Guest Editorial
Recent Advances in Solid State Lighting

THE innovation in solid state lighting technology has led to revolution in the fields of energy efficiency, display, sensing, and smart lighting applications. The progress in the solid state lighting technology was enabled by the advances in both material and device technologies, as well as the rapid implementation into systems applications. Currently, both the organic and inorganic light-emitting diodes (LEDs) have penetrated into many of the consumer electronics, energy-efficiency technologies, and smart device technologies and systems.

This Special Issue on Solid State Lighting, comprising the April/May/June 2013 issues of the IEEE/OSA JOURNAL OF DISPLAY TECHNOLOGY, focuses on the material physics and innovations, device physics and simulations, new device concepts and engineering, and system implementation of high efficiency solid state lighting technologies. The 45 papers of this Special Issue on Solid State Lighting covers both the innovations in inorganic and organic LEDs technologies, as well as the new concepts required for system implementation of the technology. We are very fortunate to have several excellent manuscripts in the key topics areas related to the progress for achieving high internal quantum efficiency and novel approaches for improving light extraction in III-Nitride LEDs, new concept for achieving phosphor-converted white LEDs, and key advances in the important field of organic LEDs. The progress in both organic and inorganic LEDs is very important, and the advances are complementary of one another attributed to the different key applications enabled by these two technologies.

This Special Issue on Solid State Lighting covers three separate categories: 1) innovations for addressing the internal quantum efficiency and efficiency-droop in III-Nitride LEDs; 2) novel approaches for addressing light extraction efficiency in III-Nitride LEDs, and enabling circuits and systems for LEDs; and 3) novel approaches for white LEDs, and key advances and review on the material and device concepts in organic LEDs.

Starting the Special Issue, in the April 2013 issue, the papers will cover the innovations and recent progress in the fields of non-/semi-polar QW, polar QW with large overlap design, and barrier engineering for suppressing the charge separation in InGaN-based LEDs (3 papers). Extensive collections of the issues and solutions for addressing the efficiency-droop in InGaN-based LEDs will also be presented (11 papers). The works cover the fundamental understanding of droop in nitride LEDs, barrier engineering and doping engineering for suppression of carrier leakages, and new materials and device concepts for addressing the droop issue. The solutions for addressing efficiency-droop in III-Nitride LEDs is important for enabling the practical and low-cost implementation of the technology in general illumination market. The progress in patterned and nano-patterned sapphire substrate as the alternative substrate materials for achieving defect reduction in GaN LEDs will also be reported (2 papers).

In the second category, in the May 2013 issue, extensive works on the solutions and fundamental physics of light extraction efficiency in III-Nitride LEDs will be covered (11 papers). The recent works on photonic crystals LEDs, self-assembled microlens arrays LEDs, LEDs with 2-D nano/micro-pillars and 1-D grating method, and vertical-based LEDs will be presented. Low cost and large area scale manufacturing processes for achieving large extraction efficiency in III-Nitride LEDs are important. The development of efficient driver circuits for LEDs is also presented (2 papers), and the development of accurate method for predicting the LED junction temperature will be discussed (1 paper).

In the third category, in the June 2013 issue, the recent progress in white LEDs (8 papers) and important advances in organic LEDs (7 papers) are presented. New concept and important analysis on the estimation of the maximum white luminous efficacy for light sources are presented. The progress in phosphor-converted and quantum-dot based solid state lighting for white LEDs are presented. Significant progress had been achieved in the field of organic LEDs. The recent progress in the field of white organic LEDs is covered, and the important advance in interlayer methods for achieving efficient electron injection in polymer LEDs is covered. The material synthesis and development for achieving high efficiency organic LEDs in green and broadband white spectral regimes are discussed. The progress in the printed microlens arrays for achieving improved light extraction in organic LEDs is presented, and the recent development of graphene-ITO electronics for both organic LEDs and inorganic LEDs is discussed.

The manuscripts included in this Special Issue represent the state-of-the-art advances in the fields of III-Nitride LEDs, white LEDs, and organic LEDs. All these technologies play important role in the development and implementation into illumination, display, and energy-efficiency systems. The Guest Editors anticipated that the progress in solid state lighting will continue to advance at a rapid pace in the next decade, and this technology will penetrate further into our daily life attributed to the energy-efficient solutions offered from the technology. We expect that the works presented here will continue to serve as a useful reference in the future development of solid state lighting.

ACKNOWLEDGMENT

The publication of the Special Issue requires commitment from a team effort involving the Guest Editors, Editor-in-Chief, and IEEE Photonics Society staff members. The peer review and production of the Special Issues would not have been completed in timely manner without the professionalism, commitment, dedication, and tireless efforts of all the team members

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listed above. The Guest Editors would like to express the appreciation to all the authors of the scientific papers, who have put together the time and efforts in preparing the manuscripts in this exciting research topic. The high quality of the manuscripts is a reflection of the works by the authors. We also would like to thank all the reviewers who had contributed in the peer-review process of the manuscripts. The reviewers have provided their time and efforts in providing high quality and timely evaluations of the manuscripts, which are absolutely essential in maintaining the quality of the Special Issue. The Guest Editors would also like to express our strong appreciation to the Editor-in-Chief, Prof. Arokia Nathan (an299@cam.ac.uk, University of Cambridge, Cambridge, U.K.), who had initiated and supported this project of a Solid State Lighting Special Issue in IEEE/OSA JOURNAL OF DISPLAY TECHNOLOGY.

Most importantly, we would like to extend our great gratitude to to Ms. Daphne Moses (d.moses@ieee.org, IEEE Photonics Society), who has been incredibly helpful and superbly efficient in handling the peer review of the Special Issue. The Guest Editors would also like to express the splendid appreciation to Ms. Mona Mittra (m.mittra@ieee.org) and Ms. Jenessa Jimenez (j.m.jimenez@ieee.org), along with their team in the IEEE Transactions/Journals department, who had handled the manuscript editing and production of all the manuscripts in the Special Issue with incredible efficiency and attention to details. Ms. Moses, Ms. Mittra, and Ms. Jimenez provided the great support that has enabled the publication of this Special Issue. We are profoundly grateful to these individuals for their assistance and support.

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Nelson Tansu was born in 1977. He received the B.S. degree in applied mathematics, electrical engineering, and physics (with Highest Distinction) and the Ph.D. degree in electrical engineering/applied physics from the University of Wisconsin–Madison, Madison, WI, USA, in 1998 and 2003, respectively.

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Dr. Tansu served as the Primary Guest Editor of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS (2008–2009) and IEEE/OSA JOURNAL OF DISPLAY TECHNOLOGY (2012–2013), and he also serves as an Associate Editor for IEEE PHOTONICS JOURNAL (2009–present). He served on the Technical Program Committee for several major technical conferences for IEEE, OSA, SPIE, and APS, including IEEE/OSA Conference on Lasers and Electro-Optics (2007–2009, 2013), SPIE Photonics West (2009–2013), APS March Annual Meeting (2007, 2009–2011), and ACP (2012, 2013), and others. He was selected as Invited General Participant at the 2008 National Academy of Engineering (NAE)'s U.S. Frontiers of Engineering (FOE) Symposium, and he served as the Organizing Committee for the 2009 NAE's U.S. Frontiers of Engineering Symposium. Recently, he has been invited to participate in the NAE's 2012 German–American Frontiers of Engineering Symposium (GAFOE).

Franky So (M'05–SM'06–F'12) received the Ph.D. degree in electrical engineering from the University of Southern California, Los Angeles, CA, USA, in 1991.

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Dr. So is a Charter Fellow of the National Academy of Inventors, the Optical Society of America (OSA), and the International Society of Optics and Photonics (SPIE). He is the Editor-in-Chief of the journal *Materials Science and Engineering Reports*, and also an Associate Editor of IEEE/OSA JOURNAL OF DISPLAY TECHNOLOGY, IEEE JOURNAL OF PHOTOVOLTAICS , and *SPIE Journal of Photonics for Energy*. He has received many awards and recognitions. While at Motorola, he was given the Distinguished Innovator and the Master Innovator Awards. At the University of Florida, he was given the Innovation Award, the MSE Department Faculty Excellence Award. In 2011, he was named the University of Florida Research Foundation Professor. he was also an recipient of the DOE Solid State Lighting Significant Achievement Award in 2009 and 2010.

Qibing Pei received the B.S. chemistry degree from Nanjing University, China, and the Ph.D. degree polymer science from the Institute of Chemistry, Chinese Academy of Science, Beijing.

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Dr. Pei is a member of the Materials Research Society, American Chemical Society, and a Fellow of the International Society for Optics and Photonics.