

Interdisciplinary Microsystems Group

Annual Report 2021

2021 Year End Highlights	3
Introduction.....	4
Faculty Spotlight	5
<i>Jennifer Andrew</i>	<i>5</i>
<i>David P. Arnold</i>	<i>6</i>
<i>Z. Hugh Fan</i>	<i>7</i>
<i>Philip Feng</i>	<i>8</i>
<i>Jack Judy</i>	<i>9</i>
<i>Saeed Moghaddam.....</i>	<i>10</i>
<i>Toshikazu (Toshi) Nishida.....</i>	<i>11</i>
<i>Mark Sheplak</i>	<i>12</i>
<i>Roozbeh Tabrizian</i>	<i>13</i>
<i>Y.K. Yoon</i>	<i>14</i>
Honors & Awards	15
<i>Student Awards</i>	<i>15</i>
<i>Faculty Honors and Intellectual Leadership</i>	<i>15</i>
Educational Activities	18
<i>Ph.D. Graduates (12)</i>	<i>18</i>
<i>New Alumni</i>	<i>18</i>
<i>Classroom Instruction.....</i>	<i>19</i>
<i>IMG Seminars Series</i>	<i>21</i>
Research Activities	22
<i>Federal Sponsorship</i>	<i>22</i>
<i>Other Sponsorship</i>	<i>25</i>
<i>Industry Sponsorship (including NSF I/UCRC MIST Center Sponsorship)</i>	<i>25</i>
<i>Internal Sponsorship</i>	<i>26</i>
<i>Research Financial Summary</i>	<i>26</i>
Publications	28
<i>Editorial Advisory Boards</i>	<i>28</i>

Reviewers for Scholarly Journals 28
Peer-reviewed journals (49) 28
Conference Publications (29) 32
Patents Issued (11) 34
Patent Applications (17) 34

2021 Year End Highlights

~100
Members

10
Faculty

12
PhD Graduates

49
Journal Publications

11
Issued Patents

29
Conference
Publications

17
Patent Applications

57
Active
Research Projects

\$5.3M
Research Expenditures



Introduction

The Interdisciplinary Microsystems Group (IMG) is a college-wide multi-departmental education and research program within the Herbert Wertheim College of Engineering at the University of Florida. IMG operates under the direction of Mark Sheplak, Hugh Fan, and Saeed Moghaddam of the Department of Mechanical and Aerospace Engineering; Toshikazu Nishida, David Arnold, Y.K. Yoon, Jack Judy, Roozbeh Tabrizian, and Philip Feng of the Department of Electrical and Computer Engineering; and Jennifer Andrew of the Department of Materials Science and Engineering.

IMG research focuses on micro- and nanosystems for healthcare, energy, security, aerospace, transportation, consumer electronics, and other industries. Efforts include design, fabrication, characterization, and ultimately deployment of micro and nanotechnologies for a wide variety of applications. Founded in 1998, IMG has steadily grown in size, scope, and impact. Since its inception, IMG has graduated 147 PhD students and published 703 journal articles and 666 conference papers. IMG faculty have participated in 337 sponsored research projects valued at \$147M (IMG portion was \$68M). Of these, 270 projects (80%) were led by an IMG faculty member as PI, and 88 (26%) included more than one IMG investigator. IMG's student training and research impact have been fueled by true interdisciplinary research and strong internal and external collaborations.



IMG photo from spring break picnic at Lake Wauburg, Micanopy, FL.

Faculty Spotlight

Jennifer Andrew

Associate Professor

Jennifer Andrew is currently the Margaret A. Ross Associate Professor in the Department of Materials Science & Engineering at the University of Florida. She received her B.S. in Materials Science from Northwestern University in 2002, and her Ph.D. in Materials Engineering in 2008 from the University of California, Santa Barbara. Before coming to UF she was a UC President's Postdoctoral Fellow in Michael J. Sailor's lab in the Department of Chemistry and Biochemistry at the University of California, San Diego.



She was awarded the NSF CAREER Award titled "Structure-property Relationships Arising From Interfacial Coupling in Bi-phasic Ceramic Nanocomposites." Her research interests include the development of nanocomposite materials with novel multifunctional electronic and biomedical applications.

Education

Graduation Year	Degree	University	Program of study
2008	Doctorate	University of California, Santa Barbara	Materials Science and Engineering
2002	Bachelor of Science	Northwestern University	Materials Science and Engineering

David P. Arnold

Professor

David P. Arnold is the George Kirkland Engineering Leadership professor in the Dept. of Electrical and Computer Engineering at the University of Florida. He is currently UF Site Director / Director of Industry/University Partnerships for the IoT4Ag Engineering Research Center. He served as Director of the Interdisciplinary Microsystems Group (IMG) from 2016-2019.



He received dual B.S. degrees in electrical and computer engineering in 1999, followed by the M.S. degree in electrical engineering in 2001, from the University of Florida, Gainesville. He received the Ph.D. degree in electrical engineering at the Georgia Institute of Technology, Atlanta in 2004. His research focuses on magnetic thin/thick films and magnetic micro/nanostructures; magnetic microsystems and electromechanical transducers; and compact (<100 W) power/energy systems.

Dr. Arnold is an active participant in the magnetics and MEMS communities, serving on conference committees for the MEMS, PowerMEMS, Hilton Head, Transducers, Sensors, MMM, and Intermag meetings. He currently serves on the DARPA MTO Microelectronics Exploratory Council (MEC) as well as the editorial board of *J. Micromechanics and Microengineering* and *Micromachines*. His work has been recognized with several prestigious awards, including the 2008 Presidential Early Career Award in Science and Engineering (PECASE) and the 2009 DARPA Young Faculty Award. Dr. Arnold is the current UF chapter faculty advisor and member of the Eta Kappa Nu ECE engineering honor society. He is also a Senior Member of IEEE and a member of Tau Beta Pi.

Beyond his passion for research and teaching, he most enjoys spending time with his wife and three children.

Education

Graduation Year	Degree	University	Program of study
2004	Doctorate	Georgia Institute of Technology	Electrical Engineering
2001	Master of Science	University of Florida	Electrical and Computer Engineering
1999	Bachelor of Science	University of Florida	Electrical Engineering
1999	Bachelor of Science	University of Florida	Computer Engineering

Z. Hugh Fan

Professor

Dr. Hugh Fan is a professor of the Department of Mechanical and Aerospace Engineering (MAE), J Crayton Pruitt Family Department of Biomedical Engineering, and Department of Chemistry at the University of Florida (UF). He currently holds MAE Excellence Term Professorship and is a member of UF Health Cancer Center (UFHCC) and Emerging Pathogens Institute (EPI). Dr. Fan was an E.T.S. Walton visiting professor in Biomedical Diagnostics Institute at Dublin City University, Ireland in 2009. Prior to joining UF in 2003, Dr. Fan was a Principal Scientist at ACLARA BioSciences Inc. (Mountain View, CA) and was previously a Member of the Technical Staff at Sarnoff Corp. (Princeton, NJ).



Dr. Fan's research interests include microfluidics, BioMEMS (Biomedical Microelectromechanical Systems), sensors, and bioengineering. His research focus is to develop microfluidics and BioMEMS technologies and apply them to biological applications. Microfluidics is promising to reach the holy grail of "lab-on-a-chip". In analogy to shrinking a computer from the size of a room in the 1950s to a laptop today, instruments for chemical and biological analyses may be miniaturized using modern microfabrication technology. Potential applications of the portable, miniaturized devices may include point-of-care testing (e.g., in emergency rooms), environmental monitoring, and detection of biowarfare agents in the field.

Dr. Fan is a recipient of Fraunhofer-Bessel Research Award from Alexander von Humboldt Foundation. He is an elected fellow of the American Association for the Advancement of Science (AAAS), the American Society of Mechanical Engineers (ASME), and the American Institute for Medical and Biological Engineering (AIMBE). He is also an associate editor of *Microsystems and Nanoengineering* (Nature Publishing Group), an editorial board member of *Scientific Report* (Nature Publishing Group), and an editorial board member of *Biosensors* (MDPI). He received his B. Sc. from Yangzhou Teachers' College (now a part of Yangzhou University) in China and his Ph.D. from the University of Alberta in Canada. Dr. Fan worked as a postdoctoral fellow at Ames Laboratory of US Department of Energy at Iowa State University. He joined UF in 2003 after more than eight years of industrial experience.

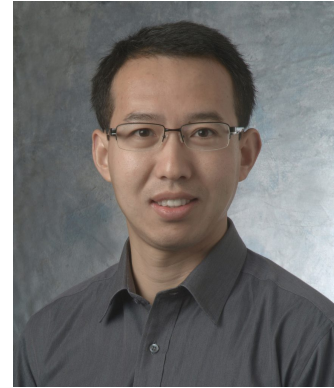
Education

Graduation Year	Degree	University	Program of study
1994	Doctorate	University of Alberta	Chemistry
1985	Bachelor	Yangzhou Teachers' College	Chemistry

Philip Feng

Professor

Dr. Philip Feng is a Professor in the Department of Electrical and Computer Engineering, at the University of Florida. He received his Ph.D. degree in Electrical Engineering from the California Institute of Technology (Caltech), Pasadena, CA, in 2007. Previously he was the Theodore L. & Dana J. Schroeder Associate Professor with the Department of Electrical Engineering and Computer Science (EECS), Case School of Engineering, Case Western Reserve University (CWRU), Cleveland, Ohio.



His research is primarily focused on emerging solid-state devices and systems, particularly nano/microelectromechanical systems (NEMS/MEMS), atomic layer semiconductors and 2D devices, silicon carbide (SiC) and other advanced semiconductors, quantum devices based on SiC and 2D materials, as well as their integration with state-of-the-art ICs and optical/photonic technologies.

Dr. Feng was an invited participant to the National Academy of Engineering (NAE) 2013 U.S. Frontier of Engineering (USFOE) Symposium. Subsequently, he received the NAE Grainger Foundation Frontiers of Engineering (FOE) Award in 2014.

His recent awards include the Presidential Early Career Award for Scientists and Engineers (PECASE, 2019), the National Science Foundation CAREER Award (2015), the Case School of Engineering Research Award (2015), and the Case School of Engineering Graduate Teaching Award (2014). He and his students have won six Best Paper/Presentation Awards at IEEE and other international conferences. He has mentored 13 Ph.D. students to successful dissertation defense and supervised 8 M.S. students with thesis research. He is a senior member of IEEE.

Education

Graduation Year	Degree	University	Program of study
2007	Doctorate	California Institute of Technology	Electrical Engineering
2002	Master of Science	California Institute of Technology	Electrical Engineering
2001	Master of Engineering	Tsinghua University	Engineering
1996	Bachelor of Science	Tsinghua University	Engineering

Jack Judy

Professor

Dr. Jack Judy is the Director of the Nanoscience Institute for Medical and Engineering Technology (NIMET) at the University of Florida, holds the Intel Nanotechnology Chair, and is a professor of Electrical and Computer Engineering, Biomedical Engineering, and has a courtesy appointment in Neurology.



The mission of NIMET is to bridge engineering, scientific, and medical communities by revealing, enabling, focusing, and coordinating related research and educational activities. NIMET also supports access to world-class centralized research facilities, technical support, and equipment for the design, fabrication, and characterization of innovative micro/nanotechnologies, as well as a dedicated hands-on instructional laboratory for training students in the use of micro/nanoscale fabrication tools and techniques.

Dr. Judy's research involves the development of novel microscale and nanoscale sensors, actuators, and systems, and their use in impactful engineering, scientific, biological, and medical, applications. A particular focus of his recent research is in the development of advanced and robust neural-interface technology components and systems for bi-directional prosthetic control and other neurotechnology applications.

Previously, Dr. Judy was a Program Manager in the Microsystems Technology Office (MTO) of the Defense Advanced Research Projects Agency (DARPA), where he created and managed the Reliable Neural-Interface Technology Program (RE-NET) to address fundamental, and yet at the time largely overlooked, critical reliability problems of chronic neural-recording interfaces. Without successfully developing robust clinical-grade high-performance neural-recording interfaces that function for the life of the patient, some widely envisioned advanced clinical applications for brain-machine interfaces and other neural-electronic technologies will not be translated effectively.

Dr. Judy served at DARPA while on leave from his faculty position at the time in the Electrical and Biomedical Engineering Departments at UCLA, where he also served as Director of the NeuroEngineering Program, the Nanoelectronics Research Facility, and the Instructional Microfabrication Laboratory. He has received the National Science Foundation Career Award, the Okawa Foundation Award, and the Office of the Secretary of Defense Medal for Exceptional Public Service.

Education

Graduation Year	Degree	University	Program of study
1996	Doctorate	University of California, Berkeley	Electrical Engineering
1994	Master of Engineering	University of California, Berkeley	Electrical Engineering
1989	Bachelor of Science	University of Minnesota	Electrical Engineering

Saeed Moghaddam

Professor

Dr. Saeed Moghaddam is the Knox T. Millsaps Professor of Mechanical and Aerospace Engineering at the University of Florida. Before joining the University of Florida in 2010, he was a postdoc (2007-2010) in the Chemical and Biomolecular Engineering Department at University of Illinois, Urbana-Champaign. His academic background is in micro-/nanoscale transport, interfacial science, micro-/nanoengineering, and ionic liquid membrane-based absorption process.



Dr. Moghaddam has made significant contributions in the field of phase-change heat transfer through invention of a new measurement technique that has enabled resolving the thermal field at the interface of a heated wall and a boiling liquid with unprecedented spatial and temporal resolutions. This work has led to addressing decades old fundamental questions regarding the underlying physics of the process at microscales.

Dr. Moghaddam is also the inventor of semi-open absorption cycle that has been successfully tested in ORNL in 2017. He has developed the world's first membrane-based IL hybrid absorption cycle for energy efficient exchange of latent and sensible heats. Dr. Moghaddam's work on nanoengineered membranes and their transport characteristics has been highlighted in Nano Science and Technology Institute (NIST) Innovation Spotlight, Nature Nanotechnology, New Scientist magazine, Heat Pumping Technologies Magazine and 2010 Guinness World Records. His research is published in nearly 100 peer-reviewed papers, 14 patents, and one book chapter. Dr. Moghaddam's research has been supported by ARPA-A, DARPA, DOE, NSF, ONR, NIH, SRC, ORNL, and private companies.

Education

Graduation Year	Degree	University	Program of study
2006	Doctorate	University of Maryland at College Park	Mechanical Engineering

Toshikazu (Toshi) Nishida

Professor and Associate Dean

Dr. Nishida is a professor in the Department of Electrical and Computer Engineering. He serves as Associate Dean of Academic Affairs in the Herbert Wertheim College of Engineering. Dr. Nishida received his Ph.D. (1988) and M.S. degrees in Electrical and Computer engineering and B.S. degree in Engineering physics at the University of Illinois at Urbana-Champaign. With colleagues and students, he has published over 190 refereed journal and conference papers and received three best paper awards. He also received the 2003 College of Engineering Teacher of the Year award. He holds 13 U.S. patents. He is a senior member of IEEE.



Dr. Nishida's research interests include the development of reliable, high performance, multi-functional semiconductor devices, sensors, and actuators for microsystems employing strained Si, SiGe, GaN, ferroelectric HfO₂, flexible hybrid electronics, and enabling multi-functional integrated system technology for smart systems.

Dr. Nishida is the Director of the NSF Industry/University Cooperative Research Center on Multi-functional Integrated System Technology (MIST).

Education

Graduation Year	Degree	University	Program of study
1988	Doctorate	University of Illinois at Urbana-Champaign	Electrical and Computer Engineering
1985	Master of Science	University of Illinois at Urbana-Champaign	Electrical and Computer Engineering
1983	Bachelor of Science	University of Illinois at Urbana-Champaign	Engineering Physics

Mark Sheplak

Professor

Mark Sheplak is currently a Professor holding joint appointments in the Department of Mechanical and Aerospace Engineering and the Department of Electrical and Computer Engineering at the University of Florida. Since 2019, he has served as Director of the Interdisciplinary Microsystems Group (IMG).

He received a BS degree in 1989, a MS degree in 1992, and a Ph.D. degree in 1995 in Mechanical Engineering from Syracuse University, Syracuse, NY. During his Ph.D. studies he was a GSRP Fellow at NASA-LaRC in Hampton, VA from 1992-1995. Prior to joining UF in 1998, he was a postdoctoral associate at the Massachusetts Institute of Technology's Microsystems Technology Laboratories, Cambridge, MA from 1995-1998.



His current research focuses on the design, fabrication, and characterization of high-performance, instrumentation-grade, MEMS-based sensors and actuators that enable the measurement, modeling, and control of various physical properties. Specific applications include technology development to enable large-channel count micromachined directional microphone arrays for aeroacoustic noise source localization and miniature skin-friction sensors for aerodynamic drag characterization and flow control.

He is a member of the Multi-functional Integrated System Technology Center (MIST) and the Florida Center for Advanced Aero-Propulsion (FCAAP). He is past chair of the AIAA Aerodynamic Measurement Technology Technical Committee. He is also an associate editor for JASA Express Letters. He is an associate fellow of AIAA and a fellow of the Acoustical Society of America.

Education

Graduation Year	Degree	University	Program of study
1995	Doctorate	Syracuse University	Mechanical Engineering
1992	Master of Science	Syracuse University	Mechanical Engineering
1989	Bachelor of Science	Syracuse University	Mechanical Engineering

Roozbeh Tabrizian

Assistant Professor

Roozbeh Tabrizian is an Associate Professor and the Alan Hastings Faculty Fellow at the Department of Electrical and Computer Engineering at the University of Florida.

He received his B.S. (2007) degree in Electrical Engineering from Sharif University of Technology, Iran, and the Ph.D. (2013) degree in Electrical and Computer Engineering from the Georgia Institute of Technology. He was a Post-Doctoral Scholar (2014-2015) at the University of Michigan.

His research interests include RF micro- and nano-electro-mechanical systems (RF N/MEMS), nonlinear, nonreciprocal, and hybrid NEMS for sensing and information processing, and emerging ferroelectric materials and devices.

Tabrizian has received the DARPA Director's Fellowship (2021), a DARPA Young Faculty Award (2019), and an NSF CAREER Award (2018). He is also the recipient of the 2021 Pramod P. Khargonekar Award for the most outstanding College of Engineering faculty member undergoing tenure review. His research has resulted in more than 70 journal and refereed conference papers. He holds 16 patents and patent applications. Tabrizian and his students are recipients of multiple outstanding paper awards at top-tier conferences such as IEEE MEMS and Transducers.



Education

Graduation Year	Degree	University	Program of study
2013	Doctorate	Georgia Institute of Technology	Electrical and Computer Engineering
2007	Bachelor of Science	Sharif University of Technology	Electrical Engineering

Y.K. Yoon

Professor

YK Yoon is currently a Professor in the Department of Electrical and Computer Engineering at the University of Florida, Gainesville, FL. His current research interests include three-dimensional (3-D) micromachining and nano fabrication; design and implementation of metamaterial for radio frequency (RF) and microwave applications; micromachined millimeter wave and terahertz antennas and waveguides; bio/microfluidic systems for the lab-on-a-chip applications; wireless telemetry systems for biomedical applications; and ferroelectric material development for high density memory devices and/or tunable RF devices.



He received his BS and MS degrees in electrical engineering from Seoul National University in Korea. He also earned an MSEE degree from the New Jersey Institute of Technology, Newark, NJ in 1999 and the Ph.D. degree in electrical and computer engineering from the Georgia Institute of Technology, Atlanta, GA in 2004. He held a postdoctoral position in the Microelectronics Research Center of Georgia Institute of Technology from 2004 to 2006. In 2006, he joined the faculty of the University at Buffalo, the State University of New York as an Assistant Professor in the Department of Electrical Engineering, where he directed the Multidisciplinary nano and Microsystems (MnM) laboratory until 2010. He received the NSF Early Career Development Award (CAREER) in 2008 and the Young Investigator Award from the University at Buffalo in 2009. He has more than 200 peer reviewed publications. He is a member of IEEE society. He actively participates in multiple technical conferences including Microelectromechanical systems (MEMS), Transducers, Hilton Head, micro total analysis systems (μ TAS), American Vacuum Society (AVS), International Microwave Symposium (IMS), Electronic Components and Technology Conference (ECTC), and Antenna Propagation Symposium (APS)

Education

Graduation Year	Degree	University	Program of study
2004	Doctorate	Georgia Institute of Technology	Electrical and Computer Engineering
1999	Master of Science	New Jersey Institute of Technology	Electrical and Computer Engineering
1994	Master of Science	Seoul National University	Electrical Engineering
1992	Bachelor of Science	Seoul National University	Electrical Engineering

Honors & Awards

Student Awards

- **Woosol Lee, Meisam Habibi Matin, Abdul Halim Miah**, IMG Excellence for Research Award (2021)
- **Brett Freidkes, Carlos Manzananas, Connor Smith**, IMG Excellence for Service Award (2021)
- **Troy Tharpe**, Outstanding Paper Award at Transducers 2021 Conference
- **Faysal Hakim**, Best Paper Award (Finalist) at IEEE International Frequency Control Symposium (IEEE IFCS 2021)
- **Wen Sui**, Finalist for *Best Paper Award at IEEE International Frequency Control Symposium (IFCS 2021)*
- **Haoran Wang**, Finalist for *Outstanding Paper Award at Transducers 2021*
- **Brittney Freeman**, NASA Graduate Fellowship
- **Tahmid Kaisar**, Best Research Work Award, 67th American Vacuum Society (AVS) International Symposium (Oct. 25-28, 2021, Virtual)
- **Enamul Yousuf**, Best Student Presentation Award, 67th American Vacuum Society (AVS) International Symposium (Oct. 25-28, 2021, Virtual)
- **Woosol Lee**, IEEE Antennas and Propagation Society (AP-S) Doctoral Research Award Dec. 2021
- **Hae-In Kim**, UKC EEC Symposium Best Abstract Award, Dec. 2021
- **Hae-In Kim**, UF HWCOE Chun Korean Scholastic Excellence Award, Dec. 2021
- **JiHo Han**, UFIC Outstanding Merit for the International Student Award, Nov. 2021
- **Alexander Wilcher, Brenden Mears**, UF HWCOE Dean's Research Fellowship Award, (2021 – 2025)
- **Woosol Lee**, UF ECE GSO TA of the Year (2021)
- **JiHo Han**, KSEA YoungSoo Yoo and KyungBin Im Undergraduate Scholarship (2021)

Faculty Honors and Intellectual Leadership

Prof. Jennifer Andrew

- *Honors*
 - Faculty Excellence Award, Dept. of Materials Science and Engineering, UF 2021
 - Margaret Ross Professorships 2020-present
- *Conference Leadership*
 - Co-Organizer, Frontiers in Biomagnetic Particles 2014-present
 - Symposium Organizer, Functional Materials for Biological Applications 2020-present
 - Co-Chair, Electronic Materials and Applications 2021
 - Chair, Electronic Materials and Applications 2022

Prof. David Arnold

- *Honors*
 - George Kirkland Engineering Leadership Professorship 2016-present
 - UF Term Professorship 2020-2022
 - DARPA MTO Microelectronics Exploratory Council (MEC) 2022-2025
 - ECE Faculty of the Year (student selected) 2021-2022
- *Conference Technical Program Committee*
 - PowerMEMS Intl. Steering Committee 2018-present

Prof. Z. Hugh Fan

- *Honors*

- University of Florida Term Professorship 2019-2022
 - UF Academy for Emerging Leaders 2021-2022
 - Fellow, the American Institute for Medical and Biological Engineering (AIMBE) 2021-present
 - Fellow, the American Society of Mechanical Engineers (ASME) 2018-present
 - Fellow, American Association for the Advancement of Science (AAAS) 2017-present
- Prof. Philip Feng*
- *Conference Leadership*
 - Organizer/Technical Chair, SiC Materials & Devices Workshop 2017-present
 - Chair, MEMS 2021 2021
 - Elected Member, IEEE MEMS International Steering Committee 2020-present
- Prof. Jack Judy*
- *Conference Leadership*
 - Intel and Charles Young Nanotechnology Professorship 2013-present
 - General Chairman: Transducers 2021 → 2025 2013-present
 - Leadership Committee: IEEE Neuroethics Framework 2019-present
 - Chair: NanoFlorida Conference 2021-2022
 - Chair: NanoDay Conference 2019-present
 - Co-Chair: Ultimate Symposium on Bioelectronics for Pain 2021
 - Co-Chair: Ultimate Symposium on Bioelectronics for Substance Use Disorder 2021
- Prof. Saeed Moghaddam*
- *Honors*
 - University of Florida Term Professorship Award 2021-2023
 - Fellow, American Society of Mechanical Engineers (ASME) 2020-present
 - William Powers Professor 2021-present
 - Knox T. Millsaps Professor 2019-2021
 - *Conference Leadership*
 - HEFAT-ATE Technical Program Committee 2022
 - Micro Flow and Interfacial Phenomena (μ FIP) Conference Planning Committee 2021
 - Panel lead: Emerging Technologies & Florida's Renewable Energy Future, Florida Energy and Climate Summit 2021
 - ASHRAE Technical Committee TC8.10 2021-present
 - ASHRAE Technical Committee TC8.3 2018-present
- Prof. Toshikazu Nishida*
- *Honors*
 - Associate Dean of Academic Affairs 2017-present
- Prof. Mark Sheplak*
- *Honors*
 - ASA Fellow 2009-present
- Prof. Roozbeh Tabrizian*
- *Honors*
 - DARPA Young Faculty Award (YFA) Class of 2019 2019-2022
 - 2018 National Science Foundation (NSF) CAREER Award 2018-2023
 - UF Research Foundation Professorship 2019-2022
 - Alan Hastings Faculty Fellow Award 2020-2023
 - DARPA Director's Fellowship 2021
 - Pramod P. Khargonekar Award 2020-2021

Prof. Yong-Kyu Yoon

- *Conference Technical Program Committee*
 - IEEE ECTC 2021-Present
- *Conference Leadership*
 - Focus/Special Sessions Vice-Chair, IEEE International Microwave Symposium 2021
- *Honors*
 - Teacher of the Year: UF ECE GSO 2021

Educational Activities

Ph.D. Graduates (12)

Graduate student	Advisor	Title
Sara Mills	Andrew	Fabrication of thick and stable magnetic nanoparticle films via electrophoretic deposition for power component applications
Prabal Tiwari	Andrew	Kinetics of electrophoretic deposition for efficient and scalable assembly of nanomaterials
Connor Smith	Arnold	Magnetic 0-3 Nanocomposites for Power, Stretchable/Flexible, and Radio-Frequency Applications
Yuzheng Wang	Arnold	Development of Ultrathick Electroplated CoPt Magnets and their Application in Electro-Permanent Magnet Device
Kartik Sondhi	Nishida/Fan	Materials and methods for fabrication of multi-layer circuits and devices
Pablo Dopico	Fan	Isolation of Circulating Tumor Cells using Microfluidics and the Analysis of Tumor DNA during Cancer Therapy
Haoran Wang	Feng	Development of piezoelectric micromachined ultrasonic transducers (pMUTs) for endoscopic photoacoustic imaging applications
Meisam Habibimatin	Moghaddam	Science of thin liquid films formation, evaporation and motion in microchannels
Brett Freidkes	Sheplak	The Design and Characterization of a MEMS-Based Dual-Axis Wall Shear Stress Sensor
Dingkang Wang	Sanjeev Koppal (for Huikai Xie)	Quasi-static Scanning and Monolithic Forward Scanning Electrothermal MEMS Mirrors for LiDAR
Renuka Bowrothu	Yoon	Energy Efficient Passives for 5G and Millimeter Wave Applications
Dong Zheng	Yoon	An Integrated Dual Vertical MEMS Mirror and Its Application to Forward-Scan Endoscopic Optical Coherence Tomography

New Alumni

Alumnus	Degree	Advisor	Company
Sara Mills	Doctorate	Andrew	Naval Research Laboratory
Prabal Tiwari	Doctorate	Andrew	Entegris
Connor Smith	Doctorate	Arnold	US Naval Academy

Yuzheng Wang	Doctorate	Arnold	Intel
Kartik Sondhi	Doctorate	Nishida/Fan	Western Digital
Pablo Dopico	Doctorate	Fan	Resilience international
Haoran Wang	Doctorate	Feng	Applied Materials
Meisam Habibimatin	Doctorate	Moghaddam	Purdue
Brett Freidkes	Doctorate	Sheplak	IC2
Dingkang Wang	Doctorate	Sanjeev Koppal (Huikai Xie)	Texas Instruments
Renuka Bowrothu	Doctorate	Yoon	Apple
Dong Zheng	Doctorate	Yoon	

Classroom Instruction

Spring 2021

Instructor	Course Number	Course Name	Enrolled
Andrew	EMA3011	Fundamental Principles of Materials	40
Andrew	EMA6313	Structure & Mechanics of Materials	64
Arnold	EEL 3008	Physics of EE	100
Arnold	EGN 6933	Engineering Faculty Development	27
Feng	EEE 6465	Design of MEMS Transducers	10
Judy	EEL 6935	Nanotech Medical Devices	4
Tabrizian	EEE 4222 EEE 5225	Resonant MEMS	7 6
Yoon	EEL5426	RF/microwave Passive Circuits	14
Yoon	EEE5354L	Semiconductor Device Fabrication Lab	21

Fall 2021

Instructor	Course Number	Course Name	Enrolled
Andrew	EMA3050	Intro Inorganic Materials	58
Arnold	EEL 3008	Physics of Electrical Engineering	53
Fan	EGN 3353c	Fluid Mechanics	74
Fan	BME 5580	Microfluids/BioMEMS	8
Feng	EEL 4930 EEL 5934	Intro to Quantum Devices & Quantum Eng.	6 6
Moghaddam	EML 6154	Conduction Heat Transfer	25
Sheplak	EGN 3353C	Fluid Mechanics	118
Tabrizian	EEL 5225	Principles of Microelectric Mechanisms	14
Yoon	EEL 4930 EEL 5934	Introduction to RF Circuits	10 11
Yoon	EEE 5354L	Semiconductor Device Fabrication Lab	16

IMG Seminars Series

Supported by the IMG Alumni fund

Date	First speaker	Second speaker
3/5/2021	Dr. Kevin Tang (Invited Speaker – UF) “Quantifying Lenition with Posterior Phonological Probabilities: a Preliminary Study”	
3/19/2021	Dr. Sherya Saxena (Invited Speaker – UF) “Modeling Neural Activity and Ongoing Behavior to Illuminate Neural Dynamics”	
4/2/2021	Mr. YunPeng Zhao (Invited Speaker – UF) “Public health surveillance using social media data”	
9/3/2021	Dr. Changchun Liu (Invited Speaker- University of Connecticut) “Point-of-Care Medical Devices for Infectious Disease Diagnostics”	
9/17/2021	Dr. Farimah Farahmandi (Invited Speaker- UF) “Vulnerability Assessments of ICs Against Fault-Injection Attacks”	
10/1/2021	Dr. Erin Patrick (Invited Speaker- UF) “Using the Laplace and Poisson Equations in Physical Modeling”	Dr. Jaesung Lee (Invited speaker- UF), “Design of Strongly Nonlinear Graphene Nanoelectromechanical Systems in Quantum Regime”
10/15/2021	Dr. Yu Wang (Invited Speaker-UF) “Data-Driven Process Design and Planning by Reinforcement Learning”	
10/29/2021	Dr. Shreya Saxena (Invited Speaker- UF) TBD	Dr. Halim Miah (Invited Speaker-UF) “A Dual-Transduction Receiver for Electrodynamic Wireless Power Transfer”
11/12/2021	Dr. Edward Kluender (Invited Speaker- Zurich Instruments) “Lock-in Amplifiers”	
12/3/2021	James Fleetwood (Invited Speaker- UF) “Laboratory Safety”	

Research Activities

In the year 2021, IMG had active research projects funded through the federal, industry (including the MIST Center), other, and UF-internal sponsors.

Federal Sponsorship

Title of Grant	Faculty Member	Funding Agency	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
The Emergence of Ferroic Phenomena and Size-Effects in Fluorite-Based Nanoparticles	Andrew	NSF	\$360,282	\$71,378
SNM: Batch Manufacturing of Integrated Magnetic Devices	Andrew	NSF	\$587,693	\$62,335
Phase II IUCRC University of Florida: Center for Multi-functional Integrated System Technology (MIST)	Andrew	NSF	\$40,872	\$46,923
Collaborative: Controlling Large Microrobot Teams	Arnold	NSF	\$295,191	\$88,230
Magnetic Thick Films for Integrated Microwave Devices	Arnold	ARO (DARPA)	\$837,078	\$187,095
SNM: Large Area Manufacturing of Integrated Magnetic Devices	Arnold	NSF	\$446,515	\$176,258
NSF Engineering Research Center for Internet of Things for Precision Agriculture (IoT4Ag)	Arnold	UPenn (NSF)	\$536,653	\$353,788
Phase II IUCRC University of Florida: Center for Multi-functional Integrated System Technology (MIST)	Arnold	NSF	\$45,955	\$46,923
Phase II IUCRC at University of Virginia	Arnold	UVA (NSF)	\$27,982	\$15,183
Phase II IUCRC University of Central Florida	Arnold	UCF (NSF)	\$27,982	\$17,565
A Rapidly Deployable, Inexpensive and Easy-to-use In Situ Detector for Aerosolized SARS-CoV-2	Fan	Aerosol Devices (DoD)	\$161,029	\$98,442
Multiplexed Detection of Mosquito-Borne Viruses at the Point-of-Care	Fan	NIH	\$537,078	\$192,008
Multiplexed Airborne Virus Collection and Detection at the Point-of-Care	Fan	NIH	\$288,739	\$101,454
Novel Methods of Chemosensitizing Low-proliferative Disseminated Tumor Cells	Fan	NIH	\$122,137	\$37,727

in Triple Negative Breast Cancer				
A multimodal imaging system and targeted nanoprobes for image guided treatment of breast cancer	Feng	USF (NIH)	\$461,546	\$111,314
Radiation Effects in Nanoscale Electromechanical Logic Devices: Pathways Toward Robust Computing in Extreme Environment	Feng	DTRA	\$350,000	\$111,324
Collaborative Research: Harnessing Crystalline Phase Transition in 2D Materials for Ultra-Low-Power and Flexible Electronics	Feng	NSF	\$145,121	\$60,195
CAREER: Dynamically Tuning 2D Semiconducting Crystals and Heterostructures for Atomically-Thin Signal Processing Devices and Systems	Feng	NSF	\$224,526	\$139,008
EFRI ACQUIRE: A Scalable Integrated Quantum Photonic Interconnect	Feng	NSF	\$156,401	\$150,669
Collaborative Research: FET: Small: Massive Scale Computing & Optimization through On-chip Parametric Oscillating Machines (OPTIMA)	Feng	NSF	\$220,000	\$62,441
Planning Grant: Engineering Research Center for Neural Engineered Systems with Societal Impact	Judy	NSF	\$100,000	\$40,787
Reliable Miniature Implantable Connectors with High Channel Density for Advanced Neural-Interface Applications	Judy	NIH	\$407,206	\$89,827
Tissue Engineered Electronic Neural Interface (TEENI)	Judy	NIH	\$800,499	\$268,658
Membrane-Based Ionic Liquid Absorption System for Ultra-Efficient Dehumidification And Heating	Moghaddam	DOE	\$1,081,169	\$356,685
Deciphering the Physics of Critical Heat Flux (CHF)	Moghaddam	NSF	\$349,996	\$82,038
Characterization of Critical Two-Phase Flow Regimes for Design and Reliable Operation of Compact Naval Energy Systems	Moghaddam	ONR	\$408,377	\$67,548

Physics of High-Quality Phase Change Under Extreme Confinement	Moghaddam	ONR	\$158,306	\$55,000
Phase II IUCRC University of Florida: Center for Multifunctional Integrated System Technology (MIST)	Nishida	NSF	\$263,173	\$89,676
Stress-Mediated Sc-Doped AlN Ferroelectric Transducer for Intrinsically Configurable Solidly Mounted Filter Array	Nishida	DARPA	\$24,324	\$932
Examination of Pressure and Velocity Fields and Their Relationships to Radiated Noise in a Jet	Sheplak	NSF	\$164,963	\$0
A Flat-Packed Optical Shear Stress Sensor Using Moir Transduction for Harsh Environments	Sheplak	NASA	\$55,000	\$20,855
Stress-Mediated Sc-Doped AlN Ferroelectric Transducer for Intrinsically Configurable Solidly Mounted Filter Array	Tabrizian	DARPA	\$917,759	\$661,641
Ferroelectrically Transduced Ge Nano-Fin Bulk Acoustic Resonators for Chip-Scale Instinctually Adaptive RF Spectral Processing	Tabrizian	DARPA	\$750,000	\$396,028
CAREER: Active Nano-Acoustic Waveguide Matrix to Tackle Signal Processing Limits	Tabrizian	NSF	\$500,000	\$82,034
Selective Doping of Embedded Si Nanowires for Self-Amplified Nano-resonators	Tabrizian	Sandia National Labs	\$3,125	\$1,407
Hardware-in-the-Loop Simulator Development	Yoon	Eglin AFB	\$85,340	\$30,693
STTR: Low Loss, High Gain Glass Based Radar Arrays	Yoon	Mosaic Microsystems (USAF)	\$75,000	\$75,000
STTR: Low Loss, High Gain Glass Based Radar Arrays	Yoon	Mosaic Microsystems (USAF)	\$300,366	\$79,557
Energy Dense and High Rate Electrochemical Capacitors: Advanced Nanomanufacturing and Designer Electrolytes	Yoon	Mainstream Engineering (AFOSR)	\$107,477	\$0
Magnetic Thick Films for Integrated Microwave Devices	Yoon	DARPA	\$282,850	\$137,368
IRES Track I: Collaborative	Yoon	NSF	\$29,328	\$5,627

Research: Interdisciplinary Research in Korea on Applied Smart Systems (IRiKA) for Undergraduate Students				
SenSE: Smart Electropalography for Linguistic and Medical Applications (SELMA)	Yoon	NSF	\$373,290	\$150,652
Collaborative Research: SWIFT: LARGE: MAC-on-MAC: A Spectrum Orchestrating Control Plane for Co-existing Wireless Systems	Yoon	NSF	\$250,035	\$55,444
Total			\$13,110,328	\$4,822,273

Other Sponsorship

Title of Grant	Faculty Member	Funding Agency	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
Symbiosis in Aquatic Systems: Magnetic Nanoparticles and Symbiosis	Arnold	Moore Foundation	\$94,163	\$16,630
Intra-/Inter Chip RF Interface	Yoon	Seoul National University	\$251,104	\$109,000
Total			\$345,267	\$125,630

Industry Sponsorship (including NSF I/UCRC MIST Center Sponsorship)

Title of Grant	Faculty Member	Funding Agency	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
MIST Center Projects (Phase 1)	Nishida	Multiple Sponsors	\$64,414	\$5,858
MIST Center Projects (Phase 2)	Fan	Multiple Sponsors	\$75,000	\$22,397
MIST Center Projects (Phase 2)	Nishida	Multiple Sponsors	\$255,000	\$89,676
MIST Center Projects (Phase 2)	Sheplak	Multiple Sponsors	\$175,000	\$104,857
MIST Center Projects (Phase 2)	Yoon	Multiple Sponsors	\$50,000	\$896
Self-Powered Micromechanical Wireless Temperature Sensors	Feng	Contitech USA	\$29,999	\$27,382

Thermally Driven Industrial Semi-Open Absorption Heat Pump Dryer	Moghaddam	Micro Nano Technologies	\$49,515	\$14,062
Capacitive Vector Skin Friction Measurement Systems for Complex Flow Fields	Sheplak	IC2	\$99,999	\$48,874
Autonomous Missile Detection using Bio-Inspired Sensors	Yoon	Quantum Ventura	\$25,000	\$6,322
Total			\$823,927	\$320,324

Internal Sponsorship

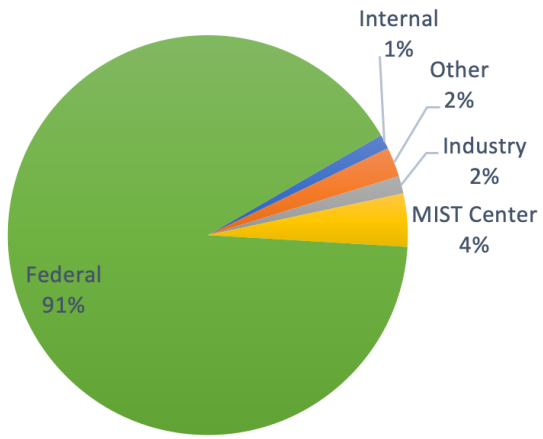
Title of Grant	Faculty Member	Funding Agency	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
Ross Professorship	Andrew	UF Foundation	\$97,405	\$25,630
Development of a Point-of-Care Platform for HIV Viral Load Testing	Fan	UF Office of Research	\$63,777	\$33,347
DSR Matching Support for NSF Fellowship	Sheplak	UF Office of Research	\$8,999	\$8,865
Total			\$170,181	\$67,842

Research Financial Summary

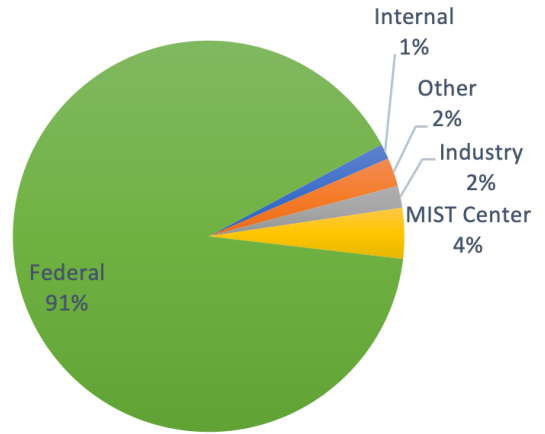
Total Funding

	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
Total	\$14,449,703	\$5,336,069

Research Awards



Research Expenditures



Publications

Editorial Advisory Boards

- Jennifer Andrew: Associate Editor, *IEEE Trans. Nanobioscience* 2015-present
- David Arnold: Editorial Board, *Micromachines* 2019-present
- David Arnold: Editorial Board, *J. Micromachines and Microengineering* 2013-present
- Z. Hugh Fan: Editorial Board, *Scientific Reports* 2013-present
- Z. Hugh Fan: Associate Editor, *Microsystems and Nanoengineering* 2017-present
- Z. Hugh Fan: Editorial Board, *Biosensors* (MDPI), 2020-present
- Philip Feng: Associate Editor, *IEEE Trans. Ultrasonics, Ferroelectrics, and Frequency Control* 2018-present
- Philip Feng: Associate Editor, *Frontiers in Mechanical Engineering – Micro- and Nanoelectromechanical Systems* 2016-present
- Toshi Nishida: Editorial Board, MDPI Sensors 2015-present
- Mark Sheplak: Associate Editor, *JASA Express Letters Transduction Acoustical Devices for the Generation & Repro of Sound* 2011-present
- Roozbeh Tabrizian: Topic Editor, *Micromachines* 2020-present
- Y.K. Yoon, Editor, *Micro and Nano Systems Letters* 2017-present
- Y.K. Yoon, Associate Editor, *IEEE Trans. Components, Packaging and Manufacturing Technology* 2018-present

Reviewers for Scholarly Journals

- Accounts of Chemical Research
- ACS Nano
- ACS Photonics
- Advanced Photonics Research
- Applied Physics Letters
- IEEE Electron Device Letters
- IEEE Journal of Microelectromechanical Systems (JMEMS)
- IEEE Transactions on Electron Devices
- IEEE Transactions on Nuclear Science
- Journal of Applied Physics
- J. Microelectromechanical Systems
- J. of Micromechanics & Microengineering
- Lab on a Chip
- Micromachines
- Nano Letters
- Nano Today
- Nanophotonics
- Nature Communications
- Nature Electronics
- Optica
- Optics Express
- Optics Letters
- Physica Status Solidi (RRL)
- Photonics Research
- Science Advances
- Sensors & Actuators: A. Physical
- Small
- Trans. Antennas and Propagation

Peer-reviewed journals (49)

- Bhanvadia, R. T. Farley, Y. Noh, and T. Nishida, "High-resolution stereolithography using a static liquid constrained interface," *Communication Materials* 2, 1-7 (2021)
- Renuka Bowrothu, Haein Kim, Seahee Hwangbo, and YK Yoon, "High-Radiation Efficiency in Array Antennas Using Cu/Co Metaconductors," *IEEE Transactions on Antennas and Propagation*, vol. 69, no. 11, pp. 7993 – 7998, Oct. 2021 (6 pages), DOI: 10.1109/TAP.2021.3083814

- P. Chojecki, G. Walters, Z. Forrester, and T. Nishida, "Preisach modeling of imprint on hafnium zirconium oxide ferroelectric capacitors," *J. Appl. Phys.* 130, 094102 (2021); <https://doi.org/10.1063/5.0053185RJ98>
- H. O. Fasanya, P. J. Dopico, Z. Yeager, Z. H. Fan, D. W. Siemann, "Using a combination of gangliosides and cell surface vimentin as surface biomarkers for isolating osteosarcoma cells in microfluidic devices", *Journal of Bone Oncology*,28,2021, 100357 (8 pages)
- N. D. Ferson, A. M. Uhl, J. S. Andrew, Piezoelectric and Magnetolectric Scaffolds for Tissue Regeneration and Biomedicine; A Review, *IEEE Trans. Ultrasonics, Ferroelectrics, and Frequency Control*, 68, 229, 2021.
- Gao, N. Kumar, Z. Yang, K. Gluesenkamp, A. Abuheiba, S. Moghaddam, and V. Baxter, "Internally Cooled Membrane-based Absorber for Dehumidification and Water Heating: Validated Model and Simulation Study," *Energy Conversion and Management*, vol. 230, February 15, 2021.
- T. J. George, A. Ali, Y. Wang, J. Lee, A. M. Ivey, D. DeRemer, K. C. Daily, C. J. Allegra, S. J. Hughes, Z. H. Fan, M. E. Cameron, A. R. Judge, J. G. Trevino, "Phase II study of 5-fluorouracil, oxaliplatin plus dasatinib (FOLFOX-D) to promote inhibition of Src in first-line metastatic pancreatic adenocarcinoma", *The Oncologist*, 26,2021, 1-12, DOI: 10.1002/onco.13853
- Hakim, T. Tharpe, and R. Tabrizian, "Ferroelectric-on-Si Super-High-Frequency Fin Bulk Acoustic Resonators with Hf_{0.5}Zr_{0.5}O₂ Nano-Laminated Transducers," *IEEE Microwave and Wireless Components Letters*, vol. 31, no. 6, pp. 701-704, June 2021.
- M.A. Halim, A.A. Rendon-Hernandez, S.E. Smith, J.M. Samman, N. Garraud, and D.P. Arnold, "A chip-sized piezoelectric receiver for low-frequency, near-field wireless power transfer: design, modeling and experimental validation," *Smart Mat. Syst.*, vol. 30, no. 4, 045011, 11 pages, Mar. 2021.
- M.A. Halim, A.A. Rendon-Hernandez, S.E. Smith, J.M. Samman, N. Garraud, and D.P. Arnold, "Miniature electrodynamic wireless power transmission receiver using a micromachined silicon suspension," *J. Microelectromech. Syst.*, vol. 30, no. 1, pp.144-155, Feb. 2021.
- X. Jiang, J. C. Loeb, M. Pan, T. B. Tilly, A. Eiguren-Fernandez, J. A. Lednicky, C.-Y. Wu, Z. H. Fan, "Integration of Sample Preparation with RNA-Amplification in a Hand-Held Device for Airborne Virus Detection", *Analytica Chimica Acta*, 1165,2021, 338542 (9 pages), DOI: 10.1016/j.aca.2021.338542
- Mary Kasper, Bret Ellenbogen, Ryan Hardy, Madison Cydis, Jorge Mojica-Santiago, Abdullah Afridi, Benjamin S. Spearman, Ishita Singh, Cary A. Kuliasha, Eric Atkinson, Kevin J. Otto, Jack W. Judy, Carlos Rinaldi-Ramosba, Christine E. Schmidt, "Development of a magnetically aligned regenerative tissue-engineered electronic nerve interface for peripheral nerve applications." *Biomaterials* 279 (2021):121212.
- Cary A .Kuliasha, and Jack W. Judy. "The Materials Science Foundation Supporting the Microfabrication of Reliable Polyimide–Metal Neuroelectronic Interfaces. " *Advanced Materials Technologies* 6, no. 6 (2021): 2100149.
- O. L. Lanier, C. Velez, D. P. Arnold, and J. Dobson, "Model of magnetic particle capture under physiological flow rates for cytokine removal during cardiopulmonary bypass," *IEEE Trans. Biomed. Eng.*, vol. 68, no. 4, pp. 1198-1207, Apr. 2021.
- N. Le, Z. H. Fan, "Exosome Isolation Using Nanostructures and Microfluidic Devices", *Biomedical Materials*, 16,2021, 022005 (23 pages).
- Lee J, Feng PXL, "Self-Sustaining MoS₂ Nanomechanical Oscillators and Feedback Cooling", *Applied Physics Letters* 119,243506 (2021). DOI:10.1063/5.0063079.
- Woosol Lee, Suk-il Choi, Hae-In Kim, Sunghyun Hwang, Saeyeong Jeon, and Yong-Kyu Yoon, "Metamaterial-integrated high gain rectenna for RF sensing and energy harvesting applications," *Sensors*, vol. 21, no. 19, 6580, Oct. 1, 2021, DOI: 10.3390/s21196580.

- H. Li, S. N. Shankar, C. T. Witanachchi, J. A. Lednicky, J. C. Loeb, M. M. Alam, Z. H. Fan, K. Mohamed, A. Eiguren-Fernandez, C. Y. Wu, "Environmental surveillance and transmission risk assessments for SARS-CoV-2 in a fitness center", *Aerosol and Air Quality Research*, 21,2021, 210106 (14 pages), DOI:10.4209/aaqr.210106.
- Liu X, Islam A, Yang N, Odhner B, Tupta MA, Guo J, Feng PXL, "Atomic Layer MoTe₂ Field-Effect Transistors and Monolithic Logic Circuits Configured by Scanning Laser Annealing", *ACS Nano* 15,19733-19742(2021). DOI:10.1021/acsnano.1c07169.
- Manos M. Tentzeris, Omeed Momeni, and Yong-Kyu Yoon, "IMS 2021 Focus Sessions," *IEEE Microwave Magazine*, May 2021, pp. 38, 59
- Manzanas, M. M. Alam, J. C. Loeb, J. A. Lednicky, C. Y. Wu, Z. H. Fan, "A Valve-Enabled Sample Preparation Device with Isothermal Amplification for Multiplexed Virus Detection at the Point-of-Care", *ACS Sensors*, 6,2021, 4176–4184, DOI: 10.1021/acssensors.1c01718.
- Matin, M.H. and Moghaddam, S. "On the extension of Bretherton theory for thin liquid films formed around elongated bubbles," *Physics of Fluids*, Vol. 33, Issue 12, Article 123303, 2021.
- Matin, M.H. and Moghaddam, S. "Mechanism of transition from elongated bubbles to wavy-annular regime in flow boiling through microchannels," *International Journal of Heat and Mass Transfer*, Vol. 176, Article 121464, 2021.
- S. C. Mills, N. Starr, N. Bohannon, J. S. Andrew, Chelating agent functionalized substrates for the formation of thick films via electrophoretic deposition, *Frontiers in Chemistry*, 9, 460, 2021.
- Mobini, Sahba, Cary A. Kuliasha P, Zachary A. Siders, Nicole A. Bohmann, Syed-Mustafa Jamal, Jack W. Judy, Christine E. Schmidt, and Anthony B. Brennan."Microtopographical patterns promote different responses in fibroblasts and Schwann cells: A possible feature for neural implants." *Journal of Biomedical Materials Research Part A* 109, no. 1 (2021): 64-76.
- North, Richard B., Peter E. Konrad, Jack W. Judy, Andrew J. Ries, and Robert Stevenson. "Examining the Need to Standardize Implanted Stimulator Connectors: NANS Survey Results." *Neuromodulation: Technology at the Neural Interface* 24, no.8 (2021): 1299-1306.
- Peng and S. Moghaddam, "Experimental evaluation and kinetic analysis of direct-contact ultrasonic fabric drying process," *Journal of Thermal Science and Engineering Applications*, vol. 13, 2021.
- M. Ramezani, V. Felmetsger, N. Rudawski, and R. Tabrizian, "Growth of C-Axis Textured AlN Films on Vertical Sidewalls of Silicon Micro-Fins," *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*, vol. 68, no. 3, pp. 753-759, March 2021.
- S. Rassay, F. Hakim, C. Li, C. Forgey, and R. Tabrizian, "A segmented-target sputtering process for growth of sub-50 nm ferroelectric scandium aluminum nitride films with composition and stress tuning," *Physica Status Solidi RRL*, vol. 15, no. 5, p. 2100087, April 2021.
- A. Rendon-Hernandez, S. E. Smith, M. A. Halim, and D. P. Arnold, "Hybrid piezo/magnetic electromechanical transformer," *Micromachines*, vol. 12, no. 10,1214, 18 pages, Oct. 2021.
- R. Rode, H. Chung, H. Miller, T. Gaborski, and S. Moghaddam, "Trilayer Interlinked Graphene Oxide Membrane for Wearable Hemodialyzer," *Advanced Material Interfaces*, vol. 8, Issue 3 (2001985), February 5, 2021.
- Shekhawat, A., Hsain, A., Lee, Y. H., Jones, J. L., & Moghaddam, S. "Effect of ferroelectric and interface films on the tunneling electroresistance of the Al₂O₃/Hf_{0.5}Zr_{0.5}O₂ based ferroelectric tunnel junctions," *Nanotechnology*, Vol. 32 (48), 485204, 2021.
- C.S. Smith, R. Bowrothu, Y. Wang, F. Herrault, Y.K. Yoon, and D.P. Arnold, "Screen-printable, self-biased SrM/PDMS composites for integrated magnetic microwave devices," *IEEE Trans. Magn.*, vol. 57, no. 10,2800905, 5 pages, Oct. 2021.
- S.E. Smith, M.A. Halim, S.T. Chyczewski, A.A. Rendon-Hernandez, and D.P. Arnold, "A wirelessly rechargeable AA battery using electrodynamic wireless power transmission," *Energies*, vol. 14, no. 9, 2368, 14 pages, Apr. 2021.

- K. Sondhi, S. Avuthu, J. Richstein, Z. H. Fan, T. Nishida, "Fabrication and non-destructive characterization of Through-Plastic-Via (TPV) in Flexible Hybrid Electronics", *Flexible and Printed Electronics*, 6,2021, 025001 (12 pages)
- Sui W, Zheng XQ, Lin J-T, Alphenaar BW, Feng PXL, "Thermal Response and TCf of GaN/AlN Heterostructure Multimode Micro String Resonators from -10°C to 325°C", *Journal of Microelectromechanical Systems* 30,521-529 (2021). DOI:10.1109/JMEMS.2021.3089703. [Featured as 1 of the 3 "JMEMS Right Now Papers" in the August 2021 Issue]
- R. Tabrizian and S. Bhunia, "The Hidden Authenticators: Nanometer-Scale Electromechanical Tags Could Thwart Counterfeiters," *IEEE Spectrum*, 58.6 (2021): 32-37.
- Tamvada, S.R., Alipanah M., and Moghaddam, S. "Membrane-based two-phase heat sinks for high heat flux electronics and lasers," *IEEE Transactions on Components, Packaging and Manufacturing Technology*, Vol. 11, Issue 10, 2021.
- T. Tharpe, X. Zheng, P. Feng, and R. Tabrizian, "Resolving Mechanical Properties and Morphology Evolution of Free-Standing Ferroelectric Hf_{0.5}Zr_{0.5}O₂," *Advanced Engineering Materials*, 23 (12), 2101221, Dec. 2021. [Main Cover Featured, December 2021 Issue]
- G. Walters, P. Chojcecki, Z. Forrester, and T. Nishida, "Thermal retention of atomic layer deposited Hf_{0.5}Zr_{0.5}O₂ films using H₂O and O₂-H₂ plasma oxidation methods," *Appl. Phys. Lett.* 118, 032904 (2021)
- Wang H, Yang H, Chen Z, Zheng Q, Jiang H, Feng PXL, Xie H, "Development of Dual-Frequency pMUT-Arrays Based on Thin Ceramic PZT for Endoscopic Photoacoustic Imaging", *Journal of Microelectromechanical Systems* 30,770-782 (2021). DOI:10.1109/JMEMS.2021.3096733. [Featured as 1 of the 3 "JMEMS Right Now Papers" in the October 2021 Issue]
- Y. Wang, B.Y. Jimenez, C.S. Smith, A.A. Rendon-Hernandez, J. Samman, and D.P. Arnold, "Microfabricated electro-permanent magnets using AlNiCo and CoPt," *IEEE Magn. Lett.*, vol. 12,7502405, 5 pages, Aug. 2021.
- Wang Y, Lee J, Berezovsky J, Feng PXL, "Cavity Quantum Electrodynamics Design with Single Photon Emitters in Hexagonal Boron Nitride", *Applied Physics Letters* 118, 244003 (2021). DOI:10.1063/5.0046080.
- Wang Y, Lin Q, Feng PXL, "Single-Crystal 3C-SiC-on-Insulator Platform for Integrated Quantum Photonics", *Optics Express* 29(2),1011-1022 (2021). DOI:10.1364/OE.413556.
- Wang Z, Yang R, Feng PXL, "Thermal Hysteresis Controlled Reconfigurable MoS₂ Nanomechanical Resonators", *Nanoscale* 13,18089-18095 (2021). DOI:10.1039/D1NR03286K.
- Wong, Joshua K., Wei Hu, Ryan Barmore, Janine Lopes, Kathryn Moore, Joseph Legacy, Parisa Tahafchi, Zachary Jackson, Jack W. Judy, Robert S. Raike, Anson Wang, Takashi Tsuboi, Michael S. Okun, and Leonardo Almeida, "Safety and Tolerability of Burst-Cycling Deep Brain Stimulation for Freezing of Gait in Parkinson's Disease." *Frontiers in Human Neuroscience* 15 (2021): 208.
- Xie Y, Lee JS, Wang Y, Feng PXL, "Straining and Tuning Atomic Layer Nanoelectromechanical Resonators via Comb-Drive MEMS Actuators", *Advanced Materials Technologies* 6(2), 2000794(2021). DOI:10.1002/admt.202000794. [Highlighted as Inner Cover]
- Ye F, Islam A, Zhang T, Feng PXL, "Ultrawide Frequency Tuning of Atomic Layer van der Waals Heterostructure Electromechanical Resonators", *Nano Letters* 21,5508-5515 (2021). DOI:10.1021/acs.nanolett.1c00610.
- Zheng XQ, Zhao H, Jia Z, Tao X, Feng PXL, "Young's Modulus and Corresponding Orientation in β -Ga₂O₃ Thin Films Resolved by Nanomechanical Resonators", *Applied Physics Letters* 119,013505(2021). DOI:10.1063/5.0050421.

Conference Publications (29)

- M. Alipanah, X. Jiang, C. Manzanos, J. C. Loeb, M. Pan, T. B. Tilly, J. A. Lednicky, C.-Y. Wu, Z. H. Fan, "Integration of Sample Preparation with RNA Amplification Device for Influenza Virus Detection", in *Proceedings of the 25th International Conference on Miniaturized Systems for Chemistry and Life Sciences (μ TAS'2021)*, Oct. 10-14, **2021**, Palm Springs, CA, p37-38.
- R. Bowrothu, H. Kim, C. Smith, D. Arnold, Y.K. Yoon, "Magnetically tunable 28 GHz array antenna using BaM/PDMS composite," 2021 IEEE Intl. Symposium on Antennas and Propagation and USNC-URSI Radio Science Meeting, Marina Bay Sands, Singapore, Dec.2021.
- R. Bowrothu, H. Kim, C.S. Smith, X.N. Guan, S. Cui, F. Herrault, D.P. Arnold, and Y.K. Yoon, "Batch-fabricated substrate-embedded Ka band self-biased circulators using screen-printed strontium hexaferrite/PDMS composite," Tech. Dig. Intl. Microwave Symposium, Atlanta, GA, June 2021, pp.323-326.
- Renuka Bowrothu, Yong Kyu Yoon, Stephan Schmidt, and Rafael Santos, "Low Loss Cu/Co Multilayer Metaconductor Based Band Pass Filter Using Through Fused Silica Via (TFV) Technology," *IEEE 71st Electronic Components and Technology Conference (ECTC)*, June 1 – July 4, 2021 (6 pages), Virtual.
- Hyunho Cho, Woosol Lee, and Yong-Kyu Yoon, "Highly Compact Array MIMO Module for EMI Immune 5G Wireless Communications," *IEEE International Microwave Symposium 2021*, Atlanta, GA, June 7 – 10 (Live Event), June 20 – 25 (Virtual Event), 2021 (4 pages).
- Hyunho Cho and Yong-Kyu Yoon, "Parallely and Diagonally Placed Meander-Line Slot Resonators for Mutual Coupling Reduction in a 2 x 2 Patch Array Antenna," *IEEE Wireless and Microwave Technology Conference 2020-2021*, April 28 – 29, 2021, Virtual.
- M. Ghatge, M. Rais-Zadeh, and R. Tabrizian, "High-Q Gallium Nitride Thickness-Shear Baw Resonators with Reduced Temperature Sensitivity," 21st International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers), 2021, pp. 1400-1403.
- M.A. Halim, S.E. Smith, A.A. Rendon-Hernandez, and D.P. Arnold "Electromechanical modeling and experimental validation of a dual-transduction electrodynamic wireless power receiver," Tech. Dig. 21st Int. Conf. Solid-State Sensors, Actuators, and Microsystems (Transducers 2021), virtual meeting, June 2021, pp. 1335-1338.
- C. R. Kagan, D. P. Arnold, M. G. Allen, and R. H. Olsson, "IoT4Ag: MEMS-enabled distributed sensing, communications, and information systems for the internet of things for precision agriculture" Proc. 34th IEEE Intl. Conf. Micro Electro Mechanical Systems (MEMS 2021), virtual meeting, Jan.2021, pp.350-353. (Invited)
- Hae-In Kim, Renuka Bowrothu, Woosol Lee, and Yong-Kyu Yoon, "Ultra-High Q-factor Through Fused-silica Via (TFV) Integrated 3D Solenoid Inductor for Millimeter Wave Applications," *IEEE 71st Electronic Components and Technology Conference (ECTC)*, June 1 – July 4, 2021 (6 pages), Virtual.
- Hae-In Kim, Renuka Bowrothu, and Yong-Kyu Yoon, "Cu/Co metaconductor based coplanar waveguide with sub 0.1 dB/mm insertion loss at 28 GHz," *IEEE International Microwave Symposium 2021*, Atlanta, GA, June 7 – 10 (Live Event), June 20 – 25 (Virtual Event), 2021 (4 pages).
- M. N. Le, D. Chen, K. A. Smith, D. D. Tran, Z. H. Fan, "Microfluidic Isolation and Release of Triple-Negative Breast Cancer Cells in Bone Marrow", in *Proceedings of the 25th International Conference on Miniaturized Systems for Chemistry and Life Sciences (μ TAS'2021)*, Oct. 10-14, 2021, Palm Springs, CA, p631-632.
- Woosol Lee, Hae-in Kim, Sunghyun Hwang, Saeyeong Jeon, Hyunho Cho, and Yong-Kyu Yoon, "3D integrated high gain rectenna in package with metamaterial superstrates for high efficiency wireless power transfer applications," *IEEE 71st Electronic Components and Technology Conference (ECTC)*, June 1 – July 4, 2021 (6 pages), Virtual.

- Woosol Lee and Yong-Kyu Yoon, "High Efficiency Metamaterial-based Multi-scale Wireless Power Transfer for Smart Home Applications," *IEEE International Microwave Symposium 2021*, Atlanta, GA, June 7 – 10 (Live Event), June 20 – 25 (Virtual Event), 2021 (4 pages).
- Liu Y, Wang Y, Zheng XQ, Lin Q, Feng PXL, "Nanomechanical and Optomechanical Coupling in Silicon Carbide/Hexagonal Boron Nitride Hybrid Resonator", Tech. Digest of the 21st Int. Conf. On Solid-State Sensors, Actuators and Microsystems (Transducers 2021 Virtual Conference), 541-544, Online, June 20-24 (2021).
- C. Manzananas, M. M. Alam, J. C. Loeb, M. Alipanah, J. A. Lednicky, C.-Y. Wu, Z. H. Fan, "Valve-Enabled Sequential Reagent Delivery and Paper-Based Enrichment for Simultaneous Detection of SARS-CoV-2 and Influenza Viruses", in *Proceedings of the 25th International Conference on Miniaturized Systems for Chemistry and Life Sciences (μ TAS'2021)*, Oct. 10-14, 2021, Palm Springs, CA, p837-838.
- C. Manzananas, M. M. Alam, J. C. Loeb, J. A. Lednicky, C.-Y. Wu, Z. H. Fan, "Valve-Enabled Sample Preparation and Isothermal Amplification for SARS-COV-2 Detection at the Point-of-Care", in *Proceedings of the ASME 2021 International Mechanical Engineering Congress and Exposition (IMECE2021)*, November 1-5, 2021, online, IMECE2021-69303, 5 pages.
- Mills, D., Patterson, Underbrink, J.U., and Sheplak, M., "A Flush-Mount, IEPE MEMS Piezoelectric Microphone for Aeroacoustics Applications," AIAA Aviation 2021 Forum, AIAA Paper.
- D. Mo, S. Rassay, and R. Tabrizian, "Intrinsically Switchable Ferroelectric Scandium Aluminum Nitride Bulk Acoustic Wave Resonators," 21st International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers), 2021, pp. 317-320.
- A. Rendon-Hernandez, M. A. Halim, S. E. Smith, and D. P. Arnold, "High-gain ac-dc step-up converter using hybrid piezo/magnetic electromechanical transformer," Proc. 20th Int. Conf. Micro and Nanotechnology for Power Generation and Energy Conversion Apps. (PowerMEMS 2021), virtual conference, Dec. 2021, pp. 56-59.
- Paritosh Rustogi, Abbas Furniturewalla, Erin Patrick, and Jack W. Judy, "Modeling the Impact of Surrounding Dielectric Width on the Range and Shape of the Recording Volume of Disc Microelectrodes." In 2021 10th International IEEE/EMBS Conference on Neural Engineering (NER), pp. 306-309. IEEE, 2021.
- S.E. Smith, M.A. Halim, A.A. Rendon-Hernandez, and D. P. Arnold, "Dual-transduction electromechanical receiver for near-field wireless power transmission," Proc. 34th IEEE Intl. Conf. Micro Electro Mechanical Systems (MEMS 2021), virtual meeting, Jan. 2021, pp.38-41.1.
- Sui W, Zheng XQ, Lin J-T, Alphenaar BW, Feng PXL, "Temperature Dependence of Multi-mode Gallium Nitride/Aluminum Nitride (GaN/AlN) Heterostructure String Resonator", Proc. 34th IEEE Int. Conf. on Micro ElectroMechanical Systems (MEMS 2021), 701-704, Online, January 25-29 (2021).
- T. Tharpe, F. Hakim, and R. Tabrizian, "In-Plane Bulk Acoustic Resonators Using 50nm-Thick Nano-Laminated Ferroelectric Hf_{0.5}Zr_{0.5}O₂," 21st International Conference on Solid-State Sensors, Actuators and Microsystems (Transducers), 2021, pp. 313-316. [Outstanding Paper Award]
- Wang H, Feng PXL, Xie H, "A High-Density and Dual-Frequency PMUT Array Based on Thin Ceramic PZT for Endoscopic Photoacoustic Imaging", Proc. 34th IEEE Int. Conf. on Micro ElectroMechanical Systems (MEMS 2021), 891-894, Online, January 25-29 (2021).
- Wang H, Feng PXL, Xie H, "A Dual-Electrode MEMS Speaker Based on Ceramic PZT with Improved Sound Pressure Level by Phase Tuning", Proc. 34th IEEE Int. Conf. on Micro ElectroMechanical Systems (MEMS 2021), 701-704, Online, January 25-29 (2021).
- Wang H, Yang H, Jiang H, Chen Z, Feng PXL, Xie H, "A Multi-Frequency PMUT Array Based on Ceramic PZT for Endoscopic Photoacoustic Imaging", Tech. Digest of the 21st Int. Conf. On Solid-State Sensors, Actuators and Microsystems (Transducers 2021 Virtual Conference), 30-33, Online, June 20-24 (2021).

- Yang R, Xie M, Jia Y, Duraffourg L, Feng PXL, “Hybrid Nanoelectromechanical Switch and Resistive Memory in Silicon Nanowires by VLSI NEMS”, Proc.34th IEEE Int. Conf. on Micro ElectroMechanical Systems (MEMS 2021), 701-704, Online, January 25-29 (2021).
- Zheng XQ, Feng PXL, “Temperature Coefficient of Resonance Frequency (TCf) of β -Ga₂O₃Nanomechanical Resonators”, Proc.34th IEEE Int. Conf. on Micro ElectroMechanical Systems (MEMS 2021), 701-704, Online, January 25-29 (2021).

Patents Issued (11)

- J. S. Andrew, D. P. Arnold, M. Bauer and X. Wen, “Powerless Magnetic Field Sensing Using Magnetoelectric Nanowires,” U.S. Patent 10,892,399, issued Jan. 12, 2021.
- D. P. Arnold and J. S. Andrew, “Nanocomposite Magnetic Materials for Magnetic Devices and Systems” U.S. Patent 11,062,826, issued July 13, 2021.
- D. P. Arnold and C. V. Cuervo, “Axisymmetric Electropermanent Magnets,” U.S. Patent 10,971,292, issued Apr. 6, 2021.
- D. P. Arnold and N. Garraud, “Characterizing Liquids Using Magnetic Discs,” U.S. Patent 11,054,416, issued July 6, 2021.
- S. Moghaddam, “Liquid desiccant-based dehumidification and cooling system,” US Patent 11,123,682, September 21, 2021.
- R. Tabrizian and M. Ghatge, “Phononic Frequency Synthesizer,” US patent 10,985,741, issued April 20, 2021.
- Yong Kyu Yoon, Justin Correll, Todd R. Schumann, Sheng-Po Fang, and Fong Wong, “Intelligent Fitness and Sports Mouthguard,” US Patent No. 11,109,808, Sep. 7, 2021
- Yong Kyu Yoon, Seahee Hwangbo, and Hae Yong Yang, “Fractal-Rectangular Reactive Impedance Surface for Antenna Miniaturization,” US Patent No. 11,133,601, Sep. 28, 2021
- Yong-Kyu Yoon, Seahee Hwangbo, and Hae Yong Yang, “Point Symmetric Complementary Meander Line Slots for Mutual Coupling Reduction,” US Patent No. 11,005,174, May 11, 2021
- Yong-Kyu Yoon, Todd R. Schumann, Hyup-Jong Kim, and Seahee Hwangbo, “Metaconductor Skins for Low Loss RF Conductors,” US Patent No. 11,005,149, May 11, 2021
- Yong Kyu Yoon, Xiaoyu Cheng, and Gloria Jung A Kim, “Wireless Battery-Free Diagnostic Mouth Guard,” US Patent No. 10,952,674, Mar. 23, 2021

Patent Applications (17)

- D. P. Arnold and C. V. Cuervo, “Axisymmetric Electropermanent Magnets,” U.S. Patent Application 17/188,545, filed Mar. 1, 2021. (CONT)
- D. P. Arnold, M. Miah, A. A. Rendon-Hernandez, and S. E. Smith, “Hybrid Electromechanical Transformer,” U.S. provisional patent application 63/223,756, filed July 20, 2021.
- Z. H. Fan, K. Chen, “Lateral Filter Array Microfluidic Device”, U.S. patent application, 2021/0236992 A1, 2021
- Z. H. Fan, X. Jiang., T. B. Tilly, J. Lednicky, C-Y. Wu, “Apparatus and Method for Performing Microorganism Detection”, U.S. patent application, 2021/0230533A1, 2021.
- Z. H. Fan, C. Manzanos, M. Alipanahrostami, J. Lednicky, C-Y. Wu, “Multiplex Devices and Methods for Pathogen Detection”, U.S. provisional patent application, serial No. 63/261,373, 2021
- Jack Judy and Paritosh Rustogi, “Reliable Miniature Implantable Connector with High Channel Density and Methods of Using the Same”, U.S. Patent Application 17/282,894, filed November 11, 2021.

- R. Tabrizian, "Tunable and switchable saw-baw rf resonators," U.S. Patent Application US17/314,394, May 7, 2021.
- R. Tabrizian, "Digitally Tunable Acoustic Wave Resonators," U.S. Patent Application US17/173,919, Feb. 11, 2021.
- R. Tabrizian, "Nano-Electro-Mechanical Tags for Identification and Authentication," U.S. Patent Application US17/152,294, Jan. 19, 2021.
- R. Tabrizian, "Integrated frequency selective limiter utilizing quadratic and an-harmonic energy scattering," 17/304,993, June 29, 2021.
- R. Tabrizian, "Layered Ferroelectric $\text{Sc}(x)\text{Al}(1-x)\text{N}$ Transducer," US17/170,138, Feb. 8, 2021.
- Yong-Kyu Yoon, R. Bowrothu, H. Kim, and S. Hwangbo, "Cu/Co Based Metaconductor Array Antennas," U.S. Patent Application 17/230,347, April 14, 2021.
- Yong-Kyu Yoon and Sheng-Po Fang, "Microbead and Nanofiber based Controlled Drug Release System," U.S. Patent Application 17/150,035, Jan. 15, 2021.
- Yong-Kyu Yoon and Woosol Lee, "Rollable Metamaterial Screen for Magnetic Resonance Coupling based High Efficiency Wireless Power Transfer," U.S. Patent Application 17/179,839, Feb. 19, 2021.
- Yong-Kyu Yoon, R. Wayland, L. J. Altmann, S. Jeon, S. Hwang, and K. Tang, "Smart pseudo-palate for linguistic and biomedical applications," U.S. Patent Application 17/351,541, Jun. 18, 2021
- Yong-Kyu Yoon, W. Lee, "Metamaterial inspired dual-function loop antenna," U.S. Patent Application 17/215,798, Mar. 29, 2021
- Yong-Kyu Yoon and S. Hwangbo, "Meander Line Slots for Mutual Coupling Reduction," U.S. Patent Application 17/315,964, May 10, 2021