

DEPARTMENTS

BOOK REVIEWS

Quantum Well Lasers

Peter S. Zory, Jr., Ed., 520 pages, illus., index, references. ISBN 0-12-781890-1. Academic Press, 1250 Sixth Avenue, San Diego, CA 92101-4311 (1993) \$75 hardbound. Latest in the series "Quantum Electronics—Principles and Applications," P. F. Liao and P. L. Kelley, Eds.

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The semiconductor quantum well (QW) laser structure is rapidly becoming the preferred design in many applications because of its low threshold, design flexibility, and high reliability. Zory has set himself the ambitious goal of editing a book "to provide the information necessary to achieve a thorough understanding of QW lasers." For the most part he has succeeded, and this volume should be a welcome addition to the bookshelves of serious researchers in the field and students who seek to become familiar with details of this new device technology.

The book begins with a brief, interesting foreword by C. H. Henry on the history of the QW laser concept and its early development, including the author's early involvement at Bell Telephone Laboratories. Following this introduction is a 79-page chapter by S. W. Corzine et al. on optical gain in III-V bulk and QW lasers. In my opinion, this is one of the best and most useful chapters in the book. It provides a thorough description of linear gain in the single-electron envelope approximation, beginning with first principles and proceeding step by step through most of the complexities and subtleties of matrix element anisotropy, carrier scattering, and valence-band mixing. Although these topics have been thoroughly described in various journal articles, this chapter includes them all in clear

and readable language in a common framework with consistent notation.

The next chapter on intraband relaxation and line broadening effects by M. Asada is an excellent expanded review of a topic introduced by Corzine. At this stage, however, one of the problems of having many authors becomes apparent. While the preceding chapter's examples dealt primarily with GaAs/AlGaAs and InGaAs/AlGaAs short-wavelength lasers lattice-matched to GaAs substrates, five of the six figures in Asada's chapter describe long-wavelength GaInAs/InP lasers lattice-matched to InP. The formulas in both chapters are general, but the calculations resulting from their application are complex and structure dependent. It would have been of more service to the reader to have most of the calculated examples apply to a common laser structure.

The remaining chapters describe multiple QW lasers (W. H. Engelmann et al.), low-threshold QW lasers (K. Y. Lau), dynamics of QW lasers (Lau), special aspects of AlGaAs and (short-wavelength) InGaAsP lasers (D. Z. Garbuzov and V. B. Khalfin), valence-band engineering (E. P. O'Reilly and A. Ghiti), strained-layer QW lasers (J. J. Coleman), AlGaInP QW lasers (D. P. Bour), and quantum wire lasers (E. Kapon). These chapters are well written by recognized experts in the field. Each chapter could serve as an excellent article in its own right, but in the context of a book such as this there is an unnecessary amount of duplication. For example, a brief derivation of linear gain behavior occurs in four of the chapters following Corzine's. Even allowing for the need to establish consistent notation within a chapter, some of this material could have been condensed or eliminated. There are also minor notational inconsistencies between chapters dealing with other topics, such as

strain effects in the chapters by O'Reilly and Coleman.

Although the 10 chapters cover most of what constitutes a thorough understanding of QW lasers, several topics were omitted that I consider important. For example, all of the QW models are based on ideal symmetric structures. No discussion is given of the actual nonsymmetric potentials across forward-biased laser junctions. Implicit in all of the single-particle gain models is a neglect of excitonic effects, which make the calculated absorption curves for zero or low excitation erroneous. Even in forward-biased QW lasers, there is experimental evidence that excitonic enhancement of radiative recombination is non-negligible mostly because of larger exciton binding in QWs. I believe a more balanced view of QW gain modeling that explicitly incorporates such Coulomb interaction could have been obtained by including a chapter based on many-body formalism, such as the formalism developed by H. Haug, S. Schmitt-Rink, C. Ell, W. Chow, and others. The specific consequences of QW structures on the linewidth broadening factor, Auger recombination, and optical nonlinearities have also been discussed in the literature for several years but are missing from this book.

Notwithstanding these criticisms, this book is a major contribution to the reference literature on QW lasers. The topics that are included are treated extremely well by the authors. Each chapter has an extensive list of references for those who wish to examine the primary sources. I would not recommend this book as a text because of the somewhat disjointed features of an edited, multi-author book and the advanced and specialized nature of many of its topics. However, it should serve well as a convenient and relatively current reference.