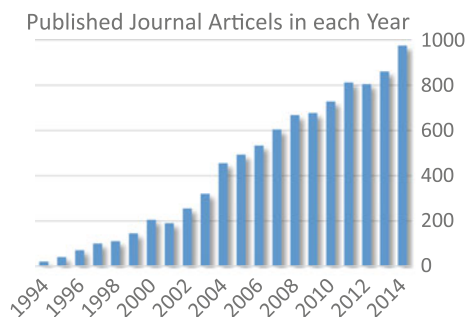


Preface

In the past two decades, group III-nitride-based ultraviolet light-emitting diodes (UV-LEDs) and their applications have undergone a progressively accelerating development. This can be demonstrated by many metrics. For example, the number of published articles in the area of UV-LEDs is steadily increasing and has reached nearly 1,000 journal articles per year in 2014 (see Fig. 1). However, we have found that the fast progress in this field makes it difficult to obtain or maintain a comprehensive overview of all these very rapidly developing research areas. Many times when researchers in the field of semiconductor materials and optoelectronics devices describe the applications of UV emitters, large gaps in information are revealed. On the other hand, developers and engineers who are working in various areas of applications of UV emitters and detectors often do not comprehend the complexities in materials and device development. In order to put all these developments into a context, various chapters in this book aim to provide a comprehensive examination of the state of the art in group III-nitride-based materials, ultraviolet emitters, and their applications. It is intended for researchers and graduate-level students in the area of electrical engineering, material science, and physics as well as scientists, developers, and engineers in various application fields of UV emitters and detectors. The book provides an overview of group III-nitride materials including their structural, optical, and electronic properties as well as key

Fig. 1 Journal articles in each year for publications under the keywords “ultraviolet” and “light emitting diode” (Source Web of Science. Retrieved 17 July 2015 from apps.webofknowledge.com)



features of various optoelectronic components, like UV-LEDs, ultraviolet lasers, and photodetectors. It also offers an introduction to a number of key applications for UV emitters and detectors, including water purification, phototherapy, gas sensing, fluorescence excitation, plant growth lighting, and UV curing. Although each chapter stands on its own and can be understood without the knowledge of the others, the organization of the chapters has been deliberately chosen to start with chapters focusing on basic materials properties, followed by chapters on ultraviolet devices, and to conclude with several chapters describing key applications for UV emitters and detectors. In the first chapter, Michael Kneissl provides an introduction to group III-nitride UV emitter technologies and their applications. This is followed by Matthias Bickermann's review of the growth and structural properties of bulk AlN substrates. In the third chapter, Eberhard Richter, Sylvia Hagedorn, Arne Knauer, and Markus Weyers review the use of sapphire as a substrate for nitride-based light emitters in the UV range, especially the growth of low defect density AlGaN templates by hydride vapor phase epitaxy. In Chap. 4 Hideki Hirayama discusses crystal growth techniques for low defect density AlN and AlGaN layers on sapphire and presents state-of-the-art performance characteristic of UVC-LEDs on sapphire. In Chap. 5 Shigefusa F. Chichibu, Hideto Miyake, Kazumasa Hiramatsu, and Akira Uedono provide an in-depth discussion of the effects of dislocations and point defects on the internal quantum efficiency of the near-band-edge emission in AlGaN-based DUV light-emitting materials. Understanding the role of defects on the IQE of UV-LEDs is critical for improving the efficiency and output power of UV-LEDs. In the area of devices, the optical polarization and light extraction from UV-LEDs is reviewed by Jens Rass and Neysha Lobo-Ploch. The homoepitaxial growth of UVC-LEDs on bulk AlN substrates and their application in water disinfection is examined by James R. Grandusky, Rajul V. Randive, Therese C. Jordan, and Leo J. Schowalter in Chap. 7. Noble Johnson, John Northrup, and Thomas Wunderer discuss optical gain in AlGaN quantum well laser heterostructures and present the state of the art in the development of AlGaN-based UV laser diodes in Chap. 8, and in Chap. 9 solar and visible blind UV photodetectors are reviewed by Moritz Brendel, Enrico Pertzsch, Vera Abrosimova, and Torsten Trenkler. In Chap. 10 Marlene Lange, Tim Kolbe, and Martin Jekel examine the application of UVC-LEDs for water purification and in Chap. 11 Uwe Wollina, Bernd Seme, Armin Scheibe, and Emmanuel Gutmann describe the application of UV emitters in dermatological phototherapy. In Chap. 12 Hartmut Ewald and Martin Degner review the role of UV emitters in gas-sensing applications and in Chap. 13 Emmanuel Gutmann, Florian Erfurth, Anke Drewitz, Armin Scheibe, and Martina Meinke discuss UV fluorescence detection and spectroscopy systems for applications in chemistry and life sciences. In Chap. 14 Monika Schreiner, Inga Mewis, Susanne Neugart, Rita Zrenner, Melanie Wiesner, Johannes Glaab, and M.A.K. Jansen examine the application of UV-LEDs for plant growth lighting, especially the triggering of the secondary plant metabolism with UVB light. In the final chapter, the application of LEDs for UV curing is reviewed by Carsten Dreyer and Franziska Mildner.

We like to thank all the authors of the various chapters for their timely and well-prepared contributions. This book would not have been possible without their commitment, hard work, and perseverance. We would especially like to thank Claus Ascheron at Springer Science for presenting us with the opportunity to edit this book and for his continued support during the process.

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