

Introduction to the Issue on Solid-State Lighting

THE guest editors of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS (JSTQE) are pleased to introduce the Special Issue on Solid-State Lighting (SSL). The July/August 2009 issues focuses on various aspects of SSL technology, covering from material aspects up to novel devices and systems. The purpose of this issue of JSTQE is to document recent advances in the physics, simulation, material, and device physics of high-efficiency SSL technology. The 35 papers of this issue describe some of the most recent and exciting work in SSL technology. We are very fortunate to have several excellent review and invited papers on the three topics focused on this issue. Two invited papers are dedicated for each topics covered in this issue. The three separate categories include: 1) material physics, material growth and processing, and novel substrates for SSL; 2) physics and simulation of SSL device technology; and 3) novel device concepts for SSL. High-quality contributed papers are presented in each category, representing state-of-the-art advances in this exciting field.

Starting this issue, the review paper provides a broad overview of the advances in SSL technology. In the first category, four papers focused on the material and novel growth techniques for III-nitride semiconductor, including an invited paper on the progress of the GaN substrate technology. The first category also includes paper on the novel epitaxy growth employing nanostructures for improved GaN material.

In the second category, we have 15 excellent papers focusing on device physics and simulation of various aspects of SSL technology. In particular, several papers focusing on device physics addressing nanostructures for high radiative efficiency in visible-spectrum LEDs, efficiency droop in LEDs, and high-power LEDs. The category also includes papers focusing on the pursuit of high-efficiency white LEDs covering color rendition, color rendering index, color temperature, as well as novel phosphor material and configuration for high efficiency and uniform emission.

In the third category, we have 13 contributed papers and two invited papers on novel device concepts for SSL. The papers in the last category focus on novel device concepts for achieving high-efficiency LEDs, in particular, addressing: 1) surface plasmon and photonic crystal LEDs; 2) novel approaches for enhancing light-extraction efficiency in LEDs; and 3) novel device cooling techniques for high-power LEDs.

The papers in this special issue represent state-of-the-art advances in the SSL research and development. We anticipate that

the level of research and development working on SSL will increase further due to the importance of this technology for high-energy-efficiency applications. We hope that this special issue will serve as a useful reference for further research works in this area.

ACKNOWLEDGMENT

The preparation for scientific publication of this special issue is a team effort involving all the Guest Editors, Editor-in-Chief, and IEEE Photonics Society. This special issue would not have been possible without the hard work, professionalism, and dedication of all the team members. The editors would like to express appreciation to the authors of the review and invited papers who have put together their time to prepare excellent quality papers. We would also like to extend our gratitude to all the authors for the high-quality contributed papers. Without the contributions from all the authors, this special issue would not have been possible. We would also like to thank all the peer reviewers who have donated their time and skill to provide timely and high-quality reviews that are important to maintain the technical quality of this special issue. The editors would also like to thank Prof. C. S. Menoni (Colorado State University) and Prof. F. J. Bartoli (Lehigh University) for their initial support for this project and helpful suggestions. Last but not least, we would like to extend our great gratitude to Ms. C. Tan-Yan (IEEE JSQTE Office), who has been amazing in handling this special issue. Ms. C. Tan-Yan provided great support to the IEEE office, and she and other IEEE staff have been great in all aspects in the production of this special issue. We are profoundly grateful to these individuals for their assistance and support.

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Dr. Tansu was a recipient of the Bohn Scholarship, the WARF Graduate University Fellowship, the Vilas Graduate University Fellowship, and the Graduate Dissertator Travel Funding Award, the 2003 Harold A. Peterson ECE Best Research Award (First Prize) at the University of Wisconsin–Madison. He was also a recipient of the 2008 Libsch Early Career Research Award at Lehigh University. He was a panel member for several times for the U.S. National Science Foundation, the U.S. Department of Defense, and other agencies in the U.S. and abroad. He has also given numerous lectures, seminars, and invited talks (total > 35) in universities, research institutions, and conferences in USA, Canada, Europe, and Asia. During 2008–2009, he was the Primary Guest Editor of the IEEE JOURNAL OF SELECTED TOPICS IN QUANTUM ELECTRONICS SPECIAL ISSUE ON SOLID-STATE LIGHTING and an Associate Editor of the IEEE PHOTONICS JOURNAL (2009–present). He was also an invited General Participant at the 2008 National Academy of Engineering (NAE)'s U.S. Frontiers of Engineering (FOE) Symposium, and he also serves as the Organizing Committee for the 2009 NAE's U.S. Frontiers of Engineering Symposium.



E. Fred Schubert received the Ph.D. degree in electrical engineering from the University of Stuttgart, Stuttgart, Germany, in 1986.

From 1981 to 1985, was a member of Scientific Staff at the Max Planck Institute for Solid-State Research, Stuttgart, where he was engaged in compound semiconductor crystal growth. During 1985–1995, he was a Postdoctoral Fellow, Member of Technical Staff, and Principal Investigator at AT&T Bell Laboratories, Holmdel, NJ, and AT&T Bell Laboratories, Murray Hill, NJ. In 1995, he entered academia at Boston University as a Professor of electrical engineering. In 2002, he joined Rensselaer Polytechnic Institute, where he is currently the Wellfleet Senior Constellation Professor of the Future Chips Constellation with appointments in the Electrical Engineering Department and Physics Department. He has made pioneering contributions to the field of compound semiconductor materials and devices in particular to the fields of alloy broadening, delta-doping, resonant-cavity LEDs, enhanced spontaneous emission in Er-doped Si/SiO₂ microcavities, elimination of unipolar heterojunction band discontinuities, p-type superlattice doping in AlGaIn, photonic-crystal LEDs, polarization-enhanced ohmic contacts, omnidirectional reflectors, LEDs with remote phosphors, low-refractive index materials, and solid-state lighting. He is the inventor or coinventor of 30 U.S. patents, and has authored or coauthored more than 250 publications. He authored the books *Doping in III–V Semiconductors* (1993), *Delta Doping in Semiconductors* (1996), and the first and second edition of *Light-Emitting Diodes* (2003 and 2006); the latter book was translated into Russian and Japanese.

Dr. Schubert is the Founding Director of the Smart Lighting Engineering Research Center (ERC) awarded by the National Science Foundation to Rensselaer Polytechnic Institute in 2008. He is the recipient of various awards, which include Senior Member IEEE (1993), Literature Prize of Verein Deutscher Elektrotechniker for book “*Doping in III–V Semiconductors*” (1994), Fellow SPIE (1999), Alexander von Humboldt Senior Research Award (1999), Fellow IEEE (1999), Fellow OSA (2000), Boston University Provost Innovation Award (2000), Discover Magazine Award for Technological Innovation (2000), R&D 100 Award for RCLED (2001), Fellow APS (2001), RPI Trustees Award for Faculty Achievement (2002 and 2008), Honorary membership in Eta Kappa Nu (2004), 25 Most Innovative Micro- and Nanoproducts of the Year Award of R&D Magazine (2007), and the SCIENTIFIC AMERICAN 50 AWARD (2007).



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Prof. Smowton is the Chair of the Novel In-Plane Laser Conference, Photonics West and the Chair of the Semiconductor Laser Programme Subcommittee of CLEO 2010. He is a Senior Member of IEEE Photonics Society and a member of the Optical Society of America (OSA) and the Institute of Physics (IOP), London, U.K.