PERSPECTIVES IN OPTOELECTRONICS

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PERSPECTIVES IN OPTOELECTRONICS

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TO ALL OUR TEACHERS

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PREFACE

In recent years, optoelectronics has emerged as a rapidly expanding frontier area of research and development. This field has, of course, crucial overlaps with optics, materials science, semiconductor technology and microelectronics. Important developments in all these areas and rapid strides made in material-growth and device-fabrication technologies, are indeed responsible for the steady progress of optoelectronics. With the availability of a wide range of tunable, pulsed, coherent optical sources and amplifiers, the low-loss single-mode silica-fiber optical transmission medium, sensitive photodetectors, novel ultra-fast modulation techniques, and efficient nonlinear optical materials, optoelectronics is playing a major role in both applied as well as basic sciences. In years to come, it is destined to change the face of information technology and robotics, involving optical sensing and control, information storage, signal and image processing, communications, and computing. Because of the possibility of using large bandwidths available at optical frequencies, and the two-dimensional optical processing, the conventional microelectronics is moving progressively towards the new technology of optoelectronics and photonics. The idea is to use and integrate in real systems more and more photonic devices in which optical photons instead of electronic charge-carriers are manipulated for performing the desired task.

In addition to a large number of review articles and monographs, several good books dealing with different aspects of optoelectronics have already been published. However, for some time now a need for a comprehensive volume describing most of the current developments and future directions in the field has been felt by many research workers and students of the field. Although, this task is necessarily difficult because of the vast spread of the subject, the present book represents an attempt in this direction. This volume tries to cover a substantial number of topics of recent importance in the field as well as topics with high potential for future development. Apart from the inclusion of crucial and useful details of lasting importance in each chapter of the volume, dealing with different aspects of the field, the idea is to present an overall view of the developments in their true relationship, i.e. a perspective. Starting from simple concepts, each chapter contains an extensive discussion of most of the recent developments in the area. Authors of these chapters are experts on respective topics. The level of each presentation is such that the volume will be useful to Ph.D. graduate students as well as to other researchers in the field.

The volume consists of 16 chapters. The first one is an introductory chapter which describes the nature and scope of optoelectronics, and some of the basic principles of optics relevant to the field. As optical sources suitable for various applications, semiconductor lasers and optical amplifiers are discussed in Chapter 2. In the context of specific applications to optical communications, erbium-doped fiber amplifiers are considered in greater detail in Chapter 9 on lightwave telecommunications. A very comprehensive exposition of optical transmission through optical fibers is

given in Chapter 5, whereas Chapter 6 deals with different kinds of photodetectors. Two important applications related to optical processing and optical computing are discussed in Chapters 7 and 8, respectively. A review of the current status of optoelectronic and photonic integrated circuits in the context of integrated receivers and transmitters in lightwave communication systems is presented in Chapter 4, whereas a more general discussion of guided-wave theory and integrated optics is given in Chapter 12. Chapter 13 deals with a very useful area of optical interconnections. The field of optical metrology and various developments in optical sensor technology are discussed in Chapter 14. An interesting development in ultrafast optoelectronics related to optical generation of electromagnetic pulses with terahertz bandwidths is described in Chapter 3.

The field of nonlinear optics and efficient materials for fabricating nonlinear optical devices are covered in Chapters 10 and 11, respectively. The role of sensitive quantum optical detectors for gravitational waves and precision optical measurements for testing the foundations of physics are presented very briefly in Chapter 15, whereas Chapter 16 describes in a great detail various concepts in the theory of optical diffraction, dispersion and space-time Fourier optics, useful for optical image processing.

Because of different types of constraints, including the size of the volume, I must admit that we have not been able to cover adequately some other important topics in the field. The notable omissions include a comprehensive review of the area on optical storage, memory and holography, besides other topics dealing with very important applications to basic sciences and medicine, and to sectors like energy and defence. In spite of this, I hope the volume has its own character, and it will be of interest to a large number of scientists and engineers.

I shall like to take this opportunity to express my sincere thanks and appreciation to all the contributors of the volume. This has been a great experience for me, and I am extremely grateful to all the authors for their excellent co-operation. In addition, I am very much obliged to Dr. K.C. Rustagi of the Centre for Advanced Technology, Indore, for his help in careful checking of most of the manuscripts. I shall also like to thank several members of the Tata Institute of Fundamental Research, Bombay, who helped me to complete the task. In particular, I appreciate greatly the support provided by Mr. M.R. Shinde, and also by Mr. R.N. Bathija and Mr. R.S. Pawar. Finally, it is a great pleasure for me to thank Mr. Tony Moore, Editor, World Scientific Publishing Company, London, who initiated the whole idea about this volume, and Dr.(Ms.) Anju Goel, the Scientific Editor, World Scientific, Singapore, for their continued cooperation and support in bringing out the volume in time.

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