PROCEEDINGS OF SPIE

[SPIDigitalLibrary.org/conference-proceedings-of-spie](https://spiedigitallibrary.org/conference-proceedings-of-spie)

Front Matter: Volume 6473

, "Front Matter: Volume 6473," Proc. SPIE 6473, Gallium Nitride Materials and Devices II, 647301 (16 February 2007); doi: 10.1117/12.727171

SPIE.

Event: Integrated Optoelectronic Devices 2007, 2007, San Jose, California, United States

PROCEEDINGS OF SPIE

Gallium Nitride Materials and Devices II

Hadis Morkoç
Cole W. Litton
Chairs/Editors

22–25 January 2007
San Jose, California, USA

Sponsored and Published by
SPIE—The International Society for Optical Engineering

Proceedings of SPIE—The International Society for Optical Engineering, 9780819465863, v. 6473

SPIE is an international technical society dedicated to advancing engineering and scientific applications of optical, photonic, imaging, electronic, and optoelectronic technologies.

The papers included in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. The papers published in these proceedings reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from this book:

Author(s), "Title of Paper," in *Gallium Nitride Materials and Devices II*, edited by Hadis Morkoç, Cole W. Litton, Proceedings of SPIE Vol. 6473 (SPIE, Bellingham, WA, 2007) Article CID Number.

ISSN 0277-786X
ISBN 9780819465863

Published by
SPIE—The International Society for Optical Engineering
P.O. Box 10, Bellingham, Washington 98227-0010 USA
Telephone 1 360/676-3290 (Pacific Time) · Fax 1 360/647-1445
<http://www.spie.org>

Copyright © 2007, The Society of Photo-Optical Instrumentation Engineers

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of copying fees. The Transactional Reporting Service base fee for this volume is \$18.00 per article (or portion thereof), which should be paid directly to the Copyright Clearance Center (CCC), 222 Rosewood Drive, Danvers, MA 01923. Payment may also be made electronically through CCC Online at <http://www.copyright.com>. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher. The CCC fee code is 0277-786X/07/\$18.00.

Printed in the United States of America.

Contents

ix	Conference Committees
xi	Introduction

GROWTH

- 647302 **New possibility of MOVPE-growth in GaN and InN: polarization in GaN and nitrogen-incorporation in InN (Invited Paper)** [6473-01]
T. Matsuoka, Tohoku Univ. (Japan) and CREST, Japan Science and Technology Agency (Japan)
- 647303 **Two-step epitaxial lateral overgrowth of α -plane GaN by MOCVD** [6473-02]
X. Ni, Ü. Özgür, H. Morkoç, A. A. Baski, Virginia Commonwealth Univ. (USA);
Z. Liliental-Weber, Lawrence Berkeley National Lab. (USA); H. O. Everitt, Duke Univ. (USA)
and U.S. Army Aviation & Missile Research, Development and Engineering Ctr. (USA)
- 647304 **Low dislocation density GaN grown by MOCVD with SiN_x nano-network** [6473-03]
J. Xie, Ü. Özgür, Y. Fu, X. Ni, H. Morkoç, Virginia Commonwealth Univ. (USA); C. K. Inoki,
T. S. Kuan, SUNY/Univ. at Albany (USA); J. V. Foreman, H. O. Everitt, Duke Univ. (USA) and
U.S. Army Aviation and Missile Research, Development and Engineering Ctr. (USA)
- 647305 **Growth and polarity control of GaN and AlN on carbon-face SiC by metalorganic vapor phase epitaxy** [6473-65]
Y. Fu, Q. Fan, S. Chevtchenko, Ü. Özgür, H. Morkoç, Virginia Commonwealth Univ. (USA);
Y. Ke, R. Devaty, W. J. Choyke, Univ. of Pittsburgh (USA); C. K. Inoki, T. S. Kuan, SUNY/Univ. at
Albany (USA)
-

Pagination: Proceedings of SPIE follow an e-First publication model, with papers published first online and then in print and on CD-ROM. Papers are published as they are submitted and meet publication criteria. A unique, consistent, permanent citation identifier (CID) number is assigned to each article at the time of the first publication. Utilization of CIDs allows articles to be fully citable as soon they are published online, and connects the same identifier to all online, print, and electronic versions of the publication.

SPIE uses a six-digit CID article numbering system in which:

- The first four digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc.

The CID number appears on each page of the manuscript. The complete citation is used on the first page, and an abbreviated version on subsequent pages.

ELECTRICAL AND OPTICAL CHARACTERIZATION

- 647306 **Enhanced luminescence from $\text{Al}_x\text{Ga}_{1-x}\text{N}/\text{Al}_y\text{Ga}_{1-y}\text{N}$ quantum wells grown by gas source molecular beam epitaxy with ammonia** [6473-04]
S. A. Nikishin, B. A. Borisov, Texas Tech Univ. (USA); G. A. Garrett, W. L. Sarney, A. V. Sampath, H. Shen, M. Wraback, U.S. Army Research Lab. (USA); M. Holtz, Texas Tech Univ. (USA)
- 647307 **Narrow-width photoluminescence spectra of InGaN quantum wells grown on GaN (0001) substrates with misorientation toward $[1\bar{1}00]$ direction** [6473-05]
K. Tachibana, H. Nago, S. Nunoue, Toshiba Corp. (Japan)
- 647308 **AFM and CAFM studies of ELO GaN films** [6473-06]
V. Kasliwal, J. C. Moore, X. Ni, H. Morkoç, A. A. Baski, Virginia Commonwealth Univ. (USA)
- 647309 **Magneto-transport properties of MOVPE-grown $\text{Al}_x\text{Ga}_{1-x}\text{N}/\text{AlN}/\text{GaN}$ heterostructures with high-mobility two-dimensional electron gas** [6473-07]
N. Biyikli, Virginia Commonwealth Univ. (USA); H. Cheng, Ç. Kurdak, Univ. of Michigan/Ann Arbor (USA); X. Ni, Y. Fu, J. Xie, Virginia Commonwealth Univ. (USA); I. Vurgaftman, J. Meyer, Naval Research Lab. (USA); H. Morkoç, Virginia Commonwealth Univ. (USA); C. W. Litton, Air Force Research Lab. (USA)
- 64730A **Investigation of current voltage characteristics of $n\text{-GaN}/i\text{-Al}_x\text{Ga}_{1-x}\text{N}/n\text{-GaN}$ structures** [6473-08]
X. Ni, J. Xie, Y. Fu, H. Morkoç, Virginia Commonwealth Univ. (USA); I. P. Steinke, Y. Liu, P. P. Ruden, Univ. of Minnesota (USA); K.-A. Son, B. Yang, Jet Propulsion Lab. (USA)
- 64730B **Characterization of the carrier dynamics and interface-state charge fluctuations in quaternary AlInGaN multiple quantum well heterostructures** [6473-57]
C.-C. Ke, C.-W. Hung, D.-C. Kuo, W.-J. Chen, H.-T. Shen, Y.-F. Wu, J.-C. Wang, T.-E. Nee, Chang Gung Univ. (Taiwan)
- 64730C **Optical properties of Berthelot-type behaviors in quaternary AlInGaN multiple quantum well heterostructures** [6473-58]
C.-W. Hung, C.-C. Ke, D.-C. Kuo, W.-J. Chen, H.-T. Shen, Y.-F. Wu, J.-C. Wang, T.-E. Nee, Chang Gung Univ. (Taiwan)
- 64730D **Characterization of the carrier localization confinement for InGaN/GaN multiple quantum well heterostructures with hydrogen-flow treatments** [6473-59]
T.-C. Kuo, W.-J. Chen, C.-C. Ke, C.-W. Hung, H.-T. Shen, J.-C. Wang, Y.-F. Wu, T.-E. Nee, Chang Gung Univ. (Taiwan)

SPECIAL TOPICS

- 64730E **Wide bandgap UV photodetectors: a short review of devices and applications (Invited Paper)** [6473-09]
F. Omnès, CNRS Grenoble (France); E. Monroy, CEA Grenoble (France); E. Muñoz, Univ. Politécnica de Madrid (Spain); J.-L. Reverchon, THALES Research and Technology (France)

- 64730F **Spontaneous polarizations, electrical properties, and phononic properties of GaN nanostructures and systems (Invited Paper)** [6473-10]
T. Yamanaka, K. Sun, Y. Li, M. Dutta, M. A. Stroscio, Univ. of Illinois at Chicago (USA)

POINT DEFECTS

- 64730L **Summary of deep level defect characteristics in GaN and AlGaIn (Invited Paper)** [6473-16]
D. Johnstone, Semetrol (USA)
- 64730M **Interplay of Ga vacancies, C impurities, and yellow luminescence in GaN** [6473-17]
F. Reurings, F. Tuomisto, Helsinki Univ. of Technology (Finland)
- 64730N **Point defect reduction in GaN layers grown with the aid of SiN_x nanonet by metalorganic chemical vapor deposition** [6473-56]
S. A. Chevtchenko, J. Xie, Y. Fu, X. Ni, H. Morkoç, Virginia Commonwealth Univ. (USA);
C. W. Litton, Air Force Research Lab. (USA)

FETS I

- 64730O **Quantum 1/f noise in GaN FETs, HFETs, MODFETs, and their oscillators' phase noise (Invited Paper)** [6473-19]
P. H. Handel, A. M. Hall, Univ. of Missouri, St. Louis (USA); H. Morkoç, Virginia Commonwealth Univ. (USA)
- 64730P **Accumulation of hot phonons in GaN and related structures (Invited Paper)** [6473-20]
A. Matulionis, I. Matulionienė, Semiconductor Physics Institute (Lithuania)
- 64730Q **Subpicosecond time-resolved Raman studies of LO phonons in GaN (Invited Paper)** [6473-21]
K. T. Tsen, Arizona State Univ. (USA); J. G. Kiang, Armed Forces Radiobiology Research Institute (USA) and Uniformed Services Univ. of the Health Sciences (USA); D. K. Ferry, Arizona State Univ. (USA); H. Morkoç, Virginia Commonwealth Univ. (USA)
- 64730R **AlGaIn/GaN MODFET regrown by rf-MBE on MOCVD templates** [6473-62]
J. Xie, H. Morkoç, Virginia Commonwealth Univ. (USA); L. Zhou, D. J. Smith, Arizona State Univ. (USA)
- 64730S **AlGaIn/GaN MOS transistors using crystalline ZrO₂ as gate dielectric** [6473-63]
X. Gu, N. Izyumskaya, V. Avrutin, J. Xie, S. Chevtchenko, B. Xiao, H. Morkoç, Virginia Commonwealth Univ. (USA)

LEDs II

- 64730T **InGaIn/GaN nanocolumn LEDs emitting from blue to red (Invited Paper)** [6473-22]
K. Kishino, A. Kikuchi, H. Sekiguchi, S. Ishizawa, Sophia Univ. (Japan) and Japan Science and Technology Agency (Japan)
- 64730U **Nitride-based light-emitting diodes with p-AlInGaIn surface layers prepared at various temperatures** [6473-23]
C. W. Kuo, C. M. Chen, C. H. Kuo, G. C. Chi, National Central Univ. (Taiwan)

- 64730V **AlGaIn-based deep ultraviolet light emitting diodes with reflection layer** [6473-24]
M. Khizar, Y. M. Akhtar Raja, Univ. of North Carolina at Charlotte (USA)

LASERS I

- 64730X **Recent achievements of AlInGaIn based laser diodes in blue and green wavelength (Invited Paper)** [6473-26]
T. Jang, O. H. Nam, K. H. Ha, S. N. Lee, J. K. Son, H. Y. Ryu, K. S. Kim, H. S. Paek, Y. J. Sung, H. G. Kim, S. H. Chae, Y. H. Kim, Y. Park, Samsung Advanced Institute of Technology (South Korea)
- 64730Y **Long lifetime cw InGaIn laser diodes by molecular beam epitaxy (Invited Paper)** [6473-27]
M. Kauer, W. S. Tan, S. E. Hooper, J. M. Barnes, J. Heffernan, Sharp Labs. of Europe (United Kingdom)
- 64730Z **Degradation studies of InGaIn/GaIn heterostructure laser diodes using a Kelvin Force Microscope** [6473-28]
A. Lochthofen, W. Mertin, G. Bacher, Univ. Duisburg-Essen (Germany); M. Fritsch, G. Brüderl, B. Hahn, U. Strauss, V. Härle, OSRAM Opto Semiconductors (Germany)

DEFECTS

- 647311 **The influence of alloy disorder and hydrostatic pressure on electrical and optical properties of In-rich InGaIn compounds (Invited Paper)** [6473-29]
T. Suski, G. Franssen, Institute of High Pressure Physics Unipress (Poland); A. Kamińska, Institute of Physics (Poland); A. Khachapuridze, H. Teisseyre, J. A. Plesiewicz, L. H. Dmowski, Institute of High Pressure Physics Unipress (Poland); H. Lu, W. J. Schaff, Cornell Univ. (USA); M. Kurouchi, Y. Nanishi, Ritsumeikan Univ. (Japan)
- 647312 **Defect studies in HVPE GaIn by positron annihilation spectroscopy (Invited Paper)** [6473-30]
F. Tuomisto, Helsinki Univ. of Technology (Finland)
- 647313 **Lanthanide impurity level location in GaIn, AlIn, and ZnO** [6473-31]
P. Dorenbos, E. van der Kolk, Delft Univ. of Technology (Netherlands)

FETS II

- 647315 **AlGaIn/GaIn field-plate FETs for microwave power applications (Invited Paper)** [6473-33]
H. Miyamoto, Y. Ando, Y. Okamoto, T. Nakayama, A. Wakejima, T. Inoue, Y. Murase, K. Ota, K. Yamanoguchi, N. Kuroda, M. Tanomura, K. Matsunaga, R&D Association for Future Electron Devices, NEC Corp. (Japan)
- 647316 **Insulator engineering in GaIn-based MIS HFETs (Invited Paper)** [6473-34]
N. Maeda, M. Hiroki, N. Watanabe, Y. Oda, H. Yokoyama, NTT Corp. (Japan); T. Yagi, NTT Advanced Technology Corp. (Japan); T. Makimoto, T. Enoki, T. Kobayashi, NTT Corp. (Japan)

- 647317 **Thermal analysis of AlGaIn/GaN HFETs using electro-thermal simulation and micro-Raman spectroscopy** [6473-35]
T. Fujishima, Ritsumeikan Univ. (Japan); K. Inoue, R&D Association for Future Electron Devices (Japan); K. Kosaka, A. Hinoki, Ritsumeikan Univ. (Japan); T. Yamada, T. Tsuchiya, J. Kikawa, S. Kamiya, R&D Association for Future Electron Devices (Japan); A. Suzuki, Ritsumeikan Univ. (Japan) and R&D Association for Future Electron Devices (Japan); T. Araki, Y. Nanishi, Ritsumeikan Univ. (Japan)
- 647318 **Epitaxial growth and characterization of AlGaIn/GaN HEMT devices on SiC substrates for RF applications** [6473-36]
A. K. Sood, Y. R. Puri, Magnolia Optical Technologies, Inc. (USA); F. W. Clarke, U.S. Army Space and Missile Defense Command (USA); J. Deng, J. C. M. Hwang, Lehigh Univ. (USA); S. K. Brierley, Raytheon RF Components (USA); M. A. Khan, Univ. of South Carolina (USA); A. Dabiran, P. Chow, SVT Associates, Inc. (USA); O. A. Laboutin, R. E. Welser, Kopin Corp. (USA)

LASERS II

- 64731D **TM-mode lasing and anisotropic polarization properties of AlGaIn multiple quantum well lasers in deep-ultraviolet spectral region (Invited Paper)** [6473-41]
H. Kawanishi, M. Senuma, T. Nukui, Kohgakuin Univ. (Japan)
- 64731E **Comparison of optical properties of InGaIn/GaN/AlGaIn laser structures grown by MOVPE and MBE** [6473-42]
T. Swietlik, C. Skierbiszewski, Institute of High Pressure Physics, Unipress (Poland); R. Czernecki, TopGaN Ltd. (Poland); G. Franssen, P. Wiśniewski, Institute of High Pressure Physics, Unipress (Poland); M. Leszczyński, I. Grzegory, Institute of High Pressure Physics, Unipress (Poland) and TopGaN Ltd. (Poland); P. Mensz, T. Suski, Institute of High Pressure Physics, Unipress (Poland); P. Perlin, Institute of High Pressure Physics, Unipress (Poland) and TopGaN Ltd. (Poland)
- 64731F **Progress in etched facet technology for GaIn and blue lasers** [6473-43]
A. Schremer, C. Stăgarescu, J. Hwang, F. Khaja, Vinateya, A. Morrow, A. Behfar, BinOptics Corp. (USA)
- 64731G **High quality UV AlGaIn/AlGaIn distributed Bragg reflectors and microcavities** [6473-44]
O. Mitrofanov, S. Schmult, M. J. Manfra, T. Siegrist, N. G. Weimann, A. M. Sergent, Bell Labs./Alcatel-Lucent (USA); R. J. Molnar, MIT Lincoln Lab. (USA)
- 64731H **High reflectivity ultraviolet distributed Bragg reflector based on AlGaIn/AlGaIn multilayer** [6473-66]
R. Shimada, J. Xie, H. Morkoç, Virginia Commonwealth Univ. (USA)

EXTENDED DEFECTS

- 64731J **Structural characterization of III-nitrides using electron microscopy (Invited Paper)** [6473-46]
D. J. Smith, L. Zhou, M. R. McCartney, Arizona State Univ. (USA)

- 64731K **Nanoheteroepitaxy of GaN on columnar SiC substrates by metalorganic chemical vapor deposition** [6473-64]
Y. Fu, Ü. Özgür, Q. Fan, N. Biyikli, S. Chevtchenko, H. Morkoç, Virginia Commonwealth Univ. (USA); Y. Ke, R. Devaty, W. J. Choyke, Univ. of Pittsburgh (USA); C. K. Inoki, T. S. Kuan, SUNY/Univ. at Albany (USA)

FETS III

- 64731L **Characterization of transient behavior of AlGaIn/GaN HEMTs (Invited Paper)** [6473-48]
T. Mizutani, Nagoya Univ. (Japan)
- 64731M **Charge trapping on defects in AlGaIn/GaN field effect transistors (Invited Paper)** [6473-49]
O. Mitrofanov, M. J. Manfra, Bell Labs./Alcatel-Lucent (USA)
- 64731N **Analytical model, simulation, and parameter extraction of AlGaIn/GaN HEMT for microwave circuit applications** [6473-50]
H. F. Huq, The Univ. of Texas-Pan American (USA); S. K. Islam, The Univ. of Tennessee (USA)
- 64731O **1/f noise in the dark current of GaN QWIPs** [6473-51]
A. M. Hall, P. H. Handel, Univ. of Missouri, St. Louis (USA)

LEDs IV

- 64731P **Light extraction analysis for GaN-based LEDs (Invited Paper)** [6473-52]
T.-X. Lee, K.-F. Go, T.-Y. Chung, C.-C. Sun, National Central Univ. (Taiwan)
- 64731R **Convergence of optical spectroscopic system for characterization of InGaIn/GaN multi-quantum well light-emitting diodes** [6473-54]
J. Park, D. Lee, S. Hong, J. W. Kim, B. Kim, Samsung Electro-Mechanics Co., Ltd. (South Korea)
- 64731S **Confocal scanning electroluminescence spectro-microscope for multidimensional light-emitting property analysis** [6473-55]
S. Hong, G. Onushkin, J. S. Park, B. K. Kim, D.-Y. Lee, A. Fomin, K. Ko, J. W. Kim, Samsung Electro-Mechanics Co., Ltd. (South Korea)

Author Index

Conference Committees

Symposium Chair

Yakov Sidorin, Photineer Technology Group (USA)

Symposium Cochair

Ali Adibi, Georgia Institute of Technology (USA)

Program Track Chair

James G. Grote, U.S. Air Force Research Laboratory (USA)

Conference Chairs

Hadis Morkoç, Virginia Commonwealth University (USA)

Cole W. Litton, U.S. Air Force Research Laboratory (USA)

Conference Cochair

James G. Grote, U.S. Air Force Research Laboratory (USA)

Program Committee

Alison A. Baski, Virginia Commonwealth University (USA)

Shigefusa F. Chichibu, University of Tsukuba (Japan)

Jen-Inn Chyi, National Central University (Taiwan)

Nicolas Grandjean, École Polytechnique Fédérale de Lausanne
(Switzerland)

Izabella Grzegory, Institute of High Pressure Physics, Unipress (Poland) and
TopGaN Ltd. (Poland)

Yong-Tae Moon, LG Electronics Inc. (South Korea)

Yasushi Nanishi, Ritsumeikan University (Japan)

Kitt Reinhardt, Air Force Office of Scientific Research (USA)

Donald J. Silversmith, Air Force Office of Scientific Research (USA)

Session Chairs

1 Growth

Alison A. Baski, Virginia Commonwealth University (USA)

2 Electrical and Optical Characterization

Charles C. Surya, The Hong Kong Polytechnic University (Hong Kong
China)

- 3 Special Topics
Jen-Inn Chyi, National Central University (Taiwan)
- 4 LEDs I
Hadis Morkoç, Virginia Commonwealth University (USA)
- 5 Point Defects
Cole W. Litton, U.S. Air Force Research Laboratory (USA)
- 6 FETs I
Hadis Morkoç, Virginia Commonwealth University (USA)
T. Mizutani, Consultant (USA)
- 7 LEDs II
Chuong A. Tran, SemiLEDs Corporation (USA)
- 8 Lasers I
Piotr Perlin, Institute of High Pressure Physics, Unipress (Poland) and
TopGaN Ltd. (Poland)
- 9 Defects
Franck Omnès, CNRS Grenoble, Institut Néel (France)
- 10 FETs II
Yasushi Nanishi, Ritsumeikan University (Japan)
- 11 LEDs III
Katsumi Kishino, Sophia University (Japan) and CREST, Japan Science and
Technology Agency (Japan)
- 12 Lasers II
Joong-Kon Son, Samsung Advanced Institute of Technology (South
Korea)
- 13 Extended Defects
Hadis Morkoç, Virginia Commonwealth University (USA)
- 14 FETs III
Arvydas Matulionis, Semiconductor Physics Institute (Lithuania)
- 15 LEDs IV
Tadeusz Suski, Institute of Physics (Poland)

Introduction

The conference on Gallium Nitride Materials and Devices, christened last year as a tribute to cap the long and productive career of Dr. G. L. Witt, continued very successfully in 2007.

As mentioned in the introduction for the 2006 GaN Materials and Devices proceedings, attainment of p-type GaN in the late 1980s broke open the logjam that had prevented researchers from demonstrating the many attractive attributes of GaN for decades. In fewer than a couple of decades since then, even with materials nowhere near the perfection that would be required for other materials, both optical and electronic devices with record-breaking or previously unavailable performance/property have been obtained. Today, the GaN-based light emitters adorn automobiles, traffic lights, moving signs, outdoor displays, handheld electronics, and background lighting in many consumer electronics, including flat-panel televisions. Soon, the more extensive applications of GaN light emitters in televisions will be seen in the marketplace. All-LED outdoor white lighting applications are already in full swing, with high-brightness large-area wafer-bonded LEDs producing optical power levels in excess of 200 mW. High-end LEDs exhibit efficacies well above 100 l/W and are being achieved by increasing numbers of LED manufacturers. Indoor general lighting applications are very near with acceptable color rendering index, not to mention the color temperature.

It is really an exciting time for GaN-based LEDs, in that applications to general illumination seem to be around the corner with tremendous advances in light extraction methods with efficiencies approaching 80%, which is remarkable. GaN-based LEDs truly represent the hottest device today, and will soon save many terawatts of power per year from being wasted. This could not come at a better time, when greenhouse emission gasses and the carbon footprint that we leave on Earth are increasingly becoming front page news in newspapers and other mass communication media across the globe. GaN-based lasers also are making their presence known with the introduction of PlayStation III by Sony late in 2006. UV detectors, particularly those in the solar blind region of the spectrum, with performance comparable to venerable photomultiplier tubes but at a fraction of the size and power requirement, have been accomplished. In the radio frequency power arena, one GaN chip is now able to produce CW power levels above 400 W at 2GHz and some 10 W in the millimeter-wave region for applications in the wireless and agile radar.

The SPIE conference on GaN Materials and Devices served to disseminate the latest results and provide an opportunity for researchers from around the world to engage in discussions to advance this exciting field even further. Many world-renowned invited speakers from Asia, Europe, and the USA set the stage with

discussions related to extended and point defects; characterization of GaN and related materials and efforts/methods to reduce defects; fundamental processes that are taking place in GaN in the context of defects, carrier and phonon dynamics, and their influence on transport and noise; very high-power FETs with hundreds of watts of power from single chips, for example base station power levels of 370 W and pulsed power of 750 W (this power levels changes upward daily); much improved lasers with over 10,000 hr projected operating lifetimes at 50 mW power, UV lasers and emission modes; detectors; and finally not just bright but HOT LEDs which continue to take the world by storm not only for displays and background lighting endemic in many consumer electronics, but also outdoor lighting, while inching ever closer to indoor illumination (dubbed with a misnomer of solid state lighting). Very high-quality contributed papers augmented and enhanced the truly exceptional image set forth by the invited speakers. Most importantly, the meeting served the purpose of getting experts in the field together for friendship and informal discussions of issues relevant to GaN and related materials and devices.

Hadis Morkoç
Cole W. Litton