

Justus Chukwunonso Ndukaife

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APPOINTMENT

Assistant Professor of Electrical Engineering, Vanderbilt University 2017-present

EDUCATION

Ph.D. in Electrical Engineering, Purdue University West-Lafayette, IN 2017

Thesis: “Plasmon Nano-optical Tweezers for Integrated Particle Manipulation: A Route to Positioning, Sensing, and Additive Nanomanufacturing On-Chip”

Master of Science in Engineering, Purdue University Calumet, IN 2012

Bachelor of Science (1st Class Honors) in Electrical Engineering, University of Lagos 2010

RECOGNITIONS, HONORS, AND AWARDS

- **Carnegie African Diaspora Fellowship Award**, 2018
- **The year 2017 Prize in Physics by Dimitris N. Chorafas Foundation** in recognition of work on “*plasmon nano-optical tweezers*” (given to the best doctoral candidate at Purdue University), 2017
- **Outstanding Graduate Student Research Award**, College of Engineering, Purdue University 2016
- **Gordon Research Conference Emerging Topic Talk (Selected out of all participants)** GRC on Plasmonics and Nanophotonics, for talk on “*Shaping the Future of Plasmon Nano-Optical Tweezers*” 2016
- **Elected as Co-chair** of 2018 Gordon Research Seminar on Plasmonics and Nanophotonics 2016
- **Golden Torch Award** by National Society of Black Engineers: Named “**Graduate Student of the Year**”, 2015
- **Best Paper Award** at the ASME Society-Wide Micro and Nanotechnology Forum, 2015
- Inducted into the **Society of Innovators of Northwest Indiana**, 2015
- Participated at the summer school on Complex Photonics at the international school of Physics Enrico Fermi in Varenna, Italy, 2015
- NSBE Graduate Student Professional Conference Scholarship, 2015 and 2016
- NSBE Board of Corporate Affiliates Scholarship, 2012
- Member of Tau Beta Pi Engineering Honor Society, 2011
- University of Lagos Endowment Scholarship for maintaining First Class GPA, 2005 to 2009

RESEARCH INTERESTS

Nanoscale Optical Tweezers, Metasurfaces, Optofluidics, Nano-biosensing, Active Matter, Nano-assembly

UNITED STATES PATENTS

- 1) Steven T. Wereley, Agwu Agbai Nnanna, Alexandra Boltasseva, **Justus C. Ndukaife** “Hybrid Device for On-Chip Concentration, Manipulation, Sorting and Sensing of Particles on a Plasmonic Substrate” U.S. Patent Application Number: 14/732,673, filed June 6, 2015. (**Patent awarded**)
- 2) **Justus C. Ndukaife**, Alexandra Boltasseva, A. G. Agwu Nnanna, Steven T. Wereley, Alexander V. Kildishev, Vladimir M. Shalaev, “System and method for manipulation of particles” U.S. Patent Application Number: 15/183,382, filed June 15, 2016. (**Patent awarded**)
- 3) **Justus C. Ndukaife**, A. G. Agwu Nnanna, Alexander V. Kildishev, Alexandra Boltasseva, “Multi-site Particle Sensing System” U.S. Patent Application Number: 15/174990, filed June 6, 2016
- 4) **Justus C. Ndukaife**, Alexandra Boltasseva, A. G. Agwu Nnanna “System and method for trapping and sensing nanoparticles with plasmonic nanopores” U.S. Patent Application Number: 62316558, filed March 31, 2016
- 5) **Justus C. Ndukaife**, Long-range and rapid transport of individual nano-objects by a hybrid electrothermoplasmonic nanotweezer” U.S. Provisional Application No. 62/648,738, filed March 27, 2018

PEER-REVIEWED JOURNAL PUBLICATIONS (> 290 citations)

- 1) Chuchuan Hong, Sen Yang, **Justus C. Ndukaife**, “Optofluidic Control with Plasmonic TiN Bowtie Nanoantenna” *Invited for special issue, Optical Materials Express, 2019 (Accepted)*
- 2) **Justus C. Ndukaife**, Yi Xuan, A. G. Agwu Nnanna, Alexander V. Kildishev, Vladimir M. Shalaev, Steven T. Wereley, Alexandra Boltasseva, “High-Resolution Large-ensemble Nanoparticles Trapping with Multifunctional Thermoplasmonic Nanohole Metasurface” *ACS Nano (2018)*
- 3) Stockman, Mark I., Kneipp, Katrin, Bozhevolnyi, Sergey I., Saha, Soham, Dutta, Aveeka, **Justus C. Ndukaife**, Kinsey, Nathaniel, et. al., **Roadmap on plasmonics**, *Journal of Optics* (2017)
- 4) **Justus C. Ndukaife**, Vladimir M. Shalaev, Alexandra Boltasseva, “Plasmonics - Turning loss into gain”, *Science* **351**, issue **6271 (2016)**
- 5) **Justus C. Ndukaife**, Alexander V. Kildishev, A. G. Agwu Nnanna, Vladimir M. Shalaev, Steven T. Wereley, Alexandra Boltasseva, “Long-range and rapid transport of individual nano-objects by a hybrid electrothermoplasmonic nanotweezer”, *Nature Nanotechnology* **11**, 53-59 (**2016**) (**listed on front cover**)
News and Views: “Plasmonic optical tweezers: A long arm and a tight grip” by Yasuyuki Tsuboi
- 6) Amr M. Shaltout*, Nathaniel Kinsey*, Jongbum Kim*, Rohith Chandrasekar*, **Justus C. Ndukaife***, Alexandra Boltasseva, and Vladimir Shalaev, “Development of optical metasurfaces: emerging concepts and new materials”, in *Proceedings of the IEEE PP*, **99**, 1-18 (**2016**) **Equal contributions*

- 7) **Justus C. Ndukaife**, Avnish Mishra, Urcan Guler, A. G. Agwu Nnanna, Steven T. Wereley, Alexandra Boltasseva, “Photothermal heating enabled by plasmonic nanostructures for electrokinetic manipulation and sorting of particles”, *ACS Nano* 8, no. 9 (2014): 9035–9043
Highlighted in Nature Nanotechnology editorial: Focusing in on applications (2015)
- 8) Urcan Guler, **Justus C. Ndukaife**, Gururaj V. Naik, A. G. Agwu Nnanna, Alexander V. Kildishev, Vladimir M. Shalaev, and Alexandra Boltasseva. "Local heating with lithographically fabricated plasmonic titanium nitride nanoparticles", *Nano letters* 13, no. 12 (2013): 6078-6083
- 9) Kennethrex, O. Ndukaife, **Justus C. Ndukaife**, A. G. Agwu Nnanna, “ Membrane fouling characterization by infrared thermography” *Infrared Physics & Technology* 68 (2015): 186-192
- 10) **Justus C. Ndukaife**, A. G. Agwu Nnanna, Shadi Salman, and Magloire C. Fandohan. "A pump-less discrete optofluidic chemical spectrophotometry system (DOCSS) for online in situ monitoring of dissolved contaminants", *Journal of Water Supply—AQUA* 63, no. 7 (2014): 560-569
- 11) **Justus C. Ndukaife**, A. G. Agwu Nnanna, and H. W. Pinnick, “Dithizone as a halochromic material for fabricating evanescent wave-based chemical sensors”, *Chemical Sensors* 2013, **3**:1

INVITED CONFERENCE PRESENTATIONS AND SEMINARS

- 1.) **Justus Ndukaife** “New Frontiers for Nano-Manipulation with Designer Thermoplasmonic Metasurfaces” Gordon Research Conference on Plasmonically-Powered Processes, July 28-August 2, 2019, Hong Kong
- 2.) **Justus Ndukaife** “New Frontiers for Nano-Manipulation with Resonant Plasmonic Nanoantennas” Novel Concepts in Photonics Research, Feb 10-15, 2019, Technion Israel Institute of Technology, Israel
- 3.) **Justus Ndukaife** “New frontiers for nanoparticle trapping and manipulation with designer thermoplasmonic metasurfaces” METANANO conference, Sep 17-21, 2018, Sochi Russia
- 4.) **Justus Ndukaife** “New Frontiers for Nano-Optical Trapping with Resonant Plasmonic Nanoantennas” Faculty of Science Seminar, August 3, 2018, University of Lagos, Nigeria
- 5.) **Justus Ndukaife** “Shaping the future of nanomanipulation” African Nano Conference, July16-21, 2018, Enugu, Nigeria
- 6.) **Justus Ndukaife** “Versatile nanoparticle manipulation with designer thermoplasmonic metasurface” Applied Computational Electromagnetism Symposium (ACES 2018), March, 29, 2018, Denver, Colorado
- 7.) **Justus Ndukaife** “Trapping and manipulating nanometer scale objects with designer thermoplasmonic metasurfaces” Chemical and Biomolecular Engineering Department Seminar, Vanderbilt University, March 12, 2018
- 8.) **Justus Ndukaife**, A. G. Agwu Nnanna, Alexander V. Kildishev, Vladimir M. Shalaev, Steven T. Wereley, Alexandra Boltasseva, “Shaping the future of plasmon nano-optical tweezing”, (**invited for presentation as “late breaking talk”** at the **Gordon Research Conference on Plasmonics and Nanophotonics** July, 2016)
- 9.) **Justus Ndukaife**, Alexander V. Kildishev, A. G. Agwu Nnanna, Steven T. Wereley, Vladimir M. Shalaev, Alexandra Boltasseva, “Electrothermoplasmonic flow for plasmon-assisted optical trapping”, (SPIE Conference on Plasmonics: Metallic Nanostructures and Their Optical Properties XIII, San Diego, California, USA, August 9-13, 2015)

CONFERENCE PRESENTATIONS

- 1) **Justus Ndukaife** and A. G. Agwu Nnanna, “Thermoplasmonic metasurface for optofluidic particle manipulation”, (Oral presentation at ASME IMECE 2017 conference, November, 2017)
- 2) Simeon Bogdanov, Mikhail Y. Shalaginov, **Justus C. Ndukaife**, Oksana A. Makarova, Alexey V. Akimov, Alexei S. Lagutchev, Alexander V. Kildishev, Alexandra Boltasseva, Vladimir M. Shalaev, "Towards integrated plasmonic quantum devices (Conference Presentation)," Proc. SPIE 10359, Quantum Nanophotonics, (September 29, 2017)
- 3) **Justus C. Ndukaife**, Benjamin Isaacoff, Mikhail Y Shalaginov, Simeon Bogdanov, Agbai G Nnanna, Julie S Biteen, Mordechai Segev, Vladimir M Shalaev, Alexandra Boltasseva “Massive Parallel Positioning of Nanodiamonds on Nanophotonic Structures”, (Oral presentation at CLEO Conference May, 2017)
- 4) **Justus C. Ndukaife**, A. G. Agwu Nnanna, Alexander V. Kildishev, Vladimir M. Shalaev, Steven T. Wereley, Alexandra Boltasseva "On-demand rapid transport and stable trapping of nanoparticles of nanoparticles by a hybrid electrothermoplasmonic nanotweezer (Oral Presentation at SPIE Nanoscience+ Engineering International Society for Optics and Photonics, 2016)
- 5) **Justus C. Ndukaife**, A. G. Agwu Nnanna, Alexander V. Kildishev, Vladimir M. Shalaev, Steven T. Wereley, Alexandra Boltasseva "Controlled rapid delivery and on-chip trapping of nanoparticles by a hybrid electrothermoplasmonic nanotweezer, (oral presentation at CLEO 2016 Conference)
- 6) **Justus C. Ndukaife**, A. G. Agwu Nnanna, Vladimir M. Shalaev, Steven T. Wereley, Alexandra Boltasseva, “The hybrid electrothermoplasmonic nanotweezer: a new paradigm in nanomanipulation”, (presented at MRS Spring Meeting, Phoenix, AZ, March 2016)
- 7) **Justus C. Ndukaife**, A. G. Agwu Nnanna, Alexander V. Kildishev, Vladimir M. Shalaev, Steven T. Wereley, Alexandra Boltasseva, “Hybrid Electroplasmonic Nanotweezer (HENT): Shaping the Future of Nanomanipulation”, (poster presented at ASME IMECE Micro/Nano Forum 2015, Houston Texas, USA, November 13-19, 2015). **(Best paper award)**
- 8) **Justus C. Ndukaife**, Alexander V. Kildishev, A. G. Agwu Nnanna, Steven T. Wereley, Vladimir M. Shalaev, Alexandra Boltasseva, “Hybrid Electroplasmonic Nanotweezer (HENT): Versatile Plasmoﬂuidic Device for On-chip Capture, Manipulation and Printing of Particles on Plasmonic Hotspots”, (poster presented at Summer School on Complex Photonics at the International School of Physics, Enrico Fermi, Varenna, Italy, July 13-18, 2015)
- 9) **Justus C. Ndukaife**, Alexander V. Kildishev, A. G. Agwu Nnanna, Steven T. Wereley, Vladimir M. Shalaev, Alexandra Boltasseva, “Versatile Plasmoﬂuidic Device for On-chip Concentration, Manipulation and Sensing of Particles in Suspensions”, (poster presented at the **Gordon Research Conference on Microfluidics**, Mount Snow, VT, June 2015)
- 10) **Justus C. Ndukaife**, Alexander V. Kildishev, A. G. Agwu Nnanna, Steven T. Wereley, Vladimir M. Shalaev, Alexandra Boltasseva, “Plasmon-Assisted Optoelectrofluidics”, (oral presentation AW3K.5, CLEO /A&T Topical Review - Optofluidics Microsystems I, 2015 Conference, San Jose, CA, USA, May 10-15, 2015)

Curriculum Vitae *Justus Ndukaife* justus.ndukaife@vanderbilt.edu

- 11) **Justus C. Ndukaife**, Avanish Mishra, Urcan Guler, A. G. Agwu Nnanna, Steven T. Wereley, Alexandra Boltasseva, “Photothermal heating enabled by plasmonic nanoantennas for electrokinetic manipulation and sorting of submicron particles”, (oral presentation FTh1K.2, CLEO, San Jose, CA, USA, June 8-13, 2014)
- 12) Urcan Guler, **Justus C. Ndukaife**, Gururaj V. Naik, A. G. Agwu Nnanna, Alexander V. Kildishev, Vladimir M. Shalaev, and Alexandra Boltasseva, “Local heating with titanium nitride nanoparticles,” (oral presentation QTu1A.2, CLEO/QELS, San Jose, CA, USA, June 9-14, 2013)

PROFESSIONAL SERVICE & LEADERSHIP EXPERIENCE

- 1) Executive committee member of the OSA Optical Trapping in Biology Technical Group (July 2018-2021)
- 2) Member of Materials Research Society (MRS) Government Agency Sub-Committee (November 2018-2021)
- 3) Member of Materials Research Society (MRS) Government Affairs Committee (November 2018-2021)
- 4) Served on PhD and MS thesis committees at Vanderbilt University
- 5) **Co-chair** of the 2018 Gordon Research Seminar on Plasmonics and Nanophotonics
- 6) **Co-chair** of “1st Annual Conference on Micro & Nanoscale Science for Addressing Grand Challenges” (URL: grandchallengespurdue.org), Purdue University, April 20, 2016
- 7) **President of Nanotechnology Student Advisory Council (NSAC)** at the Birck Nanotechnology Center (BNC) (March 2014 – July 2016)
- 8) **President of Optical Society of America, Purdue University Student Chapter** (May 2015 – May 2017)
- 9) **President of National Society of Black Engineers (NSBE)** Purdue Calumet Chapter (Sep 2011-June 2012)
- 10) Organizing committee member of Innovate: Soft Photonics Competition at University of Michigan, June 2016
- 11) **Session Chair** at MRS Fall Meeting: “New Metaphotonic Designs and Fabrications II”, 2015
- 12) Symposium Assistant at MRS Fall Meeting on Optical Metamaterials—From New Plasmonic Materials to Metasurface Devices, 2015
- 13) Technical **reviewer for 8 journals**: *ACS Photonics*, *ACS Nano*, *Optics Express*, *Optics Letters*, *Nature Scientific Report*, *Optical Materials Express*, *New Journal of Physics*, and *Photonics Research*
- 14) Technical reviewer for ASME Summer Heat Transfer Conference
- 15) Admissions Committee Member for Interdisciplinary Materials Science Graduate Program, Vanderbilt University: *reviewed applications, held phone interviews and made recommendations*
- 16) Graduate Faculty Delegate Assembly (GFDA): Representative for EECS Department at Vanderbilt
- 17) NSBE Scholarship Application Reviewer
- 18) **Invited Speaker** at Convocation Ceremony, Saint Francis Catholic Secondary School, 2010

TEACHING ACTIVITIES

Teaching

1. **Optical Manipulation for Biology & Colloidal Assembly** (EECE 8396), Department of Electrical Engineering, Vanderbilt University, Spring 2019

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2. **Principles and Models of Semiconductor Devices** (EECE 4283/5283), Department of Electrical Engineering, Vanderbilt University, Fall 2018
3. **Micro & Nanoscale Optofluidics** (EECE 8396), Department of Electrical Engineering, Vanderbilt University, Spring 2018
4. **Guest Lecturer**, School of Electrical and Computer Engineering, Purdue University West-Lafayette, Fall 2016 Course: **ECE 414 Elements of Electro and Fiber-Optics**
5. **Guest Lecturer**, School of Electrical and Computer Engineering, Purdue University West-Lafayette, Fall 2013 Course: **ECE 695 Nanophotonics and Optical Metamaterials**
6. **Guest Lecturer**, Department of Mechanical Engineering, Purdue University Calumet, Fall 2013 Course: **ME 523 Electronic Systems Cooling**

STUDENT SUPERVISING EXPERIENCE

1.) Chuchuan Hong	PhD	Vanderbilt University (in progress)	Supervisor
2.) Sen Yang	PhD	Vanderbilt University (in progress)	Supervisor
3.) Yesol Choi	PhD	Vanderbilt University (rotation)	Supervisor
4.) Patrick Mudge	BSc	Vanderbilt University	Supervisor
5.) Rayni Jules	BSc	Vanderbilt University (in progress)	Supervisor
6.) Irfan Mohd	BSc	Vanderbilt University	Supervisor

MENTORING AND STUDENT ENGAGEMENT TO ENHANCE DIVERSITY AND INCLUSION

Mentoring

- 1.) National Society of Black Engineers (NSBE) Graduate Student Council Member (**organized biweekly Technical Research Talks series** on research opportunities for undergraduate NSBE student members)
- 2.) Mentored **three underrepresented minority graduate students** on MS thesis research (*the experience has resulted in journal articles, conference presentations and prizes in the annual graduate student research day presentations*)
- 3.) Mentored **incoming Ph.D. students** in Electrical Engineering during the Fall 2015 and 2016 Purdue Graduate School eMentoring program
- 4.) Mentored an undergraduate student on senior design project focused on automated water quality monitoring sensors (*the student upon graduation got employed in a water quality firm*)
- 5.) Organized educational activities for K-12 students during Nano-Days: mock cleanroom experiences for over **200 Girl's Scout** students (April 2014, 2015 and 2016)
- 6.) Organized workshop series to provide tutorials and learning materials on emerging research topics to students

PROFESSIONAL MEMBERSHIP

Optical Society of America (OSA), International Society for Optics and Photonics (SPIE), Materials Research Society (MRS), National Society of Black Engineers (NSBE), and Institute of Electrical and Electronic Engineers (IEEE)