PREFACE

Nanoscience is a rapidly developing area of research which promises a lot in physics, chemistry, and medicine, and some of the ideas have been already realized. Nanoscale materials are particularly interesting for photonics, which can be defined as the science and technology of light. Photonics supplements electronics in the form of optoelectronics, and it is considered as one of the key technology areas of the 21st century. Silicon is the leading material for electronics; hence integration of all optical functions into silicon technology is practically very important and widely recognized as a great challenge. This book combines the concepts of nanoscience, photonics, and silicon technology. A lot of research activity has been carried out in these fields, and it is impossible to cover all aspects. Our book presents a special viewpoint of Silicon Nanophotonics, and the content is mainly limited by photonic properties of silicon nanocrystals and by closely related topics. We believe that silicon nanocrystals offer a promising practical perspective for photonics and the related materials are exciting also from the fundamental and educational points of view.

Research on silicon nanocrystals was strongly activated by Leigh T. Canham who discovered in 1991 bright visible emission from porous silicon. Very many studies have been devoted to understanding of the light-emission mechanisms and a number of models have been suggested. An important opinion was published by Philippe Fauchet and co-workers in 1999 when they provided strong arguments in favor of surface origin of the light emission from oxidized porous silicon. Light amplification (optical gain) in silicon nanocrystals in silica was reported first by an Italian research group led by Lorenzo Pavesi. Indeed, generation of light in silicon is a challenging perspective; however, the issue of a laser and other light emitting devices limits neither the activity in the field nor the contents of this book. The studies cover light modulators, optical waveguides and interconnectors, optical amplifiers, detectors, memory elements, *etc*.

The present book collects recent results of a number of groups worldwide. The contributors of our book work in United States, Japan, and eight European countries. The book contents include: (i) Basic principles of the most important photonic elements based on silicon nanocrystals; (ii) Theoretical analysis of optical properties, light emission and optical gain of silicon nanocrystals; (iii) Experimental studies of the most important phenomena and optoelectronic properties of silicon nanocrystals such as light emission, optical gain and lasing, structure, optical properties, optical waveguiding, optical and electrical memory. The experimental results are illustrated by simple modeling; (iv) Experimental methods (transmission electron microscopy, Raman spectroscopy, *etc*.), preparation technique (molecular beam deposition, laser ablation, ion implantation, *etc*.), and sample architecture (silicon-rich silicon oxide films, Si/SiO_2 superlattices, free-standing films) described in appropriate places; (v) Silicon-based material with additional doping (Er-doped silicon nanocrystals and SiN materials) and single silicon dots; (vi) Perspective applications and some related topics. The authors present rich bibliography helping further reading. Some overlap between the chapters is inevitable; however, this allows the chapters to be understood independently. Some differences in opinions and interpretations between the authors can be found, which is also understandable for this hot and quickly developing field. In any case, we have tried to indicate in our book where the field is now and where it is going. We hope that this information will be useful for a broad readership including young researchers coming to the field of nanoscience and nanotechnology.

The Editor thanks all contributors for accepting his invitation to participate in the book and writing exciting stories.

Leonid Khriachtchev
Editor
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