DEPARTMENTS

BOOK REVIEWS

Optical Materials: A Series of Advances, Vol. 1

Edited by Solomon Musikant, 430 pages, illus., index, references. ISBN 0-8247-8131-7, Marcel Dekker, Inc., 270 Madison Ave., New York, NY 10016 (1990) $115 hardbound. Brian J. Thompson, consulting editor.

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Optical materials are the stuff from which optics are made. Their importance cannot be overemphasized. To make a lens, an antireflection coating, a polarizer, a modulator, a hologram, or a waveguide requires certain optical materials. Light generation and detection also takes place within appropriate materials. Although self-evident, this basic fact is not always sufficiently appreciated. Therefore the appearance of the first volume of this series of reviews is both welcome and timely (and coincides incidentally with the announcement of a new journal, *Optical Materials,* R. C. Powell, Ed., that will soon be published by North-Holland).

This is a field of vast scope, and this first volume can only cover some of that ground. The book consists of three chapters of roughly equal length: Nematic Liquid Crystals for Active Optics by Shin-Tson Wu, Optical Fiber Materials by Paul A. Tick and Peter L. Bocko, and Crystalline Optical Materials for Ultraviolet, Visible, and Infrared Applications by James A. Savage. I will comment on each chapter separately.

The chapter by Wu concentrates on the optical, electro-optical, and thermal properties of thin layers of oriented nematic liquid crystals (LCs). All of the essential aspects of alignment, birefringence, anisotropic absorption (dichroism), scattering, and electro-optic response times are considered. Factors that control birefringence (including the design of new LC molecules) are emphasized. Whenever possible, equations are given (for the most part without derivation) that describe a specific behavior. Numerous experimental results (obtained mostly by the author at Hughes Research Laboratories) are presented in graphs and tables. The section on applications is necessarily brief and covers spatial light modulators (mainly IR⟷ visible image converters) and, to a lesser extent, tunable retardation waveplates. The references are extensive and include titles; the list makes evident the important contributions of the author in this field.

I would have liked to have seen a Kramers-Kronig-type dispersion relation that links the birefringence and dichroism of the LC medium; this could have put the author's discussion of the connection between these two properties on firmer ground. The use of the terms "optical rotatory power" and "optical activity" to describe the effect of a twisted nematic LC layer is a bit unfortunate and is inconsistent with the original meaning of these terms (as descriptive of optical properties of media that contain chiral molecules). Worse yet is the use of the term "plane of polarization" on p. 50 to mean the transverse plane that contains the elliptical vibration of the electric vector of light. Furthermore, Fig 1.23 and the captions of Figs. 1.1 and 1.2 are deficient, and Eq. (1.28b) is missing a "pi." I have also found a few typos and some poorly worded statements. Examples of the latter are: "speeding up the LC response times" and "Many LC molecules look milky," on p. 12; "The rest wavelength in the bandwidth...," p. 14; "Optical activity is not the same as the phase retardation effect," p. 16; "light enters...at a normal angle," p. 20; and "The required operation voltage to reorient LC molecules, say 10^5 V/cm..." p. 43. These, however, are minor imperfections in an otherwise excellent chapter.

The ongoing transformation of the telecommunications network from copper wires that carry electrical currents to light-guiding glass fibers is a major manifestation of the new photonics age. This spectacular technological advance would have been impossible were it not for the dedicated research and development efforts of materials scientists and engineers that accomplished a three-order-of-magnitude reduction in the attenuation of silica optical fibers, down to nearly the theoretical limit of about 0.1 dB/km. Because Corning Glass Works played a significant role in this achievement, it is only fitting that Chap. 2 on "Optical Fiber Materials" be contributed by two scientists from this organization. There is an impressive amount of painstakingly collected data from the world literature on all important properties (optical, thermal, and mechanical) of the major classes of glassy fiber materials (oxides, halides, and chalcogenides) as well as crystalline fibers. However, the discussion of active (e.g., Er-doped) fibers is brief, and nonlinear materials are effectively declared outside the scope of this chapter. The importance of active and nonlinear fibers will easily justify separate coverage in a future volume.

The weakest part of this chapter is its opening section on the design and properties of optical fibers. The very first equation (2.1) is in error and the authors' definition of bandwidth (p. 151) is incomprehensible. The amount of information contained in Tables 2.1 and 2.2 hardly justifies their inclusion. I encountered several typographical and other minor errors that could have easily been caught in a careful proofreading. The chapter ends with an important and extensive list of references. However, the reader will be a bit disappointed because nearly half of the references appear without titles. Again, these imperfections do not detract from the value of the reference material contained in this chapter.

The title of the third and last chapter, Crystalline Optical Materials for Ultraviolet, Visible, and Infrared Applications, by James A. Savage, is misleading. Those interested in crystal or polarization optics may think that there is something in it for them, but they will be disappointed. In fact, the author's interests appear to lie mainly with lens and window materials that are effectively optically isotropic (i.e., either cubic or polycrystalline); the major classes of oxides, halides, chalcogenides, and semiconductors are all covered. However, dominant birefringent materials for the control of light polarization such as calcite, quartz, or lithium niobate (and others) are simply left out. In addition to refractive index dispersion data, there is an emphasis on methods of preparation or growth of these materials. The latter, although instructive, is a bit sketchy for specialists.

This chapter is relatively free of typographical errors. (I found only one on p. 326.) An odd verb "HIPing" appears on p. 388 and a spatial frequency is cited in "cycles per minute" on p. 380. As if to fulfill its position in a sequence, this last chapter includes no titles for any of the papers it cites. The following subject index for the entire book starts off with two mysterious entries (1738 and 2025). However, it will not take the reader long to decipher their meaning!

The book as a whole is praiseworthy. The initiative in starting this series is commendable. One can only hope that this series will continue for the benefit of the optics community and as a continuing tribute to Solomon Musikant who passed away recently (OE Reports, August 1991, p. 15).

Image Recognition by Holography

G. I. Vasilenko and L. M. Tsibul'kin (translated from Russian by Albin Tybulewicz), ix + 332 pages, illus., references. ISBN 0-306-11017-2 Consultants Bureau, A Division of Plenum Publishing Corp., 233 Spring St., New York, NY 10016 (1989) $85 hardbound.

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Although a number of books on similar topics exist, the book by Vasilenko and Tsibul'kin is different because it draws much of its material from Soviet (from the days before the putsch) work of which western academics are largely ignorant. Of the 158 publications cited in *Image Recognition by Holography*, 53 are Soviet in origin.

Chapter 1 covers statistical image recognition methods that deal with analytical and computational concepts pertaining to decision making and decision functions, multizonal images, search and recognition, and linear filtering. This is an extremely well-written chapter. The following chapter is on the fundamentals of optical data processing. This chapter takes its reader through the traditional coverage of Maxwell's equations, a rather rigorous treatment of Rayleigh-Sommerfeld and Fresnel-Kirchoff diffraction integrals, and signal modulation by optical components such as prisms, lenses, and mirrors. The last two sections of Chap. 2 are rather unusual in that few books treat so many nontrivial mathematical operations of optical data processing and optical systems in such an interesting fashion. Any Fourier optics course instructor will find these two sections sufficiently rewarding.

Chapter 3 first introduces optical correlators and then discusses the synthesis of holographic filters. This and related mathematical concepts are followed by four nontrivial sections on holographic filtering of images, matched filtering, inverse filtering, and generalized filtering. In Chap. 4, the authors cover the various types of optical correlators. The discussion on the Vander Lugt correlator is followed by a description of correlators with mutually modulated Fourier transforms, also know as joint Fourier transform correlators (JFTC). Two variations of these correlators are described next. One, referred to as the photoelectric type, uses a scanning photodetector. The other, referred to as the heterodyne type, uses a moving grating with a variable period. It may be argued that JFTC researchers will encounter surprises in these sections. Section 4.4 attempts to describe the possibility of real-time optical processing, but the discussion is not due to the lack of spatial light modulators in the Soviet Union. Perhaps for the same reason, the book does not comment on the development of phase-only filtering. A discussion of the impact of partly coherent illumination is followed by a consideration of improvements in holographic correlators.

Chapter 5 considers the important characteristics of holographic correlators. This chapter examines the influence of geometric distortions, the often-ignored errors in Fourier analysis due to linear frequency and amplitude approximations, and the influence of random disturbances. The chapter also reviews, although briefly, Mellin-transform-based correlators for achieving insensitivity to changes in scale and rotation of an object.

The last two chapters deal with specific applications of holography. In comparison, these chapters are descriptive and have more figures. Chapter 6 considers alphanumeric character readers exclusively, but adequately addresses issues pertaining to memory densities and data search systems. Finally, Chap. 7 examines applications of holographic recognition systems in areas such as botany, optical computing, weather satellites, flight navigation, and target tracking.

In my opinion, the book has all the elements necessary for a reader interested in holography and its applications. The text has been written from a theoretical view but does justice to realities. Since the chapters have no exercise problems and few figures, the book could not be used as the primary text in a classroom; however, *Image Recognition by Holography* has considerable material that no other text has. I am positive that this book could be used as a reference text by graduate students and scientists interested in holography. Some notational difficulties and inconsistencies exist, but none are too harmful. However, the absence of an index will cause frustration for many readers.