

# **Solid State Lighting Technology and Application Series**

Volume 4

## **Series Editors**

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Driven by societal needs and challenges, fast development of LED and semi-conductors technologies, lighting is going through a radical transformation. This transformation is characterized by continuous and aggressive efficacy increase and cost reduction to replace traditional light sources by LED; revolution of forms and fixtures; seamless integration of LED light sources with semiconductors to create digitalized and smart lighting systems and solutions; emerging of “more than Illumination” functions and applications by using LED for healthcare and wellbeing, horticulture and food, communication, safety and security, etc. The success of this lighting transformation depends on not only the industry and market development, but also the creation and exploitation of new fundamental knowledge and talent development. This book series is the concerted action of global experts from industry and academia. It aims to provide the state-of-the-art fundamental theory and knowledge, the latest technology development, best industrial practices and guidance for academic research, technology and industrial development. It will cover all aspects of development of SSL, such as materials, device technologies, packaging and modules, luminaries & systems, thermal management, testing, reliability, total life time management, equipment, power management, sensors, communication and control, design and architecture, and other newly emerged scientific domains.

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Jinmin Li • G. Q. Zhang  
Editors

# Light-Emitting Diodes

Materials, Processes, Devices  
and Applications

 Springer

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# Foreword

From the report of red light-emitting diodes (LEDs) by Nick Holonyak in the 1960s to the Nobel Prize in Physics awarded for the invention of blue LEDs in 2014, we have witnessed many historical milestones of LED research, development, and industrialization. It is no exaggeration to say that solid-state lighting (SSL) based on compound semiconductor materials has revolutionized artificial lighting. Benefits of the progress in lighting technology on civilization have led to a greatly improved standard of living for all of mankind. For instance, SSL has enabled the realization of bright and energy-saving white light sources, full-color display, and projection. Besides, many novel and emerging applications have been possible thanks to the SSL technology, such as visible light communications, LED-enabled medical treatment, and lighting for semiconductor manufacturing, agriculture, fish industry, horticulture, and animal breeding. These achievements have dramatically expanded the application boundary of lighting, marking a brand new horizon of illumination. At the same time, they have also triggered new challenges for future research and technology development.

Contributors to this book are global leading SSL engineers and scientists. They provide an overview of the latest developments in the relevant areas, as well as their personal views about future development directions. It covers wide aspects of the device from deep ultraviolet to the visible spectrum made from compound semiconductor materials. This book is divided into four parts, and the concept covers all key processes of the research, from epitaxial growth of the materials on different substrates, structure design and optimization, packaging, and reliability to the emerging applications. This book will be of interest to scientists and engineers working on LED technology and applications, as well as graduate students in material science, optical engineering, applied physics, and electrical engineering.

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