortion and scan nonlinearity. Chapter 10 covers the observer-related performance metrics of minimum resolvable temperature difference and minimum detectable temperature.

In addition to test engineers, this book will be valuable to users of infrared imager systems, as well as managers, analysts, and designers, who must understand performance specification and measurement issues.

### BOOKS RECEIVED

**Collision-Induced Absorption in Gases**, by Lothar Frommhold. xii + 410 pp., illus., subject index, general references following each chapter, references at end of book. Vol. 2 of the Cambridge Monographs on Atomic, Molecular, and Chemical Physics. ISBN 0-521-39345-0. Cambridge University Press, 40 West 20th Street, New York, NY 10011-4211 (1994) \$89.95 hardbound. Deals with the infrared spectra of complexes of two and three molecules in collisional interaction. More than 800 original papers have been published in the field since the discovery of collision-induced absorption by Welsh and associates in 1949. This volume is the first attempt to present the theoretical and experimental foundations of this basic science of

the interaction of radiation with supermolecular systems.

**Semiconductor Optoelectronic Devices**, by Pallab Bhattacharya. xix + 535 pp., color illus., subject index, ten appendixes, problems following each chapter. Suggested texts for more extensive reading and key articles from journals and periodicals are listed at the end of each chapter and as footnotes. ISBN 0-13-805748-6. Prentice Hall, Englewood Cliffs, NJ 07632 (1994) \$62 hardbound. The first four chapters lay the foundation for optoelectronic devices. Chapter 4 describes junction theory, including metal-semiconductor junctions and heterojunctions. The devices themselves are described in Chaps. 5 through 11 in the following order: light-emitting diodes, lasers, photodetectors, solar cells, and light modulators. The text is concluded in Chap. 12 with a review of optoelectronic integrated circuits. The text has been developed at two levels, to benefit both seniors and graduate students.

**Introduction to Semiconductor Optics**, by Nasser Peyghambarian, Stephan W. Koch, and Andre Mysyrowicz. ix + 485 pp., illus., subject index, references and problems following each chapter, glossary of symbols, conversion of units. From the Prentice Hall Series in Solid State Physical Electronics. ISBN 0-13-638990-2. Prentice Hall, Englewood Cliffs, NJ 07632 (1993) \$61 hardbound. The book's goal is to provide readers with a basic understanding of the optical properties of solids and introduce the new areas of interest in this field. It shows, from the first principles, why the absorption spectrum of the semiconductor looks the way it does, and how absorption changes with laser irradiation and external electric fields.

**Optics, Optoelectronics and Photonics: Engineering Principles and Applications**, by Alan Billings. xv + 404 pp., illus., subject index, five appendixes, references following each chapter. From the Prentice Hall International Series in Optoelectronics. ISBN 0-13-709115-X. Prentice Hall, Englewood Cliffs, NJ 07632 (1994) \$37 softbound. This book is written with engineering students in mind. The idea of system response through input-output relationships is emphasized by the consistent use of Fourier optics and system impulse response. The use of these concepts is second nature to electrical and electronic engineers. It provides important insights that lead to the presentation of topics relating to diffraction and propagation in a manner easily understood by engineering students.