Guest Editorial >>>

# Special Topic on Optoelectronic Integrated Chips, Systems, and Key Technologies

Guest Editor

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Integrating electronics and photonics on a single chip is a key step towards low power consumption and efficient computing systems. In particular, multiple quantum well (MQW) diodes that inherently exhibit multifunctionalities of light emission, detection, modulation, and energy harvesting have great potential for the development of monolithic optoelectronic systems. Their emission spectra partially overlap with their responsivity spectra due to the same MQW active region, enabling monolithic photonic integration of optical transmitters, modulators, waveguides and receivers on a tiny chip. We can unite energy conservation, gravitational field and energy diagram theory to exploit the dual emission-detection characteristics of the MQW diode. We can also conclude that the gravitational effect creates irreversibility based on the following postulations: 1) individual objects cannot be completely isolated from their environment in reality, and the gravitational force must always act on them under any circumstances; 2) objects at different positions have different quantized states in a gravitation field and their masses, in turn, depends on their energy states; 3) the amount of work done against the gravitational force varies depending on the object's movement from one location to another and back to its original position. Furthermore, the monolithic photonic circuit enables on-chip bidirectional real-time data transmission between arbitrary nodes within the optical network, and all communication nodes have equal and complete mapping characteristics, paving the way for sophisticated all-light interconnection networks to develop advanced information processing and computing systems.

This special issue aims to gather cutting-edge research and developments in the field of monolithic photonic integration. In this issue, a series of articles are presented to address the aforementioned challenges. These articles cover a wide range of topics, including wavelength selective switches, stabilized integrated lasers, monolithic III-nitride photonic integration and high-precision stochastic computing very large-scale integration (VLSI) structures. The call-for-papers of this special issue have brought excellent submissions in both quality and quantity. After two rounds of reviews, six papers have been selected for publication in this special issue which is organized as follows.

The first paper titled "Monolithically Integrated Photonic Structures for Stable On-Chip Solar Blind Communications" presents monolithically integrated AlGaN photonic chips including light-emitting diodes, waveguides, and photodetectors. The stable on-chip solar-blind optical communication is experimentally demonstrated, confirming the great potential for future large-scale on-chip optical communication application.

The second paper titled "Research on High-Precision Sto-

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chastic Computing VLSI Structures for Deep Neural Network Accelerators" proposes a probabilistic compensation algorithm to solve the accuracy problem of stochastic calculation, wherein a fully parallel neural network accelerator based on a deterministic method is designed. This work provides a promising way to implement deep neural networks and reduce hardware consumption.

The third paper titled "Design of LCoS-Based Twin 1×40 Wavelength Selective Switch" presents a compact architecture of twin 1×40 LCoS-based wavelength selective switches, which can be regarded as a 4f system in the wavelength direction and a 2f system in the switching direction. The wavelength selective switch is a crucial component of the reconfigurable optical add/drop multiplexer, which plays a pivotal role in the next-generation all-optical networks. This work establishes a solid foundation for the future development of high-performance wavelength selective switches with larger port counts.

The fourth paper titled "Ultra-Low Linewidth Frequency Stabilized Integrated Lasers: A New Frontier in Integrated Photonics" summarizes recent advancements in integrated photonics for achieving ultra-low linewidth lasers. It particularly focuses on the breakthroughs made through the integration of Brillouin lasers, which have shown significant potential in fields such as precision measurement, quantum communication, and atomic clocks.

The fifth paper titled "Monolithically Integrating a 180° Bent Waveguide into a III-Nitride Optoelectronic On-Chip System" presents an on-chip optoelectronic system on a III-nitride-on-silicon platform fabricated via a top-down approach. The system includes a near-ultraviolet light source, monitor, 180° bending waveguide, electro-absorption modulator, and receiver, and on-chip optical data communication is demonstrated through light propagation within the system, opening a feasible route towards monolithic integration of various III-nitride-based components onto a single chip to create future optoelectronic systems with low power consumption.

The sixth paper titled "Performance Characterization of Visible Light Communication Based on GaN High-Voltage LED/PD" reports a high-voltage series-connected light-emitting diode (LED) or photodetector based on the GaN integrated photoelectronic chip, wherein MQW diodes with identical structures are integrated on a single chip through wafer-scale micro-fabrication techniques, and connected in series to construct the high-voltage series-connected LED/photodetector. The light communication performance of the high-voltage series-connected LED/ photodetector is experimentally demonstrated.

To conclude, it is hoped that this special issue will serve as a valuable resource for researchers, practitioners, and students who are interested in monolithic optoelectronic system on a chip. We also hope that it will inspire further research in this field, leading to new and innovative solutions that will drive the evolution of monolithic photonic integration. Finally, we would like to express our sincere gratitude to all the authors, reviewers, and editorial staff who have contributed to the success of this special issue. Hopefully, the articles in this special issue are both insightful and informative for prospective readers in the field.