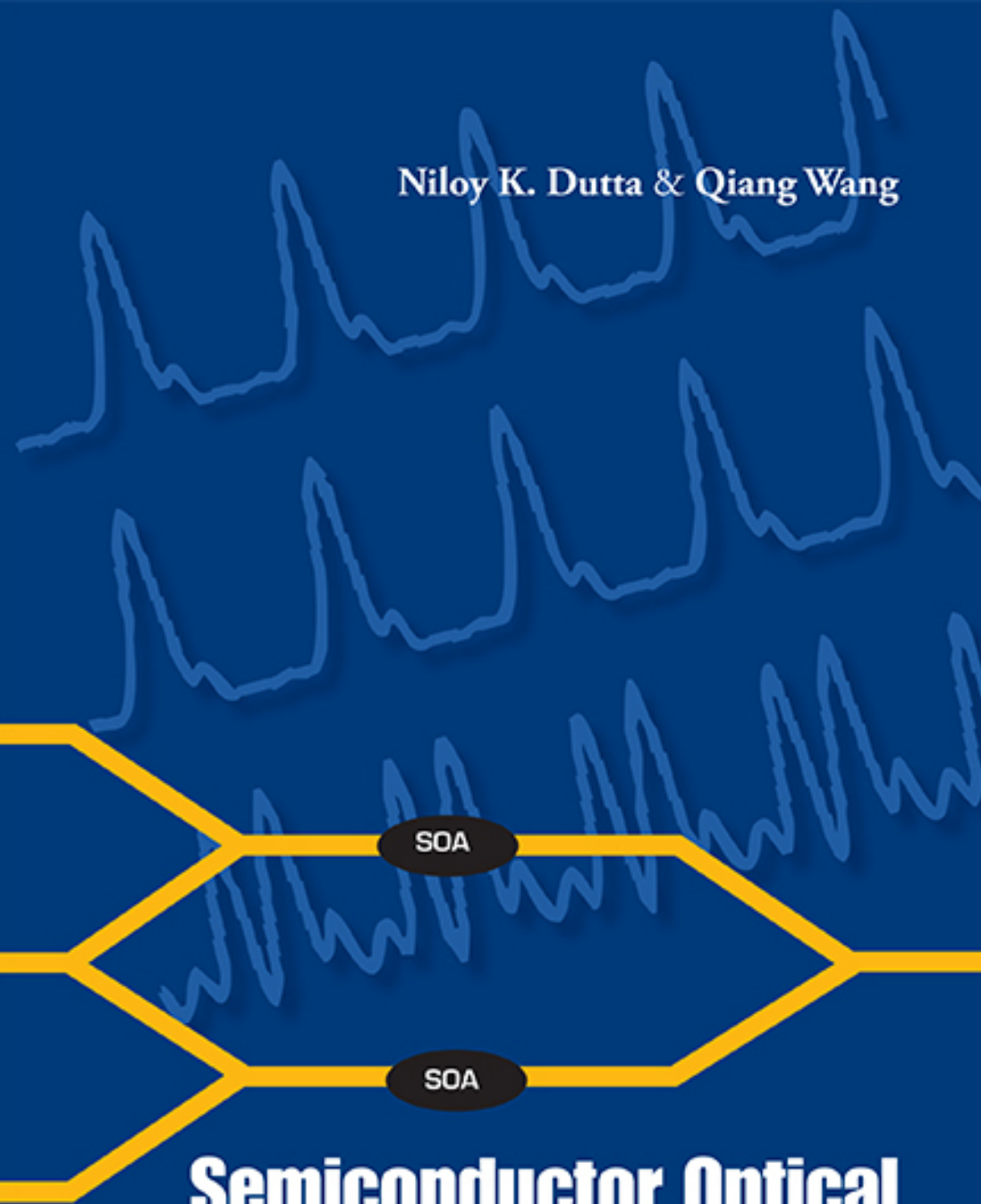
Niloy K. Dutta & Qiang Wang



Semiconductor Optical Amplifiers

Second Edition

Semiconductor Optical Amplifiers

Second Edition

This page intentionally left blank

Semiconductor Optical Amplifiers

Second Edition

Niloy K. Dutta & **Qiang Wang**

University of Connecticut, USA

World Scientific

NEW JERSEY • LONDON • SINGAPORE • BEIJING • SHANGHAI • HONG KONG • TAIPEI • CHENNAI

Published by

World Scientific Publishing Co. Pte. Ltd.

5 Toh Tuck Link, Singapore 596224

USA office: 27 Warren Street, Suite 401-402, Hackensack, NJ 07601

UK office: 57 Shelton Street, Covent Garden, London WC2H 9HE

Library of Congress Cataloging-in-Publication Data

Dutta, N. K. (Niloy K.), 1953–

Semiconductor optical amplifiers / Niloy K. Dutta & Qiang Wang. -- 2nd edition.

pages cm

Includes bibliographical references and index.

ISBN 978-9814489034 (hardcover : alkaline paper)

1. Semiconductors. 2. Optical communications. I. Wang, Qiang. II. Title.

TK8320.D87 2013

621.382'7--dc23

2013018607

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

In-house Editor: Song Yu

Typeset by Stallion Press

Email: enquiries@stallionpress.com

Printed in Singapore

Preface

In the past two decades, optical communications has totally changed the way we communicate. It is a revolution that has fundamentally transformed the core of telecommunications, i.e. its basic science, its enabling technology, and its industry. The optical networking technology represents a revolution inside the optical communication revolution and it allows the latter to continue its exponential growth.

The existence and advance of optical fiber communications are based on the invention of low-loss optical fibers, the invention of the laser, particularly the semiconductor junction laser and related disciplines like photodetectors and integrated optics. From the early pioneering ideas, it took more than 25 years, to the first commercial deployment of optical communications; the Northeast Corridor system linking Washington and New York in 1983. Another important advance is the deployment of the first transatlantic submarine optical fiber transmission system in 1988. Optical fiber communications began to seriously impact the way information is transmitted beginning with these milestone achievements.

The market demand for higher capacity transmission was helped by the fact that computers continued to become more powerful and needed to be interconnected. This is one of the key reasons why the explosive growth of optical fiber transmission technology parallels that of computer processing and other key information technologies. These technologies have combined to meet the explosive global demand for new information services including data, internet, and broadband services — and, most likely, their rapid advances have helped fuel this demand. This demand is continuing its strong growth as internet traffic keeps increasing every year.

Optical networking represents the next advance in optical communications technology. Semiconductor optical amplifier is a key

device for all-optical networks. The advances in research and many technological innovations have led to superior designs of semiconductor amplifiers. Although many optical communication systems use optical fiber amplifiers for signal amplification, semiconductor optical amplifiers are suitable for integration and can also be used as functional devices. These functional properties such as wavelength conversion, optical demultiplexing, and, optical logic elements make them attractive for all-optical network and optical time division multiplexed systems.

The need for higher capacity is continuing to encourage research in wavelength division multiplexed (WDM) based and optical time division multiplexing (OTDM) based transmission, which needs optical demultiplexer and high power tunable lasers. An important research area would continue to be the development of semiconductor optical amplifiers as Mach-Zehnder, Michelsen interferometers and low power amplifiers in integrated devices. Semiconductor optical amplifiers with quantum dot active region are important for high speed optical signal processing systems due to their high saturation power and short gain recovery time. Reflective semiconductor optical amplifiers are important for commercial wavelength division multiplexed based passive optical network (WDM-PON). Two-photon absorption in a semiconductor optical amplifier is a very fast process and may be suitable for Tera-bit/s signal processing. Semiconductor optical amplifiers and superluminescent diodes (SLDs) are high power broadband sources suitable for optical coherence tomography and sensors applications.

All-optical signal processing is expected to become increasingly important in future ultrahigh capacity telecommunication networks. The development of all-optical logic technology is important for a wide range of applications in all-optical networks, including high speed all-optical packet routing, and optical encryption. An important step in the development of this technology is the demonstration of optical logic elements and circuits, which can also operate at high speeds. These logic elements include the traditional Boolean logic functions such as XOR, OR, AND, INVERT etc, and circuits such as parity checker, all-optical adder and shift register. Semiconductor

optical amplifier based devices such as Mach-Zehnder interferometers are being investigated for the development of all-optical logic circuits.

N. K. Dutta
Q. Wang

This page intentionally left blank

Contents