DEPARTMENTS

BOOK REVIEWS

Lasers and Optical Fibers in Medicine

Abraham Katzir, 351 pp., illus., index, references, and three appendixes. Volume 4 in the Physical Techniques in Biology and Medicine series. ISBN 0-12-401940-4. Academic Press, 1250 Sixth Street, San Diego, CA 92101-4311 (1993) $85 hardbound.

Reviewed by Joseph T. Walsh, Jr., Northwestern University, Biomedical Engineering Department, Evanston, IL 60208.

The use of lasers to treat and diagnose medical problems continues to grow. In part this growth is due to the desire to develop minimally invasive procedures. Optical fibers represent the conduit in which energy and information can flow into, within, and through the body. Dr. Katzir, an acknowledged expert on the use of optical fibers in medicine, has written his book for the novice and the expert alike. He covers basic photophysics through the development and use of single optical fibers and fiber bundles for diagnostic (sensor) and therapeutic (surgical) uses.

The organizational scheme of the text involves breaking each of the subjects within each chapter into "fundamentals," "principles," and "advances." The fundamentals should be readily accessible by even a novice to the field. Dr. Katzir has provided many clear examples and figures to explain fundamental concepts. Furthermore, the emphasis in the fundamentals sections is on conceptual understanding; mathematical rigor is generally left to more appropriate texts. The principles and advances sections provide further details to the more interested or advanced readers. Again there are many examples and figures with an emphasis on concepts and issues that directly impact the practical applications. Such an organizational scheme requires some getting used to; the reader must read several sections before seeing the complete story on a particular subject. Nonetheless, as an introductory text for someone new to the field and as a reference text, the information is readily available. Again, as a reference, the appendices and glossary are well written for the scientist and clinician alike. The bibliographies, at the end of the text as well as after each chapter, are not exhaustive, but typically indicate key articles and are certainly appropriate for the initiation of a literature search for those readers interested in more in-depth coverage.

The book begins with an entertaining and well-written history of optical devices in medicine. The second chapter includes an explanation of lasers and laser-based terminology that should be quite appropriate for novices to the field. There is excellent coverage of the lasers most commonly used in medicine. Both the principles and advances sections nicely cover the important operating characteristics of most lasers being used experimentally in medicine. Each of the major classes of lasers (gas, solid-state, ion, dye, semiconductor, and even free-electron) is discussed. Safety issues are only briefly discussed to remind the novice of the optical, electrical, and plume hazards.

Chapter 3 covers the basic thermal and nonthermal interaction of laser light with tissues for diagnostic and therapeutic purposes. The fundamental nomenclature of the field is introduced in a manner that should be clear to someone new to the field. Absorption, scattering, luminescence, temperature rises due to absorption, as well as more advanced issues such as photomechanical and photoablative interactions and spectrophotometric techniques are introduced. One should note that the overview nature of this chapter by necessity precludes an in-depth coverage of these topics. For this reason the chapter will be most useful to those who are new to the field.

The next two chapters provide an understanding of the basic operation, manufacture, and use of single and bundled optical fibers. There is an excellent section on the history of optical fibers followed by a clear explanation of the principles of light transmission through such fibers. The chapter ends with an explanation of fabrication methods and specialty fibers for UV, IR, and power transmission. The next chapter extends this discussion to optical fiber bundles; both nonordered bundles, which are used primarily for transmission of light for illumination purposes, and ordered bundles, which are used in fiberscopes and endoscopes for viewing tissue within body cavities, are discussed. The practical, scientific, and engineering limitations of both ordered and nonordered systems are explained at the level of conceptual understanding and practical usage.

The discussion leads naturally into a more detailed presentation of endoscopes. The fundamental optics of endoscopes are presented as well as the major design, fabrication, and operational issues. The differences among the uses of standard (diam > 3 mm), thin (diam = 1 to 3 mm), and ultrathin (diam < 1 mm) endoscopes are explained in some detail and should be of interest to the scientist and clinician alike.

The section on fiber optic sensors is by necessity brief, because whole texts are devoted to this subject and the field is rapidly advancing. Nonetheless, Dr. Katzir has captured the essential principles of both direct and indirect sensors and explained these principles concisely. The descriptions of uses of fiber optic sensors in the measurement of physical (temperature, pressure, and flow) and chemical (pH, PCO_2, PO_2, and glucose) parameters are brief and to the point.

The final two chapters illustrate how the various aspects of fiber optic systems for medicine are integrated, how the fiber tips are altered to achieve the desired power delivery and tissue illumination, and how the scopes are constructed to allow for diagnosis, treatment, and articulation. Examples of CO_2, excimer, Nd:YAG, and pulsed dye laser-based systems are given. The application of these systems to treatment of cardiovascular disease is explained in some detail. The uses in gastrointestinal, thoracic, gynecological, neurosurgical, and oncological surgery, as well as ophthalmology, orthopedics, otolaryngology, and urology, are described briefly but focus on the essential technological and clinical issues.

The book is extremely well illustrated and easy to read throughout. The technical jargon is minimal and the emphasis on concepts is universal. The instructive nature of the book makes this an excellent introductory text for the engineering and biophysics student, as well as the postdoctoral/medical fellow who is new to this interdisciplinary field of lasers and optical fibers in medicine. It should also serve as a good reference to this rather broad field.