

Yuji Zhao

Assistant Professor

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RESEARCH SUMMARY

Research Interests

Materials science and device engineering of *wide bandgap* materials (e.g., GaN and nitride alloys, Ga₂O₃, and diamond) for applications in both *applied electronics* (e.g., energy efficiency, power electronics, RF and power ICs) and *quantum information* (novel quantum nano/hetero structures, quantum photonics, and quantum sensing).

Selected Current Projects (total \$6.25M, as PI \$5.8M, personal share ~ \$4.3M)

- Applied Electronics:
 - Power electronics: 1.2 kV-class GaN vertical power transistors (ARPAe PN DIODES)
 - Advanced ICs: High temperature GaN memory devices and ICs for space applications (NASA HOTTech)
- Quantum Information
 - Quantum Photonics: AlN IR-UV supercontinuum generation and UV optical frequency comb (ARO PECASE)
 - Quantum Sensing: III-nitride on-chip auto-correlator for single photon detection and quantum sensing

EDUCATION

University of California, Santa Barbara Ph.D. in Electrical Engineering 2008–2012

Advisor: Prof. Shuji Nakamura (Nobel Prize in Physics 2014)

Fudan University B.S. in Microelectronics 2004–2008

APPOINTMENTS

Arizona State University

- Assistant Professor Electrical, Computer and Energy Engineering 08/2014–Present

University of California, Santa Barbara

- Assistant Project Scientist Materials Department and SSLEC 01/2013–08/2014
- Graduate Student Researcher Electrical and Computer Engineering 09/2008–12/2012

SELECTED HONORS AND AWARDS

- 2019 Presidential Early Career Award in Science and Engineering (PECASE)**
nominated by ARO and DoD, the highest honor given by the US government to early-career scientists and engineers
- 2017 Selected by NASA as Honorable Faculty Scientist to Showcase Space Technology to Congress at Capitol Hill**
presented to U.S. Representative Lamar Smith, chairman of the Committee on Science, Space, and Technology
- 2017 ASU Fulton Outstanding Assistant Professor Award**
- 2016 DoD DTRA Young Investigator Program (YIP) Award**
- 2015 NASA Early Career Faculty (ECF) Award**
- 2015 Bisgrove Scholar Tenure Track Faculty Award**
- 2013 UCSB SSLEC Outstanding Postdoctoral Research Achievement Award
- 2012 Applied Physics Letters Editor's Picks of the Year Award
- 2012 Applied Physics Express Most Cited Article of the Year Award
- 2012 Semi-Finalist, CLEO Theodore Maiman Student Paper Competition (ranked 1st in Energy and Environment)
- 2012 UCSB SSLEC Outstanding Graduate Student Research Achievement Award
- 2011 UCSB SSLEC Outstanding Graduate Student Research Achievement Award
- 2010 UCSB SSLEC Outstanding Graduate Student Research Achievement Award
- 2004 Fudan University Scholarship for Excellency in Undergraduate Study

SELECTED HONORS WITH SUPERVISED STUDENTS

- 2019 ASU Joseph Palais Outstanding Doctoral Award (Houqiang Fu)**
the highest honor for ASU ECEE Ph.D graduates, 1 awardee in 2019
- 2019 ASU University Graduate Fellowship (Xin Qi)**
top honor for incoming or graduation ASU Ph.D students, 10 awardees in ECEE for 2019 Fall
- 2018 ASU GPSA Outstanding Research Award (Houqiang Fu)**
the Outstanding Research Award is given every year to students who demonstrate commitment, originality, and impact in their research efforts, 16 awardees university-wide in 2018
- 2018 ASU University Graduate Fellowship (Jinan Zhou)**
top honor for incoming or graduation ASU Ph.D students, 9 awardees in ECEE for 2018 Fall
- 2017 ASU University Graduate Fellowship (Zhijian Lu)**
top honor for incoming or graduation ASU Ph.D students, 6 awardees in ECEE for 2017 Spring
- 2017 ASU University Graduate Fellowship (Jossue Montes)**
top honor for incoming or graduation ASU Ph.D students, 6 awardees in ECEE for 2017 Spring

PROFESSIONAL SERVICE

Conference Service:

2020 CLEO Semiconductor Lasers (S&I-3), Subprogram Committee

2019 The 236th Electrochemical Society Meeting (ECS Meeting), Subprogram Committee
 2019 ASME International Technical Conference on Packaging and Integration of Electronic and Photonic Microsystems, Subprogram Committee and Session co-Chair
 2019 The 19th International Conference on Crystal Growth and Epitaxy (ICCGE-19) and the 19th Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-19), Subprogram Committee Chair and Session Chair
 2017 The 18th US Workshop on Organometallic Vapor Phase Epitaxy (OMVPE-18), Program Committee
 2017 International Symposium on Semiconductor Light Emitting Devices (ISSLED 2017), Program Committee
 2016 International Workshop on Nitride Semiconductors (IWN 2016), Session Chair
 2015 ASU Center for Photonic Innovation (CPhI) Review Conference, Organizer
 2014 Lester Eastman Conference on High Performance Devices (LEC 2014), Technical Committee

Journal Reviewer:

Nature Communications; Scientific Reports; Applied Physics Letters; Journal of Applied Physics; Optics Express; Optics Letters; IEEE Electronics Letters; Journal of Electronic Materials; Applied Physics A: Material Science and Processing; Optical Materials Express; Solid-State Electronics; Journal of Crystal Growth; Journal of Alloys and Compounds; Physica Status Solidi B: Basic Solid State Physics; Physica Status Solidi A: Applications and Materials Science

Proposal Reviewer:

NASA NSTRF proposal, NSF regular/SBIR/STTR proposal, ARO regular and YIP proposal, AFOSR regular proposal

ASU Service:

ASU MTW Core Facility Planning Committee, 2019
 ASU ECEE Faculty Search Committee, 2019
 ASU ECEE Faculty Search Committee, 2018
 ASU NanoFab Core Governance Board, 2018–present
 *Appointed by the Dean's Office as the biggest user of ASU NanoFab since 2017

NASA Service:

Subgroup leader for NASA HOTTech Program "MicroElectronics and Sensors" Subgroup, 2017–present
 *Coordinate 12 research groups from NASA centers, academic institutes, and industry within the NASA HOTTech program for strategic activities, e.g., collaborations, meetings, reporting, and future project planning

MENTORING AND TEACHING

Current Research Group: (expected graduation year for the students)

Visiting Scholar: Xuguang Deng

Posdoc: Kai Fu, Houqiang Fu

Ph.D.: Xuanqi Huang (2020), Hong Chen (2020), Jossue Montes (2021), Tsung-Han Yang (2022), Chen Yang (2022), Jingan Zhou (2023), Xin Qi (2024)

Graduated Students:

Visiting Scholars: Xiaodong Zhang (now Associate Professor at Suzhou Institute of Nano-Tech and Nano-Bionics, Chinese Academy of Science, China)

Ph.D. Students: Zhijian Lu (now Assistant Professor at Southern University of Science and Technology, China), Houqiang Fu (now postdoc in my group, looking for academic positions)

M.S. Students: Shiladitya Das, Sure Suri, Izak Baranowski

Undergraduate Students: Alex Willoughby

Teaching: (average evaluation 4.25 out of 5)

ASU EEE 436 undergraduate / EEE 598 graduate – Fundamentals of Solid-State Device, Spring 2018

ASU EEE 437 undergraduate / EEE 598 graduate – Optoelectronics, Spring 2016

ASU EEE 531 graduate – Semiconductor Devices Theory I, Fall 2017, Fall 2018, Fall 2019

ASU EEE 537 graduate – Semiconductor Optoelectronics, Fall 2014, Fall 2015, Fall 2016

ASU EEE 598 graduate – MOCVD for III-Nitride Devices, Spring 2015, Spring 2017

Outreach:

2016 ASU-High School Students Summer Engineering Experience Program (SEE@ASU), ~ 70 high school students visited

SEMINARS AND INVITED TALKS

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1. **ASME International Technical Conference on Packaging and Integration of Electronic and Photonic Microsystems (ASME InterPACK)**, Anaheim, CA, Oct 2019
 2. **University of Texas at Austin**, Department of Electrical and Computer Engineering, Austin, TX, Mar 2019
 3. **University of California, Berkeley**, Solid State Technology and Devices Seminar, Department of Electrical Engineering and Computer Sciences, Berkeley, CA, Dec 2018
 4. **University of California, Los Angeles**, Department of Materials Science and Engineering, Los Angeles, CA, Oct 2018
 5. **2018 Americas International Meeting on Electrochemistry and Solid State Science (AiMES 2018) and 234th ECS Meeting**, Cancun, Mexico, Sep 2018
 6. **2018 Government Microcircuit Applications and Critical Technology Conference (GOMACTech 2018)**, Miami, FL, Mar 2018
 7. **2018 Workshop on Compound Semiconductor Materials and Devices (WOCSEMMAD 2018)**, San Diego, CA, Feb 2018
 8. **Stanford University**, Department of Electrical Engineering, Palo Alto, CA, Nov 2017
 9. **University of California, Los Angeles**, Department of Electrical and Computer Engineering, Los Angeles, CA, Nov 2017
 10. **NASA Glenn Research Center**, Cleveland, OH, Nov 2017
 11. **Arizona State University**, ASU Nanoscience Seminar, Tempe, AZ, Oct 2017
 12. **University of Southern California**, Distinguished Lectures, Department of Chemical Engineering and Materials Science, Los Angeles, CA, Oct 2017

13. **University of California, San Diego**, Department of Electrical and Computer Engineering, La Jolla, CA, Oct 2017
14. **The 60th IEEE International Midwest Symposium on Circuits and Systems**, Boston, MA, Aug 2017
15. **2017 IEEE Photonics Society Summer Topicals Meeting**, San Juan, Puerto Rico, Jul 2017
16. **2017 International Symposium on Advanced Lighting Science and Technology (ALST 2017)**, Shaoxing, China, May 2017
17. **The 24th Space Photovoltaic Research and Technology (SPRAT) Conference**, Cleveland, OH, Sep 2016
18. **Fudan University**, School of Information Science and Technology, Shanghai, China, Jul 2015
19. **Suzhou Institute of Nano-Tech and Nano-Bionics**, Suzhou, China, Jul 2015
20. **Massachusetts Institute of Technology**, Department of Electrical Engineering and Computer Science, Cambridge, MA, May 2015
21. **Soitec Phoenix Lab Inc**, Tempe, AZ, Oct 2014
22. **Arizona State University**, School of Electrical, Computer and Energy Engineering, Tempe, AZ, May 2014
23. **University of California, San Diego**, Department of Electrical and Computer Engineering, La Jolla, CA, Apr 2014
24. **University of California, San Diego**, Department of Electrical and Computer Engineering, La Jolla, CA, Aug 2013
25. **University of California, Santa Barbara**, Nitride Special Seminar, Santa Barbara, CA, Nov 2013
26. **University of Notre Dame**, Department of Electrical Engineering, Notre Dame, IN, Jul 2013
27. **University of Virginia**, Charles L. Brown Department of Electrical and Computer Engineering, Charlottesville, VA, Apr 2013
28. **Society of Information Display (SID) 50th Anniversary Conference**, Los Angeles, CA, Sep 2012
29. **Fudan University**, School of information science and Engineering, Shanghai, China, Jun 2012
30. **University of California, Santa Barbara**, Nitride Special Seminar, Santa Barbara, CA, Feb 2012
31. **Tsinghua University**, Tsinghua National Laboratory for Information Science and Technology, Beijing, China, May 2011
32. **Peking University**, State Key Laboratory for Artificial Microstructures and Mesoscopic Physics, Beijing, China, May 2011
33. **Zhejiang University**, Center for Optical and Electromagnetic Research, Hangzhou, China, May 2011
34. **University of California, Santa Barbara**, Nitride Special Seminar, Santa Barbara, CA, Feb 2011

CURRENT EXTERNAL COLLABORATORS (last 24 months)

Tomas Palacios, Jeehwan Kim (MIT), Shanhui Fan, Eric Pop, Debbie Senesky (Stanford), Larry Lee (UIUC), Andrea Armani, Jayakanth Ravichandran, Rehan Kapadia (USC), Mark Goorsky, Chee Wei Wong, Mona Jarrahi (UCLA), Edward Yu, Alex Huang (UT Austin), Jung Han (Yale), Philip Feng (Case Western), Gary Hunter, Geoffrey Landis, George Ponchak (NASA Glenn Research Center), Piyush Shah (AFRL), Carlo De Santi (University of Podava, Italy), Sourabh Khandelwal (Macquarie University, Australia), Eugene Katz (Ben-Gurion University of the Negev, Israel)

PUBLICATIONS

Selective Media Highlights: over 100 media reports with over 6 languages

- *President Donald J. Trump announces recipients of the Presidential Early Career Award for Scientists and Engineers (PECASE), The White House, Jul 2019*
- *First steps to high temperature GaN memory?* Compound Semiconductor, Apr 2019
- *New memory device can take the heat*, IEEE Spectrum, Mar 2019
- *ASU Bisgrove Scholar illuminates the future of LED lighting*, ASU News, Apr 2018
- *ASU engineer showcases NASA research to congress on capitol hill*, ASU News, Jan 2018
- *Gallium nitride processor: next-generation technology for space exploration*, **Astrowatch, Phys.org, Spaceflightinsider, ECNMag, Technewsngadgets, ASU news, etc., English and Chinese, Dec 2017**
- *Vertical gallium nitride Schottky diodes with single and double drift layers*, Semiconductor Today, Oct 2017
- *Aluminum nitride Schottky barrier diodes with breakdown more than 1kV*, Silicon Valley Microelectronics, Aug 2017
- *Indium gallium nitride solar cells on non-polar and semi-polar substrates*, Semiconductor Today, May 2017
- *Buffer and drift layer effects on vertical gallium nitride diodes*, Semiconductor Today, Apr 2017
- *Thermophotonics: LEDs feed on waste heat*, **Nature Photonics**, Nov 2015
- *Overcoming the “green gap”*, **Nature Photonics**, Jul 2013
- *Semipolar planes delivers stable green LEDs*, Compound Semiconductor, Aug 2013
- *How LED got their shine back*, **Science**, May 2012
- *Conquering LED efficiency droop*, Optical Society of America (OSA), Apr 2012
- *New LED design drops the droop*, Photonics, May 2012
- *LEDs más eficientes para el hogar*, Sustentator, Spanish, May 2012
- *Special substrates help LEDs shine brighter without losing efficiency*, Daily Tech, May 2012
- *Reducing LED droop at high current*, Semiconductor Today, Jul 2011
- *Blue semipolar LEDs now comparable to conventional c-plane devices*, Laser Focus World, Nov 2010
- *UCSB achieves semi-polar light extraction comparable to conventional LEDs*, Semiconductor Today, Sep 2010

Legend

(underline) Yuji Zhao

(bold font) Zhao Group Ph.D. Student

(bold font with x) Zhao Group Postdoctoral Researcher

(*) Corresponding Author for ASU Journal Papers

Book chapters (in review: grey; published: black)

1. **H. Fu^x, K. Fu^x, and Y. Zhao**, “Vertical GaN on GaN power devices”, chapter in “*Wide Bandgap Semiconductor Materials and Devices (tentative)*”, edited by Stephen J. Pearton and Ren Fan, IOP Science, in preparation.
2. **H. Fu and Y. Zhao**, “Efficiency droop in InGaN/GaN LEDs”, chapter in “*Nitride Semiconductor Light-Emitting Diodes*”, 2nd edition, Elsevier, (2017).
3. C. Y. Huang, **Y. Zhao**, Y. R. Wu, and J. S. Speck, “Nonpolar and semipolar LEDs”, chapter in “*Nitride Semiconductor Light-Emitting Diodes (LEDs): Materials, Technologies and Applications*”, edited by Prof. J. J. Huang, Prof. H. C. Kuo, and Prof. S. C. Shen, Woodhead Publishing, (2014).

Journal papers (in review: grey; published and accepted: black)

1. H. Fu^x, et al., "High voltage vertical GaN p-n diodes with hydrogen-plasma based guard rings," submitted.
2. Y. Chen, et al., "Normally-off GaN vertical-channel junction field-effect transistors with regrown p-GaN by MOCVD", submitted.
3. S. R. Alugubelli, et al., "Electronic band structure of etched and regrown interfaces in p-i-n GaN structures using electron holography", submitted.
4. K. Fu^x, et al., "Effect of regrowth interface on the leakage and breakdown of vertical GaN-on-GaN Schottky diodes", submitted.
5. K. Song, et al., "Normally-off AlN/ β -Ga₂O₃ field-effect transistors using polarization-induced doping", submitted.
6. J. Zhou, et al., "First demonstration of β -Ga₂O₃ optical waveguides and the analysis of their propagation losses in the visible spectrum", submitted.
7. H. Chen, J. Zhou, D. Li, D. Chen, A. K. Vinod, H. Fu^x, X. Huang, T. H. Yang, J. Montes, K. Fu^x, C. Yang, C. Z. Ning, C. W. Wong, A. M. Armani, and Y. Zhao*, "On-chip directional octave-spanning supercontinuum generation from high order mode in near ultraviolet to infrared spectrum using AlN waveguides", arXiv: 1908.04719. Paper in review.
8. K. Fu^x, H. Fu^x, X. Huang, H. Chen, T. H. Yang, J. Montes, C. Yang, J. Zhou, and Y. Zhao*, "Demonstration of 1.27 kV etched-then-regrown GaN-on-GaN vertical p-i-n diodes with low leakage current", accepted to *IEEE Electron Device Lett.* Early Access online.
9. X. Huang, W. Li, H. Fu, D. Li, C. Zhang, H. Chen, Y. Fang, K. Fu^x, S. DenBaars, S. Nakamura, S. Goodnick, C. Z. Ning, S. Fan*, and Y. Zhao*, "High temperature polarization-free III-nitride solar cells with self-cooling effects", *ACS Photonics* **6**, 2096 (2019).
10. S. R. Alugubelli, H. Fu, K. Fu^x, H. Liu, Y. Zhao, and F. A. Ponce*, "Dopant profiling in p-i-n GaN structures using secondary electrons", *J. Appl. Phys.* **126**, 015704 (2019).
11. H. Chen, H. Fu, J. Zhou, X. Huang, T. H. Yang, K. Fu^x, C. Yang, J. A. Montes, and Y. Zhao*, "Study of crystalline defect induced optical scattering loss inside protonic waveguides in UV-visible spectral wavelengths using volume current method", *Opt. Express* **27**, 17262 (2019).
12. H. Fu, K. Fu^x, H. Liu, S. Alugubelli, X. Huang, H. Chen, J. Montes, T. H. Yang, C. Yang, J. Zhou, F. A. Ponce, and Y. Zhao*, "Implantation- and etching-free high voltage vertical GaN p-n diodes terminated by plasma-hydrogenated p-GaN: Revealing the role of thermal annealing", *Appl. Phys. Express* **12**, 051015 (2019).
13. J. Montes, C. Yang, H. Fu, T. H. Yang, K. Fu^x, H. Chen, J. Zhou, X. Huang, and Y. Zhao*, "Demonstration of mechanically exfoliated β -Ga₂O₃/GaN p-n heterojunction", *Appl. Phys. Lett.* **114**, 162103 (2019).
14. H. Liu, H. Fu, K. Fu^x, S. R. Alugubelli, P. Y. Su, Y. Zhao, and F. A. Ponce*, "Non-uniform Mg distribution in GaN epilayers grown on mesa structures for applications in GaN power electronics", *Appl. Phys. Lett.* **114**, 082102 (2019).
15. X. Huang, R. Fang, C. Yang, K. Fu^x, H. Fu, H. Chen, T. H. Yang, J. Zhou, J. Montes, M. Kozicki, H. Barnaby, B. Zhang, and Y. Zhao*, "Steep-slope AlGaIn/GaN HEMT with oxide based threshold switching device", *Nanotechnology* **30**, 215201 (2019).
16. K. Fu, K. Fu^x, X. Huang, T. H. Yang, H. Chen, I. Baranowski, J. Montes, C. Yang, J. Zhou, and Y. Zhao*, "Threshold switching and memory behaviors of epitaxially regrown GaN-on-GaN vertical pn diodes with high temperature stability", *IEEE Electron Device Lett.* **40**, 375 (2019).
 - *Highlight on IEEE EDL Journal Cover.*

- *Featured in IEEE Spectrum, Compound Semiconductor, etc.*

17. **J. Montes, T. H. Yang, H. Fu, H. Chen, X. Huang, K. Fu^x, I. Baranowski,** and Y. Zhao*, “Effect of proton radiation on ultra-wide bandgap AlN Schottky barrier diodes”, *IEEE Trans. Nucl. Sci.* **66**, 91 (2019).
18. **T. H. Yang, K. Fu^x, H. Chen, X. Huang, J. Montes, I. Baranowski, K. Fu,** and Y. Zhao*, “Temperature-dependent electrical properties of β -Ga₂O₃ Schottky barrier diodes on highly doped single-crystal substrates”, *J. Semicond.* **40**, 012801 (2019). (Invited Paper)
19. **K. Fu^x, H. Fu, H. Liu, S. R. Alugubelli, T. H. Yang, X. Huang, H. Chen, I. Baranowski, J. Montes,** F. A. Ponce, and Y. Zhao*, “Investigation of GaN-on-GaN vertical p-n diode with regrown p-GaN by metal organic chemical vapor deposition”, *Appl. Phys. Lett.* **113**, 233502 (2018).
20. **H. Fu, X. Zhang, K. Fu^x, H. Liu, S. Alugubelli, X. Huang, H. Chen, I. Baranowski, T. H. Yang,** K. Xu, F. A. Ponce, B. Zhang, and Y. Zhao*, “Nonpolar vertical GaN-on-GaN p-n diodes grown on free-standing (10-10) m-plane GaN substrates”, *Appl. Phys. Express* **11**, 111003 (2018).
21. **Z. Lu, P. Tian, H. Fu, J. Montes, X. Huang, H. Chen, X. Zhang,** X. Liu, R. Liu, L. Zheng, X. Zhou, E. Gu, Y. Liu, and Y. Zhao*, “Experimental demonstration of non-line-of-sight visible light communication using a GaN-based micro-LED and practical IEEE 802.11ac”, *AIP Adv.* **8**, 105017 (2018).
22. **X. Huang, H. Chen, H. Fu, I. Baranowski, J. Montes, T. H. Yang, K. Fu^x,** B. P. Gunning, D. D. Koleske, and Y. Zhao*, “Energy band engineering of InGaN/GaN multi-quantum-well solar cells via AlGaIn electron- and hole-blocking layers”, *Appl. Phys. Lett.* **113**, 043501 (2018).
23. **H. Fu, K. Fu^x, X. Huang, H. Chen, I. Baranowski, T. H. Yang, J. Montes,** and Y. Zhao*, “High performance vertical GaN-on-GaN p-n power diodes with hydrogen-plasma based edge termination”, *IEEE Electron Device Lett.* **39**, 1018 (2018).
24. **H. Fu, H. Chen, X. Huang, I. Baranowski, J. Montes, T. H. Yang,** and Y. Zhao*, “A comparative study on the electrical properties of vertical (-201) and (010) β -Ga₂O₃ Schottky barrier diodes on EFG single-crystal substrates”, *IEEE Trans. Electron Devices* **65**, 3507 (2018).
25. **H. Chen, H. Fu, X. Huang, J. A. Montes, T. H. Yang, I. Baranowski,** and Y. Zhao*, “Characterizations of the nonlinear optical properties for (010) and (-201) beta-phase gallium oxide”, *Opt. Express* **26**, 3938 (2018).
26. Y. Zhao*, **H. Fu,** G. T. Wang, and S. Nakamura, “Toward ultimate efficiency: progress and prospects on nonpolar and semipolar InGaIn light emitting diodes”, *Adv. Opt. Photonics* **10**, 246 (2018) (Invited Review).
 - *Featured in ASU News.*
27. **X. Huang, H. Fu, H. Chen, Z. Lu, I. Baranowski, J. Montes, T. H. Yang,** B. P. Gunning, D. Koleske, and Y. Zhao*, “Reliability analysis of InGaIn multi-quantum-well (MQW) solar cells under thermal stress”, *Appl. Phys. Lett.* **111**, 233511 (2017).
28. **H. Chen, H. Fu, X. Huang, X. Zhang, T. H. Yang, J. A. Montes, I. Baranowski,** and Y. Zhao*, “Low loss GaIn waveguides at the visible spectral wavelengths for integrated photonics applications”, *Opt. Express* **25**, 31758 (2017).
29. **H. Fu, X. Huang, H. Chen, Z. Lu, I. Baranowski,** and Y. Zhao*, “Ultra-low turn-on voltage and on-resistance vertical GaIn-on-GaN Schottky barrier diodes with high mobility double drift layers”, *Appl. Phys. Lett.* **111**, 152102 (2017).
 - *Featured in Compound Semiconductor, Semiconductor Today, etc.*

30. H. Y. Huang*, Y. Fan, Z. Lu, T. Luo, H. Fu, H. Song, Y. Zhao, and J. B. Christen, "Variable self-powered light detection CMOS chip with real-time adaptive tracking digital output based on a novel on-chip sensor", *Opt. Express* **25**, 24138 (2017).
31. H. Fu, X. Huang, H. Chen, Z. Lu, and Y. Zhao*, "Fabrication and characterization of ultra-wide bandgap AlN based Schottky diodes on sapphire by MOCVD", *IEEE J. Electron Devices Soc.* **5**, 518 (2017).
32. Z. Lu, P. Tian, H. Chen, I. Baranowski, H. Fu, X. Huang, J. Montes, Y. Fan, H. Wang, X. Liu, R. Liu, and Y. Zhao*, "Active tracking system for visible light communication using a GaN-based micro-LED and NRZ-OOK", *Opt. Express*, **25**, 17971 (2017).
33. H. Fu, X. Zhang, X. Huang, I. Baranowski, H. Chen, Z. Lu, J. Montes, and Y. Zhao*, "Demonstration of AlN Schottky barrier diodes with blocking voltage over 1kV", *IEEE Electron Device Lett.* **38**, 1286 (2017).
 - *Featured in Silicon Valley Microelectronics, Semiconductor Today, etc.*
34. H. Chen, X. Huang, H. Fu, Z. Lu, X. Zhang, J. Montes, and Y. Zhao*, "Characterizations of nonlinear optical properties on GaN crystals in polar, nonpolar, and semipolar orientations," *Appl. Phys. Lett.* **110**, 181110 (2017).
35. H. Fu, X. Huang, H. Chen, Z. Lu, X. Zhang, and Y. Zhao*, "Effect of buffer layer design on vertical GaN-on-GaN p-n and Schottky power diodes", *IEEE Electron Device Lett.* **38**, 763 (2017).
 - *Featured in Silicon Valley Microelectronics, Semiconductor Today, etc.*
 - *Top 50 most popular articles in April, May, and June 2017 in IEEE EDL.*
36. X. Huang, H. Fu, H. Chen, X. Zhang, Z. Lu, J. Montes, M. Iza, S. P. DenBaars, S. Nakamura, and Y. Zhao*, "Nonpolar and semipolar InGaN solar cells with improved carrier collection efficiency", *Appl. Phys. Lett.* **110**, 161105 (2017).
 - *Featured in Semiconductor Today.*
37. H. Chen, H. Fu, X. Huang, Z. Lu, X. Zhang, J. Montes, and Y. Zhao*, "Optical cavity effects in InGaN core-shell light-emitting diodes with metallic coating", *IEEE Photonics J.* **9**, 8200808 (2017).
38. H. Fu, H. Chen, X. Huang, Z. Lu, and Y. Zhao*, "Theoretical analysis of modulation doping effects on intersubband transition properties of semipolar AlGaIn/GaN quantum well", *J. Appl. Phys.* **121**, 014501 (2017).
39. H. Fu, Z. Lu, Y. Zhao*, "Phase-space filling effect on the modeling of low-droop performance of semipolar InGaN light-emitting diodes", *AIP Adv.* **6**, 065013 (2016).
40. X. Huang, H. Fu, H. Chen, Z. Lu, D. Ding, and Y. Zhao*, "Analysis of loss mechanisms in InGaN solar cells using a semi-analytical model", *J. Appl. Phys.* **119**, 213101 (2016).
41. H. Fu, Z. Lu, X. Huang, H. Chen, and Y. Zhao*, "Crystal orientation dependent intersubband transition in semipolar AlGaIn/GaN single quantum well for optoelectronic applications", *J. Appl. Phys.* **119**, 213101 (2016).
42. H. Fu, Z. Lu, X. Zhao, Y. H. Zhang, S. P. DenBaars, S. Nakamura, and Y. Zhao*, "Study of low-efficiency-droop semipolar (20-2-1) InGaN by time-resolved photoluminescence", *J. Display Technol.* **12**, 736 (2016).
43. H. Chen, H. Fu, X. Huang, Z. Lu, and Y. Zhao*, "Optical properties of highly polarized InGaN light-emitting diodes modified by metallic grating," *Opt. Express* **24**, A856 (2016).
44. C. C. Pan, Q. Yan, H. Fu, Y. Zhao*, Y. R. Wu, C. G. Van de Walle, S. Nakamura, and S. P. DenBaars, "High optical power and low efficiency droop blue light-emitting diodes using compositionally step-graded InGaN barriers", *Electron. Lett.* **51**, 1187 (2015).
45. R. Ivanov, S. Marcinkevicius, Y. Zhao, D. L. Becerra, S. Nakamura, S. P. DenBaars, and J. S. Speck, "Impact of carrier localization on recombination times in semipolar (20-21) plane InGaN/GaN quantum wells", *Appl. Phys. Lett.* **107**, 211109 (2015).

46. J. Xue, Y. Zhao, S. H. Oh, J. S. Speck, S. P. DenBaars, S. Nakamura, and R. J. Ram, "Thermally Enhanced Blue Light-Emitting Diodes", *Appl. Phys. Lett.* **107**, 121109 (2015).
- **Featured in Nature Photonics, vol. 9, 782 (2015).**
47. K. Gelzinyte, S. Marcinkevicius, Y. Zhao, D. L. Becerra, S. Nakamura, S. P. DenBaars, and J. S. Speck, "High spatial uniformity of photoluminescence spectra in semipolar (20-21) plane InGaN/GaN quantum wells", *J. Appl. Phys.* **117**, 023111 (2015).
48. D. L. Becerra, Y. Zhao, S. H. Oh, C. D. Pynn, K. Fujito, S. P. DenBaars, and S. Nakamura, "High-power low-droop violet semipolar (30-3-1) InGaN/GaN light-emitting diodes with thick active layer design", *Appl. Phys. Lett.* **105**, 171106 (2014).
- **Featured in Semiconductor Today.**
49. Y. Zhao, R. M. Farrell, Y. R. Wu, J. S. Speck, "On the optical polarization ratio and valance band separation for nonpolar and semipolar InGaN quantum well light-emitting devices", *Jpn. J. Appl. Phys.* **53**, 100206 (2014). (Invited Review)
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68. C. Y. Huang, Y. Zhao, F. Wu, Y. Kawaguchi, D. Feezell, S. P. DenBaars, J. S. Speck, and S. Nakamura, "Growth characteristics of InGaN/GaN quantum wells on semipolar (20-21) and (20-2-1) planes", *2012 International Workshop on Nitride Semiconductors (IWN 2012)*, Oct 2012, Sapporo, Japan, Post Presentation.
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Patents

1. "Low droop light emitting diode structure on gallium nitride semipolar substrates", US Patent No. 8686397, Publication Date 2014/4/1.
2. "Ga₂O₃ passivation for GaN regrowth to reduce contamination effects", ASU Patent Pending.
3. "Thick buffer layer design for GaN power devices grown on bulk GaN substrates", ASU Patent Pending.
4. "Plasma-based edge terminations for gallium nitride power devices", ASU Patent Pending.
5. "Low-leakage regrown GaN p-n junctions for GaN power devices", ASU Patent Pending.
6. "GaN vertical-channel junction field-effect transistors with regrown p-GaN by MOCVD", ASU Patent Pending.
7. "High temperature gallium nitride memory devices", ASU Patent pending.
8. "PN junctions with mechanically exfoliated gallium oxide and gallium nitride", ASU Patent Pending.
9. "Nonpolar III-nitrides solar cell devices", ASU Patent Pending.
10. "GaN based threshold switching device and memory diode", ASU Patent Pending.
11. "Steep slope transistors with threshold switching devices", ASU Patent Pending.
12. "AlN Power Device", ASU Patent Pending.
13. "High power semipolar {30-3-1} light-emitting diodes with low current droop and low thermal droop", UCSB Patent Pending.
14. "High power, high efficiency and low efficiency droop III-nitride light-emitting diodes on semipolar {20-2-1} substrates", UCSB Patent Pending.
15. "Two-step surface roughening technique for high light extraction efficiency III-nitride light emitting diodes", UCSB Patent Pending.
16. "High indium uptakes and high polarization ratio on gallium nitride semipolar {20-2-1} substrates for III-nitride optoelectronic devices", UCSB Patent Pending.
17. "Nonpolar and semipolar devices", Patent Pending.
18. "Optical polarization modification by controlling quantum well's chemical composition profile for (B,Al,In,Ga)N nonpolar and semipolar semiconductor light emitters", Patent Pending.
19. "PEC etching for semipolar {20-2-1} gallium nitride for external efficiency enhancement for light emitting diode applications", UCSB Patent Pending.
20. "Reversed p-n epilayer structure for semipolar InGaN/GaN light-emitting diodes and laser diodes with InGaN sacrificial layers for photoelectrochemical etching (PEC)", UCSB Patent Pending.
21. "High emission power and low efficiency droop semipolar {20-2-1} blue light emitting diodes", UCSB Patent Pending.
22. "Opto-electrical devices", UCSB Patent Pending.

RESEARCH FUNDING

Awarded external grants (total \$6.25M, as PI \$5.8M, personal share ~ \$4.3M)

1. **(PI) DOE ARPAE PNDIODES Extension Grant**, "Effective selective area doping for GaN vertical power transistors enabled by innovative materials engineering", 2019 to 2020 (15 month), \$1M
2. **(PI) ARO DURIP**, "Upgrade of the III-N integrated quantum photonics laboratory instrumentation", 2019, \$110k

3. **(PI) ARO PECASE**, “On-chip frequency comb generation at visible wavelengths using III-nitride photonic integrated circuits”, 2019 to 2024, \$1M
4. **(PI) DOE ARPAe PNDIODES Collaboration Grant**, “Collaborative efforts on materials characterizations of selective area doped GaN PNDIODES”, 2019 (6 month), \$350K
5. **(Co-PI) NSF EPMD Program**, “Collaborative Research: InGaN/III-V hybrid integration for high-temperature solar cells”, 2018 to 2021, \$450K, PI: Minjoo Larry Lee (UIUC)
6. **(PI) DOE ARPAe PNDIODES Program**, “Effective selective area doping for GaN vertical power transistors enabled by innovative materials engineering”, 2017 to 2019, \$1.5MM
7. **(PI) NASA HOTTech Program**, “High temperature GaN Microprocessors”, 2017 to 2020, \$750K
8. **(PI) DoD DTRA Young Investigator Program (YIP) Award**, “Radiation effects in ultra-wide bandgap AlN and diamond Schottky diodes”, 2017 to 2020, \$300K
9. **(PI) NASA Early Career Faculty (ECF) Award**, “High temperature InGaN-based solar cells”, 2015 to 2018, \$595K
10. **(PI) SFaz Bisgrove Scholar Tenure Track Faculty Award**, “Smart LEDs: from energy efficiency to Li-Fi communication, and medical applications”, 2015 to 2017, \$200K

Awarded ASU internal grants (total \$163,500, personal share \$101,750)

1. 2019 ASU FSE/CLAS/AMI Seed Program, “Ultra-gap quantum devices”, \$57,000, PI: Zachary Holman, Co-PI: Robert Nemanich, Yuji Zhao, personal share 33%
2. 2019 ASU Fulton Engineering Research Faculty Support Program, “GaN neuron and memory for high temperature neuromorphic computing”, \$7,500, PI: Kai Fu, Co-PI: Yuji Zhao, personal share 50%
3. 2018 ASU Fulton Engineering Seed Program, “Predicting and controlling complex quantum networks”, \$40,000 (cost-sharing PI - \$5,000, ECEE - \$5,000), PI: Ying-Cheng Lai, Co-PI: Yuji Zhao, personal share 50%
4. 2018 ASU Fulton Engineering Minor Research Infrastructure Program, “UV-IR optical spectrum analyzer”, \$49,000 (cost-sharing \$9,800), PI: Yuji Zhao, personal share 100%
5. 2017 ASU Fulton Outstanding Assistant Professor Award, \$10,000, PI: Yuji Zhao, personal share 100%

Supplements and donations (total value of \$700K, currently in storage)

1. (Donation) ASM 3X2 GaN CCS MOCVD by ASM Pacific, Age 4 years, estimated value of \$550K, personal share: 100%
2. (Donation) Tomas Swan 6X2 GaN CCS MOCVD by ASM Pacific, Age 15 years, estimated value of \$150K, personal share: 100%