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Introduction

This volume features contributions from scientists and engineers in the general area of optoelectronic integrated circuits (OEIC). Optical, electronic, photovoltaic, microwave, biological, and fluidic devices are integrated to address the issues of cost, space, performance, and reliability. Demands for greater bandwidths have driven the telecom and datacom research communities to realize complex OEICs 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 OEIC application areas include all-optical packet switching, neural systems, optical computing, optical storage, smart pixel arrays, projection displays, imaging, scanning, printing, medical diagnosis, and chemical/biological sensing.

In keeping with the latest global economic demands for the use of integration to achieve low-cost solutions in critical areas, we cover in this volume the field of photovoltaic integrated circuits (PVIC) that are used in solar modules addressing the need for green renewable energy that is cost competitive with fossil fuel-based energy. Additionally, we cover the complementary emerging field of solar spectrum rectification based on integrated arrays of rectifying antennas (rectennas) that convert portions of the solar spectrum not efficiently converted to electric power by current photovoltaic approaches.

The increased level of integration in recent years has resulted in an increased level of miniaturization. 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 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.); and the packaging, assembly, reliability, and qualification of monolithic and hybrid OEICs 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 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 of OEICs, it does cover a significant cross-section of the advances happening globally in areas where OEICs are making an impact, and it provides a roadmap to the future of OEICs by presenting the cutting-edge work and the visions of leading experts who are actively inventing the future.

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