

分布式反馈激光 二极管手册

SECOND EDITION



GEERT MORTHIER • PATRICK VANKWIKELBERGE

HANDBOOK OF Distributed Feedback Laser Diodes

SECOND EDITION



GEERT MORTHIER • PATRICK VANKWIKELBERGE

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Handbook of Distributed Feedback Laser Diodes

Second Edition

Geert Morthier
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Preface

Since the first edition of this book in 1997, the photonics landscape has evolved considerably and so has the role of DFB laser diodes. Although tunable laser diodes are introduced ever more in advanced optical communication systems, DFB laser diodes are still widely applied in many deployed systems. This also includes wavelength tunable DFB laser diodes and DFB laser diode arrays, usually integrated with intensity or phase modulators and semiconductor optical amplifiers. It is moreover expected that, in the near future, optical communication will find its way in short distance interconnections between or inside computers, and that silicon photonics will be the preferred technology for such interconnections. DFB lasers in InP heterogeneously integrated on silicon-on-insulator waveguide circuits are being investigated as transmitters for optical interconnects.

This book is intended to give a comprehensive description of the different effects that determine the behavior of a DFB laser diode. Emphasis is on developing a detailed understanding of DFB lasers and on the derivation of guidelines for their design. To this end, Chapters 1–4 deal with the device physics and how they can be modeled. Both a lumped rate equation model and a longitudinal coupled-wave equation model are presented. The design is covered in Chapters 5–9, wherein the different aspects of the laser performance (i.e., current injection efficiency, spectral stability, dynamic behavior, nonlinear distortion, and noise characteristics) are subsequently discussed. These chapters contain a large number of illustrations, and have been written with the aim of providing clear explanations. Chapters 10 and 11, which are new in this second edition, discuss wavelength tunable DFB lasers and bistable and self-pulsating DFB lasers, respectively. Wavelength tunable DFB lasers are gaining importance with the evolution towards coherent communications, but

are also important in future optical sensing systems. Bistable and self-pulsating DFB lasers can be applied in more advanced applications, such as optical logic, optical signal regeneration, and clock extraction. Chapter 12 discusses the fabrication and packaging of DFB laser diodes, while the epilogue gives an updated outlook on future DFB laser devices and future applications. Although this book is focused on DFB lasers, much of the material is directly applicable to Fabry-Perot lasers.

This book should therefore be of interest to researchers, engineers, and students in device fabrication and design, optical-fiber communications, and any other field wherein DFB laser diodes are used. Any person with a reasonable background in semiconductor and electromagnetic theory should be able to follow the text easily.

Most of the authors' knowledge and understanding about this topic is the result of several years of research at the Department of Information Technology of Ghent University. It is therefore our great pleasure to acknowledge Prof. Paul Lagasse, who has been director of this department for over twenty years, and Prof. Roel Baets, who has headed the Photonics Research Group for over twenty years, for providing all the necessary means and opportunities for doing this research. We owe them much for the opportunities to collaborate and interact with many other researchers, both at the department and at several internationally recognized industrial and academic laboratories. It would be an impossible task to list all of the individuals with whom we had stimulating discussions or interesting collaborations and who thus contributed to our own work. Early collaborators—such as Jens Buus, Bart Verbeek, Piet Kuindersma, Chris Park, and Richard Ash, Francois Brillouet, Jean-Luc Beylat, Richard Schatz, and Yoshiaki Nakano—have certainly impacted our work and therefore this book. Chapters 10 and 11, which are based on more recent research, has benefitted from collaborations with Markus-Christian Amann, Ralf Meier, and Rene Todt from the Walter-Schottky Institut in Munich (Rene Todt is now at Oclaro) and from the work of Dr. Morthier's former Ph.D. student, Koen Huybrechts.

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