

The background of the cover is a complex, abstract geometric pattern. It consists of numerous thin, dark gray lines that intersect at various points, creating a network of irregular polygons. Some of these intersection points are highlighted with small, dark gray spheres, giving the impression of a molecular or crystalline structure. The overall effect is one of a sophisticated, interconnected network.

# III-Nitride Materials Devices and Nano-Structures

Editor

**Zhe Chuan Feng**

 **World Scientific**

## III-Nitride Materials Devices and Nano-Structures

Group III-Nitrides semiconductor materials, including GaN, InN, AlN, InGaN, AlGaIn and AlInGaIn, i.e. (Al, In, Ga)N, are excellent semiconductors, covering the spectral range from deep ultraviolet (DUV) to UV, visible and infrared, with unique properties very suitable for modern electronic and optoelectronic applications. Remarkable breakthroughs have been achieved in recent years for research and development (R&D) in these materials and devices, such as high-power and high brightness UV-blue-green-white light-emitting diodes (LEDs), UV-blue-green laser diodes (LDs), photo-detectors and various optoelectronics and electronics devices and applications.

The Nobel Prize in Physics 2014 was awarded jointly to Isamu Akasaki, Hiroshi Amano and Shuji Nakamura "for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources". Red and green diodes had been invented since 1960s-70s but without blue LED. Despite considerable efforts, the blue LED had remained a challenge for a long time. The success and inventions on GaN-based LEDs were revolutionary and benefiting for mankind. III-Nitrides-based industry has formed and acquired rapid developments over the world. Incandescent light bulbs lit the 20th century and the 21st century will be lit by LED lamps.

Before this book, the editor has edited two books, *III-Nitride Semiconductor Materials* (2006) and *III-Nitride Devices and Nanoengineering* (2008), both published by ICP/WSP, in the fields of III-Nitride. The developments of these materials and devices are moving rapidly. Many data or knowledge, some even just published only recently, have been modified and needed to be upgraded. This new book, *III-Nitride Materials, Devices and Nano-Structures* as the third instalment, will cover the rapid new developments and achievements in the III-Nitride fields, particularly those made since 2009.

# Milli-Metric Materials Devices and Nano-Structures

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Editor

**Zhe Chuan Feng**

Guangxi University, P. R. China



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# **III-Nitride Materials Devices and Nano-Structures**



## PREFACE

Group III-Nitrides semiconductor materials, including GaN, InN, AlN, InGaN, AlGaIn and AlInGaIn, i.e. (Al,In,Ga)N, are excellent semiconductors, covering the spectral range from deep ultraviolet (DUV) to UV, visible and infrared, with unique properties very suitable for modern electronic and optoelectronic applications. Remarkable breakthroughs have been achieved in recent years for research and development (R&D) in these materials and devices, such as high-power and high brightness UV-blue-green-white light emitting diodes (LEDs), UV-blue-green laser diodes (LDs), photo-detectors and various optoelectronics and electronics devices and applications.

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Recently, I have edited two books, *III-Nitride Semiconductor Materials* (2006) and *III-Nitride Devices and Nanoengineering* (2008), both published by Imperial College Press, in III-Nitride fields. The developments of these materials and devices are moving so rapid that many data or knowledge, even those just published quite recently, need to be modified and upgraded. This new book, *III-Nitride Materials, Devices and Nano-Structures* is the



third book after the two, will cover the rapidly new developments and achievements in the field, in particular those made since 2009. It will lean more towards the engineering and materials side than pure science.

The book is organized for a wide range of audiences and covers each of the basic and critical aspects of III-Nitrides science and technology. Each chapter, written by experts in the field, reviews the important topics and achievements in recent years, discusses progresses made by different groups, and suggests further works that need to be done. This book provides useful information on the device and nano-scale process, fabrication of LEDs, LDs, photodetectors and nano-devices, characterization, application and development on the III-Nitrides semiconductor devices and nano-engineering.

This book consists of 11 well-written review chapters in three parts:

***Part I — General:***

- (1) Comprehensive Theoretical and Experimental Studies on III-nitrides, Doping, Nano-structures and LEDs
- (2) Waste Energy Harvesting using III-Nitrides Materials
- (3) III-Nitrides for Infrared Optoelectronics
- (4) GaN-based photodetectors

***Part II - III-Nitride Materials:***

- (5) Single Crystal AlN: Growth by Modified Physical Vapor Transport and Properties
- (6) Indium-Rich III-Nitride Alloys Growth by Super-Atmospheric and Migration-Enhanced, Plasma-assisted MOCVD and Their Properties analysis
- (7) Combined Synchrotron X-ray absorption and optical spectroscopic studies on III-nitrides

***Part III - III-Nitride Devices and Nano-Structures:***

- (8) III-Nitride Nano-structures and Improving the Luminescence Efficiency from Quantum Well LEDs,
- (9) Fabrication and Characterization of Green Resonant-Cavity Light-Emitting Diodes Prepared by Wafer Transfer Technologies

- (10) Nanotexturing Effects in GaN/InGaN Multi-Quantum-Wells LED Planar Structures
- (11) Group III-Nitride Nanostructures for Light Emitting Devices and Beyond.

The current book presents the key properties of III-Nitrides materials, devices and nano-structures, describes key technologies and demonstrates the remaining challenging issues in material preparation and device fabrication for future R&D in the 21st century. This book can serve well to material growers and evaluators, device designers and processing engineers as well as potential users of III-Nitrides technologies, including new comers, postgraduate students, engineers and scientists in the III-Nitrides field.

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and Detection Technology  
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