Preface

The importance of semiconductor optical amplifiers (SOAs) as key components in optical communications and integrated optics, covering a wide range of applications for the 1550- and 1300-nm optical windows, has grown in recent years. All-optical signal processing, including wavelength conversion, optical logic gates and signal regeneration, etc, is one of the most important enabling technologies to realize optical switching, including optical circuit switching, optical burst switching and optical packet switching and SOAs are very promising in all-optical signal processing since they are compact, easy to manufacture and power efficient.

The need for all-optical elements for increasing the capacity of current and future communication networks and optimizing the operation of optical switching networks has been one of the main motivations for considering SOAs as essential elements in all-optical switching scenarios in recent years. The present book tries to mark a small portion of the SOAs and specially quantum-dot SOAs (QD-SOAs) capabilities in the mentioned topics.

In Chap. 1 of this book authors have tried to introduce different aspects of a SOA specially a QD-SOA including structural, optical and electrical specifications of a QDSOA. Different definitions in the field of a SOA such gain-related mechanisms, SOA polarization characteristics, effect of impurity doping in the active region and fabrication requirements are presented in this chapter.

Chapter 2 presents a general overview for different simulation methods of QD-SOAs. One of the most accurate ways of modeling a SOA is to solve the Semiconductor Bloch Equation (SBE). However, this method is extremely time-consuming. The computation time is not acceptable for the system applications of SOA-based devices, where many optical pulses have to be transmitted through the SOA to evaluate the system performance. Simplified approaches including certain physical processes phenomenologically, as it is done in rate-equation models, have much faster calculation speeds and are quite successful in explaining the experimental results. Although the accuracy for sub-picosecond pulses is not as good as the SBE calculation. Numerical modeling is always necessary to understand the working principle of the devices and to optimize their performance. Physical modeling of complex devices including SOA, such as all-active MZIs, is necessary

in order to understand their potential and limitations. In this chapter three different methods for investigation of the QD-SOA performances based on rate-equation model i.e. numerical methods, equivalent circuit-modeling methods and analytical methods is briefly described.

Chapter 3 of the book covers different techniques toward utilizing the high-speed operation capabilities of SOAs for high-bit-rate signal processing. This chapter reviews the most recent techniques in the field of bulk, quantum well and also quantum dot-based SOAs and gives an insight for possible future optimization methods for increasing the response of SOA-based devices for high-speed operations.

Chapter 4 covers the applications of SOAs in all-optical logic gates and subsystems which seem to be essential elements in all-optical signal processing scenarios. In this chapter it has been tried to introduce different techniques for realization of SOA-based optical units and hence, it hasn't suffice to QD-SOA based structures. This diversity of introduced structures may provide inspiration for novel ideas in eager readers. Authors believe that investigation of QD-SOA specifications in the beginning chapters and presentation of practical methods based on different types of SOAs provides this ability for researchers who are interested in the topics.

Finally, in Chap. 5 of the present book, recent progresses in all-optical signal processing and switching with considering SOAs as one of the main elements in the proposed structures are presented. Although these applications are not the whole SOA based architectures for optical switching and signal processing, a small part of recent development in this field is has been reviewed in this chapter.

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