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Introduction

This volume features contributions from scientists and engineers in the areas of optoelectronic integrated circuits (OEIC) and photonic integrated circuits (PIC). Photonic, optoelectronic, electronic, photovoltaic, microwave, biological, and fluidic devices are integrated to address the need for rapid progress in cost, space, performance, and reliability. Demands for greater bandwidths have driven the telecom and datacom research communities to realize complex OEICs and PICs such as transceivers, low chirp optical sources, switching systems, and multi-channel optical distribution systems. The integration of multi-wavelength laser arrays, monitoring photodiodes, and drivers is becoming a reality in the communications arena. Other emerging application areas include all-optical packet switching, neural systems, optical computing, optical storage, smart pixel arrays, projection displays, imaging, scanning, printing, medical diagnosis, chemical/biological sensing, as well as 3D environment sensing/mapping and object detection, classification and tracking.

The increased level of integration in recent years has resulted in an increased level of miniaturization, so we covered in this volume the emerging field of VLSI Photonic ICs, as well as Nanoscale and Quantum OEICs. The scientific and technological issues and challenges concerning the micro/nano/quantum-scale integration of optoelectronic devices, circuits, components, modules, subsystems and systems include the size effect, proximity effect, energy confinement effect, microcavity effect, single photon effect, optical interference effect, high field effect, nonlinear effect, noise effect, quantum optical effect, and chaotic noise effects. Optical alignment between miniature devices, minimizing interconnection and coupling losses, and maintaining the stability of optical interfaces, are some of the important issues that are receiving careful consideration.

Papers in these proceedings include discussions of the physics, theory, design, modeling, simulation, and scaling of a wide range of OEICs and PICs with regard to their optical, electrical, thermal and mechanical properties; the integration of different optoelectronic structure types including dots, wells, planar, free space, one-dimensional, two-dimensional and three-dimensional photonics crystals; the integration of different functions including lasers, amplifiers, detectors, sensors, solar cells, modulators, isolators, circulators, electrically-actuated/all-optical switches, attenuators, couplers, multi/demultiplexers, filters, wavelength converters, polarization controllers, chromatic/polarization mode dispersion compensators, intra-chip/chip-to-board/board-level optical interconnects, and control electronics; the fabrication, processing, and manufacturing techniques (UV/deep UV/X-ray/e-beam lithography, casting, molding, embossing, etching, passivation, etc.) as well as the packaging, assembly, reliability and qualification of monolithic and hybrid OEICs and PICs in a variety of materials

(semiconductors, silica, polymers, ferroelectrics, magnetics, metals, biomaterials, etc.). Some papers describe the refinement of existing schemes and processes, while others introduce novel concepts and new designs. Papers from academic and research institutions push the state of the art in miniaturization, level of integration, and performance figures of merit, and papers from the industry emphasize design criteria and manufacturing methods that result in practical OEICs and PICs that can be deployed commercially today or in the near future.

Although this volume cannot include all the recent important work in the vast field comprising OEICs and PICs, it does cover a significant cross-section of the advances happening globally in areas where these components are making an impact, and it provides a roadmap to the future of OEICs and PICs by presenting the cutting-edge work and the visions of leading experts who are actively inventing the future.

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