DEPARTMENTS

BOOK REVIEWS

Optical Fiber Amplifiers, Design and System Applications

Anders Bjarklev, 406 pages, illustrations, index, and references. ISBN 0-89006-659-0. Artech House, Inc., 685 Canton Street, Norwood, MA 02062 (1993) $88 hardbound.

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Optical fiber amplifiers are now widely recognized as having revolutionized the design and performance of optical transmission systems and networks. This book tells the amplifier story from fabrication and spectroscopy, through pump choices, to system implementation. The scope is not limited to the erbium-doped fiber amplifier (EDFA), but also covers the neodymium- and praseodymium-doped fluoride fiber amplifiers for the 1300-nm window. Other fluoride fiber amplifiers, such as thulium for 800 and 1470 nm, and erbium for 850 and 1550 nm, are not discussed in any detail.

After the initial introductory chapter, Chap. 2 covers the various manufacturing techniques for both silica and fluoride fibers, and also describes some of the more novel methods, such as distributed erbium fibers with very low concentration and tapered fibers for improved noise performance. Chapter 3 covers the properties of the rare earths in glasses, concentrating on those aspects that are of particular significance for fiber amplifiers, such as the effect of the core codopants, the limitations imposed by excited state absorption and ion-ion up-conversion in erbium, codoping with ytterbium and lanthanum for improved performance, and temperature effects. The level of this treatment is adequate for a book of this nature, which is not intended to provide detailed spectroscopic information.

The next chapter describes basic characterization methods for the fiber preform, the fiber itself, and also the complete amplifier. This concentrates on optical measurements, and so, for example, electrical methods of noise figure measurement are not discussed. Chapter 5 covers the basics of EDFAs. The starting point for this is the determination of the cross sections and formulation of the system of rate and propagation equations to describe the amplifier performance. Numerical solution of these equations is then discussed, with a useful further section on approximate and analytic solutions and their range of validity. The final part of the chapter then shows experimental verification of the proposed model. This model, or slight variants, is used extensively throughout the rest of the book to illustrate points under discussion.

Chapters 6 and 7 cover optimization of the fiber and choice of pump wavelength, again for the EDFA. This is fairly extensive and includes a choice of codopant, pumping configuration, and index profile, and considers 800, 980, and 1480 nm as major pump bands. Small signal and large signal amplifiers are considered separately, as they frequently require different optimization steps. Advanced EDFAs are covered next, including the use of intra-amplifier filtering and/or isolators to improve efficiency and improve the spectral response, together with reflective configurations and tapered amplifiers for improved noise performance. Again, extensive use is made of simulations to illustrate the points being raised. The 1300-nm amplifier, using neodymium or praseodymium in fluoride fibers, forms the basis of Chap. 9. Problems with neodymium to do with excited state absorption and competition from the far stronger 1060-nm transition are clearly discussed, together with techniques to mitigate their effect, and, while there is less space devoted to praseodymium, the basic characteristics of the system and potential optimization routes are clearly described.

The remainder of the book covers system applications, including both digital and analog systems, and includes sufficient theory to allow limiting factors and system performance to be discussed quantitatively. A number of different system options is considered, including remote pumping and multiwavelength systems. Distributed amplification has a complete chapter devoted to it, including noise and figure of merit, together with a discussion of optimum fiber design when dispersion is taken into account. There is a reasonable reference list to systems experiments, although the latest date in this list is 1992, consistent with the book's 1993 publication date.

Overall, the book is thoughtfully laid out, with clear illustrations. Each chapter ends in a brief summary of the chapter contents, together with the references for that chapter, making it easy to use. The contents of the book, and the degree of depth with which the various topics are covered, reflects to a large extent the balance of interests within the author's research group, although the work of other groups is referred to where appropriate. In conclusion, this book is a worthwhile addition to the growing number of books covering this topic.