

# Interdisciplinary Microsystems Group

## Annual Report 2020



<b>2020 Year End Highlights .....</b>	<b>3</b>
<b>Introduction.....</b>	<b>4</b>
<b>Faculty Spotlight .....</b>	<b>5</b>
<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>Roosbeh Tabrizian .....</i>	<i>13</i>
<i>Huikai Xie .....</i>	<i>14</i>
<i>Y.K. Yoon .....</i>	<i>15</i>
<b>Honors &amp; Awards .....</b>	<b>16</b>
<i>Student Awards .....</i>	<i>16</i>
<i>Faculty Honors and Intellectual Leadership .....</i>	<i>16</i>
<b>Educational Activities .....</b>	<b>18</b>
<i>Ph.D. Graduates (10) .....</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>
<b>Research Activities .....</b>	<b>22</b>
<i>Federal Sponsorship .....</i>	<i>22</i>
<i>State Sponsorship .....</i>	<i>25</i>
<i>Industry Sponsorship (including NSF I/UCRC MIST Center Sponsorship) .....</i>	<i>25</i>
<i>Other Sponsorship .....</i>	<i>25</i>
<i>Internal Sponsorship .....</i>	<i>27</i>



*Research Financial Summary* ..... 27

**Publications** ..... **29**

*Editorial Advisory Boards* ..... 29

*Reviewers for Scholarly Journals* ..... 29

*Peer-reviewed journals (44)* ..... 30

*Conference Publications (25)* ..... 32

*Patents (13)* ..... 34

*Patent Applications (9)* ..... 35

## 2020 Year End Highlights

**~100**  
Members

**11**  
Faculty

**10**  
PhD Graduates

**44**  
Journal Publications

**14**  
Issued Patents

**25**  
Conference  
Publications

**8**  
Patent Applications

**71**  
Active  
Research Projects

**22**  
Different Sponsors

**\$3.7M**  
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, Huikai Xie, 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 135 PhD students and published 654 journal articles and 637 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.



## 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 was the technical program co-chair of the 2009 PowerMEMS and is currently on 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, J Crayton Pruitt Family Department of Biomedical Engineering, and Department of Chemistry at the University of Florida (UF). He currently holds UF Term Professorship and is a member of UF Health Cancer Center. 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 a Fellow of the American Association for the Advancement of Science (AAAS) and the American Society of Mechanical Engineers (ASME), an editor of *Microsystems and Nanoengineering* (Nature Publishing Group), and an editorial board member of *Scientific Report* (Nature Publishing Group). 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*

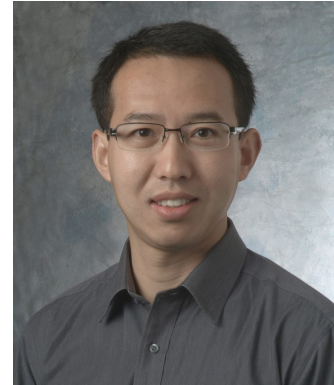
Graduation Year	Degree	University	Program of study
1994	Doctorate	University of Alberta	Chemistry
1985	Bachelor	Yangzhou Teachers' College	Chemistry



*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), 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 four Best Paper/Presentation Awards at IEEE and other international conferences. He has mentored over 10 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 and affiliate professor in the Department of Mechanical and Aerospace Engineering. He serves as Associate Dean of Academic Affairs in the Herbert Wertheim College of Engineering.



H

e is a Term Professor and an Alan Hastings Faculty Fellow. 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 170 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, ferroelectrics, and polymers 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 member and 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 received his B.S. in Electrical Engineering from Sharif University of Technology, Tehran, Iran, in 2007, and Ph.D. in Electrical and Computer Engineering from Georgia Institute of Technology, 2013. In 2014, he joined the Department of Electrical Engineering, University of Michigan as a Postdoctoral research fellow. In August 2015, he joined the Department of Electrical and Computer Engineering, University of Florida as an Assistant Professor.



His research at the University of Florida involves linear, nonlinear, and nonreciprocal nano-acoustic devices, RF M/NEMS, mixed-domain nanosystems for time-keeping / transfer, frequency reference, and spectroscopy applications, and micro- / nano-fabrication technologies. Dr. Tabrizian is the recipient of DARPA Young Faculty Award (2019) and NSF CAREER award (2018). His research has resulted in more than 50 journal and conference papers, 2 book chapters, 3 published patents and 10 patent applications. He and his students are the recipients of outstanding paper awards at the IEEE International Conference on Micro Electro Mechanical Systems (MEMS) and International Conference on Solid-State Sensors, Actuators, and Microsystems (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

Huikai Xie

*Professor*

Huikai Xie was a professor at the Department of Electrical and Computer Engineering at the University of Florida from 2002-2020. He received his master's degree in electro-optics from Tufts University in 1998 and his Ph.D. degree in electrical and computer engineering from Carnegie Mellon University in 2002. He also holds BS and MS degrees both in electronic engineering from Beijing Institute of Technology. He was a research faculty at the Institute of Microelectronics at Tsinghua University, Beijing, China.



His research is mainly focused on development of innovative optical and acoustic MEMS devices and their applications in various beam steering microsystems and endoscopic imaging modalities. The goal is to develop enabling micro/nanofabrication technology and build innovative integrated microsystems with improved performance, functionality and affordability for medical, industrial, space and consumer electronics applications. His current research activities include optical MEMS, micro-mirrors, microactuators, piezoelectric MEMS microspeakers and ultrasonic transducers, biophotonics, optical endomicroscopy, optical coherence tomography (OCT), photoacoustic microscopy, two-photon microscopy for in vivo brain imaging, microLiDAR, and microspectrometers.

*Education*

Graduation Year	Degree	University	Program of study
2002	Doctorate	Carnegie Mellon University	Electrical and Computer Engineering
1998	Master of Science	Tufts University	Electro-Optics
1992	Master of Science	Beijing Institute of Technology	Microelectronics
1989	Bachelor of Science	Beijing Institute of Technology	Electronic 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 ( $\mu$ TAS), American Vacuum Society (AVS), International Microwave Symposium (IMS), Electronic Components and Technology Conference (ETC), 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

- **Austin Vera**, National Defense Science and Engineering Graduate (NDSEG) Fellowship
- **Troy Tharpe**, Outstanding Paper Award at the 21st International Conference on Solid-State Sensors, Actuator and Microsystems (Transducers 2021)
- **Keisha Castillo-Torres, Dingkang Wang, Liang Zhou**, IMG Excellence for Research Award (2020)
- **Aftab Bhanvadia, Yuzheng Wang**, IMG Excellence for Service Award (2020)

### Faculty Honors and Intellectual Leadership

#### *Prof. Jennifer Andrew*

- *Honors*
  - *Early Career Scholar*, Journal of Materials Research Society 2020
  - *Faculty Excellence Award*, Dept. of Materials Science and Engineering, UF 2020
  - *Margaret Ross Professorships* 2020-present
- *Conference Leadership*
  - *Co-Organizer*, *Frontiers in Biomagnetic Particles* 2014-present
  - *Symposium Organizer*, *Electronic Materials and Applications* 2020
  - *Co-Chair*, *Electronic Materials and Applications* 2021
  - *Chair*, *Electronic Materials and Applications* 2022

#### *Prof. David Arnold*

- *Honors*
  - *George Kirkland Engineering Leadership Professorship* 2016-present
- *Conference Technical Program Committee*
  - *PowerMEMS Intl. Steering Committee* 2018-present

#### *Prof. Z. Hugh Fan*

- *Honors*
  - *University of Florida Term Professorship* 2019-2022
  - *ASME Fellow* 2018-present
  - *AAAS Fellow* 2016-present
- *Technical Program Committee*
  - *Executive TPC,  $\mu$ TAS* 2020

#### *Prof. Philip Feng*

- *Conference Leadership*
  - *Chair*, *MEMS 2021* 2021
  - *Elected Member*, *IEEE MEMS International Steering Committee* 2020-present
- *Conference Technical Track/Group Chair*
  - *IEEE IFCS-ISAF, Group 4 Chair* 2020
- *Professional Society Committee*
  - *Elected Ad Com Member*, *IEEE UFFC-S* 2020

#### *Prof. Jack Judy*

- *Conference Leadership*
  - *Co-Chairman*: *Gordon Research Conference on Neuroelectronic Interfaces* 2022
  - *General Chairman*: *Transducers 2021* 2021



*Prof. Toshikazu Nishida*

- *Honors*
  - Associate Dean of Academic Affairs 2017-present
  - UF Term Professorship 2017-2020
  - Alan Hastings Faculty Fellow Award 2017-2020

*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
  - Awarded Senior Member IEEE 2020
- *Conference Technical Program Committee*
  - Hilton Head Workshop 2020
  - IEEE International Frequency Control Symposium 2020

*Prof. Huikai Xie*

- *Honors*
  - SPIE Fellow 2018-present
  - IEEE Fellow 2017-present

*Prof. Yong-Kyu Yoon*

- *Conference Technical Program Committee*
  - IEEE MEMS 2020
  - IEEE ECTC 2021
- *Conference Leadership*
  - Focus/Special Sessions Vice-Chair, IEEE International Microwave Symposium 2021

## Educational Activities

### Ph.D. Graduates (10)

Graduate student	Advisor	Title
<b>Morteza Alipanahrostami</b>	Moghaddam	Science and Engineering of Membrane-Based Two-Phase Heat Sink – New Discoveries and Universal CHF Model
<b>Keisha Castillo-Torres</b>	Arnold	Magnetic Isolation of Fecal Indicating Bacteria using Bio-Functionalized Magnetic Microdiscs for Water Quality Monitoring
<b>Timothy Clingenpeel</b>	Yoon	Nano-Layered Nonmagnetic/Ferromagnetic Metaconductors for Energy Efficient Radio Frequency Passives
<b>Chen Li</b>	Moghaddam	Nanomembranes for Wearable Microfluidic Dialyzer
<b>Mohammad Moulod</b>	Moghaddam	Science and Engineering of a Wearable Artificial Kidney
<b>Richard Rode</b>	Moghaddam	Bilayer Graphene Oxide Membrane for Wearable Dialysis
<b>Aniruddh Shekhawat</b>	Moghaddam	Ferroelectric Properties of HfO <sub>2</sub> -Based Thin Films and Their Application for Low Power and Scalable Ferroelectric Tunnel Junctions Towards
<b>Glen Walters</b>	Nishida	Scaling and Design of Thin Film Ferroelectric Hafnium Oxide for Memory and Logic Devices
<b>Haocheng Zhou</b>	Sheplak	A MEMS-based Five-Hole Probe with Optical Pressure Transducers
<b>Liang Zhou</b>	Feng	Electrothermal MEMS Scanning Mirrors and Lenses with Large Range and High Robustness for Two-Photon Microscopy

### New Alumni

Alumnus	Degree	Advisor	Company
<b>Morteza Alipanahrostami</b>	Doctorate	Moghaddam	UF (postdoc)
<b>Keisha Castillo-Torres</b>	Doctorate	Arnold	UF (postdoc)
<b>Timothy Clingenpeel</b>	Doctorate	Yoon	L3 Harris
<b>Mayur Ghatge</b>	Doctorate	Tabrizian	Intel

<b>Beatriz Jimenez</b>	Master of Science	Arnold	L3 Harris
<b>Chen Li</b>	Doctorate	Moghaddam	Mattson Technologies
<b>Mohammad Moulod</b>	Doctorate	Moghaddam	Ohio State (postdoc)
<b>Richard Rode</b>	Doctorate	Moghaddam	UF (postdoc)
<b>Aniruddh Shekhawat</b>	Doctorate	Moghaddam	Applied Materials
<b>Parisa Tahafchi</b>	Doctorate	Judy	
<b>Glen Walters</b>	Doctorate	Nishida	Micron
<b>Haocheng Zhou</b>	Doctorate	Sheplak	
<b>Liang Zhou</b>	Doctorate	Feng	Cepton

### Classroom Instruction

Spring 2020

Instructor	Course Number	Course Name	Enrolled
<b>Andrew</b>	EMA3011	Fundamental Principles of Materials	55
<b>Arnold</b>	EEL 4412 EEL 5417	Applied Magnetism & Magnetic Materials	14 12
<b>Arnold</b>	EGN 6933	Engineering Faculty Development	9
<b>Fan</b>	EML 4930 BME 5580	Microfluidics and BioMEMS	1 10
<b>Judy</b>	EEL 6935	Nanotech Medical Devices	4
<b>Moghaddam</b>	EML 6155	Convective Heat Transfer 1	40
<b>Sheplak</b>	EEE 4720 EEE 5725	Acoustics	10 5
<b>Tabrizian</b>	EEE 4222 EEE 5225	Resonant MEMS	40 15
<b>Xie</b>	EEE 4210 EEE 5216	Intro to Biophotonics	14 12



<b>Yoon</b>	EEL 3111C	Circuits 1	45
<b>Yoon</b>	EEE 5354L	Semiconductor Device Fabrication Lab	26

*Fall 2020*

<b>Instructor</b>	<b>Course Number</b>	<b>Course Name</b>	<b>Enrolled</b>
<b>Andrew</b>	EMA3050	Intro Inorganic Materials	58
<b>Arnold</b>	EEL 3008	Physics of Electrical Engineering	53
<b>Fan</b>	EGN3353C	Fluid Mechanics	130
<b>Feng</b>	EEL 4930 EEL 5934	Intro to Quantum Devices & Quantum Eng.	3 7
<b>Feng</b>	EEE 6465	Design of MEMS Transducers	10
<b>Moghaddam</b>	EML 6154	Conduction Heat Transfer	37
<b>Sheplak</b>	EML 5224	Acoustics	5
<b>Tabrizian</b>	EEL 3112	Circuits 2	85
<b>Yoon</b>	EEL 3111C	Circuits 1	46
<b>Yoon</b>	EEE 5467	Micro/Nano-machined Metamaterials	6



IMG Seminars Series

Supported by the IMG Alumni fund

Date	First speaker	Second speaker
January 17	Dr. Sanjeev Koppal – computer vision and computational photography	Dr. Warren Dixon – nonlinear control and human interfaces
January 31	Dr. Eakta Jain - building human-centered computer graphics algorithms to create and manipulate artistic content	
February 14	Dr. Honggyu Kim - Advanced electron microscopy techniques and Digital image processing	
February 28	Dr. Thomas Angelini – soft tissue mechanics	Dr. Tan Wong – wireless communications
March 13	IMG 3-minute Theses	
March 27	Dr. John Conklin – gravitational waves and the LISA space mission	
April 10	Dr. Farimah Farahmandi – Formal Verification and Design Automation	
April 24	Dr. Lakiesha Williams – biological tissues for implementation into physics-based constitutive models	Dr. Jing Pan – Bio nanotechnology, synthetic biology, and medical technology
October 23	Dr. Jennifer Andrew - Nanomaterials for Electronic and Medical Applications	Dr. Ann Ramirez – Machine Learning-based Prediction for Dynamic, Runtime Architectural Optimizations of Embedded Systems
November 6	Dr. Jing Pan- DNA-encoded Nanomechanical System	
November 20	Girish Wable (Jabil)	Aftab Bhanvadia - Introduction to Zotero to collect, organize, cite, and share research
December 4	Bo Hyun Lee – diversity, inclusion, and equity	



## Research Activities

In the year 2020, IMG had active research projects funded through the federal, state, 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	\$73,110
SNM: Batch Manufacturing of Integrated Magnetic Devices	Andrew	NSF	\$587,693	\$145,818
Collaborative: Controlling Large Microrobot Teams	Arnold	NSF	\$295,191	\$72,926
Magnetic Thick Films for Integrated Microwave Devices	Arnold	ARO (DARPA)	\$737,057	\$178,556
Electromagnetic and Magnetic Penetration for High-Resolution	Arnold	DARPA	\$153,140	\$0
SNM: Batch Manufacturing of Integrated Magnetic Devices	Arnold	NSF	\$446,515	\$47,162
I/UCRC for Multi-functional Integrated System Technology	Arnold	NSF	\$401,646	\$1,261
Federal MIPR Membership	Arnold	NSF	\$50,000	\$35
NSF Engineering Research Center for Internet of Things for Precision Agriculture (IoT4Ag)	Arnold	UPenn (NSF)	\$269,154	\$0
Phase II IUCRC at University of Virginia	Arnold	UVA (NSF)	\$13,784	\$10,618
Phase II IUCRC University of Florida: Center for Multi-functional Integrated System Technology (MIST)	Arnold	NSF	\$18,141	\$61,024
Phase II IUCRC University of Central Florida	Arnold	UCF (NSF)	\$13,784	\$10,618
A Rapidly Deployable, Inexpensive and Easy-to-use In Situ Detector for Aerosolized SARS-CoV-2	Fan	Aerosol Devices (DoD)	\$161,029	\$0

<b>RAPID: Environmental Surveillance to Assess Aerosol Transmission Pathway of COVID-19 Enabled by On-The-Spot Sampling and Detection</b>	Fan	NSF	\$66,359	\$66,358
<b>Multiplexed Detection of Mosquito-Borne Viruses at the Point-of-Care</b>	Fan	NIH	\$266,758	\$25,134
<b>Multiplexed Airborne Virus Collection and Detection at the Point-of-Care</b>	Fan	NIH	\$143,551	\$17,560
<b>Novel Methods of Chemosensitizing Low-proliferative Disseminated Tumor Cells in Triple Negative Breast Cancer</b>	Fan	NIH	\$122,137	\$62,185
<b>A multimodal imaging system and targeted nanoprobe for image guided treatment of breast cancer</b>	Feng	USF (NIH)	\$461,546	\$108,809
<b>Radiation Effects in Nanoscale Electromechanical Logic Devices: Pathways Toward Robust Computing in Extreme Environment</b>	Feng	DTRA	\$350,000	\$200,315
<b>Collaborative Research: Harnessing Crystalline Phase Transition in 2D Materials for Ultra-Low-Power and Flexible Electronics</b>	Feng	NSF	\$137,121	\$5,848
<b>CAREER: Dynamically Tuning 2D Semiconducting Crystals and Heterostructures for Atomically-Thin Signal Processing Devices and Systems</b>	Feng	NSF	\$224,526	\$84,376
<b>EFRI ACQUIRE: A Scalable Integrated Quantum Photonic Interconnect</b>	Feng	NSF	\$136,716	\$5,413
<b>Planning Grant: Engineering Research Center for Neural Engineered Systems with Societal Impact</b>	Judy	NSF	\$100,000	\$26,409
<b>Reliable Miniature Implantable Connectors with High Channel Density for Advanced Neural-Interface Applications</b>	Judy	NIH	\$407,206	\$205,834
<b>Tissue Engineered Electronic Neural Interface (TEENI)</b>	Judy	NIH	\$543,973	\$229,502



<b>Membrane-Based Ionic Liquid Absorption System for Ultra-Efficient Dehumidification And Heating</b>	Moghaddam	DOE	\$1,707,780	\$376,143
<b>Deciphering the Physics of Critical Heat Flux (CHF)</b>	Moghaddam	NSF	\$349,996	\$100,337
<b>Characterization of Critical Two-Phase Flow Regimes for Design and Reliable Operation of Compact Naval Energy Systems</b>	Moghaddam	ONR	\$408,377	\$151,916
<b>Ferroelectric HfO<sub>2</sub> on Germanium Tunnel Junctions Towards</b>	Moghaddam	NSF	\$128,779	\$0
<b>Ferroelectric HfO<sub>2</sub> on Germanium Tunnel Junctions Towards Sub-Femto Joule Switching</b>	Nishida	NSF	\$167,424	\$7,682
<b>I/UCRC for Multi-functional Integrated System Technology (MIST)</b>	Nishida	NSF	\$401,646	\$1,261
<b>Phase II IUCRC University of Florida: Center for Multi-functional Integrated System Technology (MIST)</b>	Nishida	NSF	\$131,859	\$61,024
<b>Stress-Mediated Sc-Doped AlN Ferroelectric Transducer for Intrinsically Configurable Solidly Mounted Filter Array</b>	Nishida	DARPA	\$154,443	\$23,392
<b>Examination of Pressure and Velocity Fields and Their Relationships to Radiated Noise in a Jet</b>	Sheplak	NSF	\$164,963	\$0
<b>Stress-Mediated Sc-Doped AlN Ferroelectric Transducer for Intrinsically Configurable Solidly Mounted Filter Array</b>	Tabrizian	DARPA	\$787,640	\$256,021
<b>Ferroelectrically Transduced Ge Nano-Fin Bulk Acoustic Resonators for Chip-Scale Instinctually Adaptive RF Spectral Processing</b>	Tabrizian	DARPA	\$1,000,000	\$256,797
<b>CAREER: Active Nano-Acoustic Waveguide Matrix to Tackle Signal Processing Limits</b>	Tabrizian	NSF	\$500,000	\$68,542
<b>Hardware-in-the-Loop Simulator Development</b>	Yoon	Eglin AFB	\$109,340	\$54,726



<b>Energy Dense and High Rate Electrochemical Capacitors: Advanced Nanomanufacturing and Designer Electrolytes</b>	Yoon	Mainstream Engineering (AFOSR)	\$107,477	\$10,055
<b>IRES Track I: Collaborative Research: Interdisciplinary Research in Korea on Applied Smart Systems (IRiKA) for Undergraduate Students</b>	Yoon	NSF	\$29,284	\$8,007
<b>Magnetic Thick Films for Integrated Microwave Devices</b>	Yoon	DARPA	\$145,458	\$43,535
<b>SenSE: Smart Electropalography for Linguistic and Medical Applications (SELMA)</b>	Yoon	NSF	\$373,290	\$5,121
<b>Total</b>			<b>\$13,135,066</b>	<b>\$3,063,431</b>

State Sponsorship

Title of Grant	Faculty Member	Funding Agency	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
<b>University of Florida (UF) Testbed Initiative- Transit Components</b>	Yoon	FDOT	\$63,789	\$8,065
<b>Total</b>			<b>\$63,789</b>	<b>\$8,065</b>

Other Sponsorship

Title of Grant	Faculty Member	Funding Agency	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
<b>Symbiosis in Aquatic Systems: Magnetic Nanoparticles and Symbiosis</b>	Arnold	Moore Foundation	\$94,163	\$802
<b>Intra-/Inter Chip RF Interface</b>	Yoon	Seoul National University	\$251,104	\$117,240
<b>Total</b>			<b>\$345,267</b>	<b>\$118,042</b>

*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	Andrew	Multiple Sponsors	\$102,562	\$11,451
MIST Center Projects	Arnold	Multiple Sponsors	\$189,607	\$49,110
MIST Center Projects	Fan	Multiple Sponsors	\$138,691	\$3,477
MIST Center Projects (Phase 2)	Fan	Multiple Sponsors	\$50,000	\$25,576
MIST Center Projects	Moghaddam	Multiple Sponsors	\$30,167	\$0
MIST Center Projects	Nishida	Multiple Sponsors	\$285,360	\$76,200
MIST Center Projects (Phase 2)	Nishida	Multiple Sponsors	\$75,000	\$27,401
MIST Center Projects	Sheplak	Multiple Sponsors	\$561,500	\$18,356
MIST Center Projects (Phase 2)	Sheplak	Multiple Sponsors	\$175,000	\$91,415
MIST Center Projects	Tabrizian	Multiple Sponsors	\$22,498	\$12,721
MIST Center Projects	Yoon	Multiple Sponsors	\$243,534	\$751
MIST Center Projects (Phase 2)	Nishida	Multiple Sponsors	\$50,000	\$49,061
New Generation Ultra-Efficient Air-Conditioning Systems	Moghaddam	Micro Nano Technologies	\$123,970	\$2,056
SBIR - Capacitive Vector Skin Friction Measurement Systems for Complex Flow Fields	Sheplak	IC2	\$99,999	\$55,718
Nano-Dot Labels for Product Identification and Authentic	Tabrizian	Discover Financial Services	\$70,676	\$8,115
RF Bulk Acoustic Wave Fin Resonators and Filters with Si	Tabrizian	OEM	\$140,000	\$8,443
Active-FinBAR Resonator Building Block for Configurable	Tabrizian	Intel	\$152,220	\$43,677



Directional Antennas for Glass	Yoon	Corning	\$39,038	\$6,906
Energy Dense and High Rate Electrochemical Capacitors: A	Yoon	Mainstream	\$93,475	\$0
<b>Total</b>			<b>\$1,557,064</b>	<b>\$483,527</b>

Internal Sponsorship

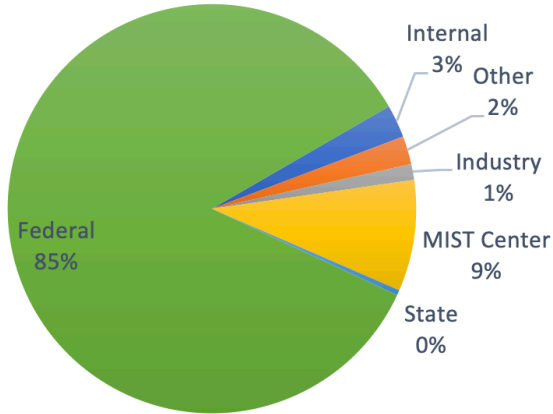
Title of Grant	Faculty Member	Funding Agency	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
Ross Professorship	Andrew	UF Foundation	\$20,375	\$4,081
Colorectal Cancer Screening Project	Fan	UF Foundation	\$299,285	\$4,821
Development of a Point-of-Care Platform for HIV Viral Load Testing	Fan	UF Office of Research	\$63,777	\$18,649
DSR NSF Matching Funds	Fan	UF Office of Research	\$4,000	\$0
DSR NSF Matching Funds	Sheplak	UF Office of Research	\$2,999	\$0
DSR NSF Matching Funds	Sheplak	UF Office of Research	\$8,999	\$1,091
DSR NSF Matching Funds	Sheplak	UF Office of Research	\$2,000	\$0
<b>Total</b>			<b>\$401,435</b>	<b>\$28,643</b>

Research Financial Summary

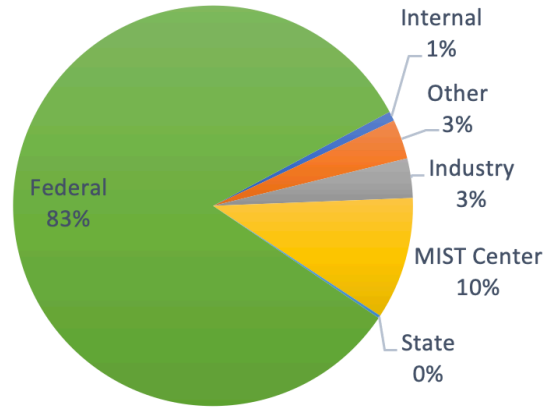
Total Funding

	Award Value (Faculty's Portion)	Expenditures (Reporting Period)
<b>Total</b>	<b>\$15,811,822</b>	<b>\$3,701,711</b>

## 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
- 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
- Jack Judy: Associate Editor, *IEEE Trans. Biomedical Engineering* 2006-present
- Mark Sheplak: Associate Editor, *Journal of Acoustical Society of America* 2011-2019
- Roozbeh Tabrizian: Topic Editor, *Micromachines* 2020-present
- Huikai Xie, Editor, *Sensors and Actuators: A* 2018-present
- Huikai Xie, Editor, *IEEE Sensors Letters* 2016-present
- Huikai Xie, Editor, *Micromachines* 2017-present
- Huikai Xie, Associate Editor, *the International Journal of Optomechatronics* 2011-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

- ACS Applied Biomaterials
- ACS Applied Materials & Interfaces
- Advanced Science
- Annalen der Physik
- Analytica Chimica Acta
- Analytical Chemistry
- Analyst
- Analytical Methods
- Angewandte Chemie
- Applied Physics Letters
- Applied Physics Review
- Chemical Reviews
- Chemical Science
- Environmental Science & Technology
- IEEE Trans. Electron Devices
- IEEE Trans. Microwave Theory & Techniques
- IEEE Trans. Ultrasonics, Ferroelectrics, and Frequency Control
- IEEE Sensors
- J. Microelectromechanical Systems
- J. Australian Ceramic Society
- J. Colloid & Interface Science
- J. Materials Chemistry C
- J. Physics: Condensed Matter
- RSC Advances
- Lab on a Chip
- Micromachines
- Nano Today
- Nature Communications
- Nature Microsystems and Nanoengineering
- Nature Scientific Reports
- Science China: Chemistry
- Small

### Peer-reviewed journals (44)

- M. Alipanah and S. Moghaddam, "Ultra-low pressure drop membrane-based heat sink with 1000 W/cm<sup>2</sup> cooling capacity and 100% exit vapor quality," *International Journal of Heat and Mass Transfer*, vol. 161, Nov. 2020.
- M Bai, H Liu, F Xie, J Zhao, W Liu, H Xie, "Light trapping enhancement via structure design," *International Journal of Modern Physics B*, 2050040 (2020).
- M. J. Bauer, A. Thomas, B. Isenberg, J. Varela, A. Faria, D. P. Arnold, and J. S. Andrew, "Ultra-low-power current sensor utilizing magnetoelectric nanowires," *IEEE Sensors J.*, vol. 20, no. 10, pp. 5139-5145, May 2020.
- R. Bowrothu, H. Kim, C. S. Smith, D. P. Arnold, and Y. K. Yoon, "35-GHz barium hexaferrite/PDMS composite-based millimeter-wave circulators for 5G applications," *IEEE Trans. Microw. Theory Techn.*, vol. 68, no. 12, pp. 5065-5071, Dec. 2020.
- K. Castillo-Torres, E. S. McLamore, and D. P. Arnold, "A high-throughput microfluidic magnetic separation ( $\mu$ FMS) platform for water quality monitoring," *Micromachines*, vol. 11, no. 16, 13 pages, Jan. 2020.
- K. Chen, J. Amontree, J. Varillas, J. Zhang, T. J. George, Z. H. Fan, "Incorporation of Lateral Microfiltration with Immunoaffinity for Enhancing the Capture Efficiency of Rare Cells", *Scientific Reports*, 10, 2020, 14210 (11 pages).
- Chen H, Jia H, Zorman CA, Feng PXL, "Determination of Elastic Modulus of Silicon Carbide (SiC) Thin Diaphragms via Mode-Dependent Duffing Nonlinear Resonances", *Journal of Microelectromechanical Systems* 29 (5), 783-789 (2020).
- C. Dolbashian, B. Chavez, M. Bauer, M. Budi, J. S. Andrew, T. M. Crawford, Magnetic properties of aligned multiferroic Janus nanofiber agglomerates measured with the Scattered Magneto-Optical Kerr Effect, *J. Phys D.*, 53, 19502, 2020.
- Freidkes, B.R., Mills, D.A., Patterson, W.C., Fournier, P.M., and Sheplak, M., "A Flush-Mounted Dual-Axis Wall Shear Stress Sensor," *J. Microelectromech. Syst.*, Vol. 29, No. 5, 960-965, Oct. 2020.
- S. Rassay, M. Ramezani, S. Shomaji, S. Bhunia, and R. Tabrizian, "Clandestine Nano-Electro-Mechanical Tags for Identification and Authentication", *Nature's Microsystems and Nanoengineering*, vol. 6(1), pp. 1-8, November 2020.
- M. Ghatge, G. Walters, T. Nishida, and R. Tabrizian, "A 30-nm thick integrated hafnium zirconium oxide nano-electro-mechanical membrane resonator", *Appl. Phys. Lett.*, vol. 116 (4), Feb. 2020, p. 043501.
- L Guan, L Zhai, H Cai, P Zhang, Y Li, J Chu, R Jin, H Xie, "Study on displacement estimation in low illumination environment through polarized contrast-enhanced optical flow method for polarization navigation applications," *Optik*, 164513 (2020).
- F. Hakim, M. Ghatge, and R. Tabrizian, "Excitation of High-Frequency In-Plane Bulk Acoustic Resonance Modes in Geometrically Engineered Hafnium Zirconium Oxide Nano-Electro-Mechanical Membrane," *Applied Physics Letters*, vol. 117, p. 063502, August 2020.
- A. Kugimiya, A. Fujikawa, X. Jiang, Z. H. Fan, T. Nishida, J. Kohda, Y. Nakano, Y. Takano, "Microfluidic paper-based analytical device for histidine determination", *Applied Biochemistry and Biotechnology*, 192, 2020, 812-821.
- J. A. Lednicky, M. Lauzardo, Z. H. Fan, A. Jutla, T. B. Tilly, M. Gangwar, M. Usmani, S. N. Shankar, K. Mohamed, A. Eiguren-Fernandez, C. J. Stephenson, Md. M. Alam, M. A. Elbadry, J. C. Loeb, K. Subramaniam, T. B. Waltzek, K. Cherabuddi, J. G. Morris, Jr., C-Y Wu, "Viable SARS-CoV-2 in the air of a hospital room with COVID-19 patients", *International Journal of Infectious Diseases*, 100, 2020, 476-482.

- Woosol Lee and Yong-Kyu Yoon, "Tunable Metamaterial Slab for Efficiency Improvement in Misaligned Wireless Power Transfer," *IEEE Microwave and Wireless Components Letters*, Sep. 2020, vol. 30, no. 9, pp. 912 – 915.
- Woosol Lee and Yong-Kyu Yoon, "Wireless Power Transfer Systems Using Metamaterials: A Review," *IEEE Access*, Aug. 2020, vol. 8, pp. 147930 – 147947.
- Woosol Lee and Yong-Kyu Yoon, "Rollable Metamaterial Screen for Magnetic Resonance Coupling based High Efficiency Wireless Power Transfer," *International Journal of Microwave and Wireless Technologies*, Aug. 06, 2020, pp. 1 – 9,
- Liu X, Islam A, Guo J, Feng PXL, "Controlling Polarity of MoTe<sub>2</sub> Transistors for Monolithic Complementary Logic via Schottky Contact Engineering", *ACS Nano* 14, 1457-1467 (2020).
- M. Matin and S. Moghaddam, "Thin liquid films formation and evaporation mechanisms around elongated bubbles in rectangular cross-section microchannels," *International Journal of Heat and Mass Transfer*, vol. 163, Dec. 2020.
- S. Mills, C. S. Smith, D. P. Arnold, and J. S. Andrew, "Electrophoretic deposition of iron-oxide nanoparticles to achieve thick nickel/iron-oxide magnetic nanocomposite films," *AIP Adv.*, vol. 10, no. 1, 015308, 5 pages, Jan. 2020.
- Mobini, Sahba, Cary A. Kuliasha, 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* (2020).
- Mohapatra, Shyam S., Robert D. Frisina, Subhra Mohapatra, Kevin B. Sneed, Eleni Markoutsas, Tao Wang, Rinku Dutta et al. "Advances in Translational Nanotechnology: Challenges and Opportunities." *Applied Sciences* 10, no. 14 (2020): 4881.
- 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* (2020).
- R. Rode, H. Chung, H. Miller, T. Gaborski, and S. Moghaddam, "Trilayer Interlinked Graphene Oxide Membrane for Wearable Hemodialyzer," *Advanced Material Interfaces*, vol. 7, December 30, 2020.
- A. Shekhawat, G. Walters, N. Yang, J. Guo, T. Nishida, and S. Moghaddam, "Data Retention and low Voltage Operation of Al<sub>2</sub>O<sub>3</sub>/Hf<sub>0.5</sub>Zr<sub>0.5</sub>O<sub>2</sub> based Ferroelectric Tunnel Junctions," *Nanotechnology*, vol. 31, 2020.
- A. Shekhawat, G. Walters, C. Chung, R. Garcia, Y. Liu, J. Jacobs, T. Nishida, and S. Moghaddam, "Effect of Forming Gas Furnace Annealing on the Ferroelectricity and Wake-Up Effect of Hf<sub>0.5</sub>Zr<sub>0.5</sub>O<sub>2</sub> Thin Films," *ECS Journal of Solid State Science and Technology*, vol. 9, no. 2, 024011, 2020.
- C. S. Smith, K. Sondhi, S. C. Mills, J. S. Andrew, Z. H. Fan, T. Nishida, and D. P. Arnold, "Screen-printable and stretchable hard magnetic ink formulated from barium hexaferrite nanoparticles," *J. Mater. Chem. C*, vol. 8, no. 35, pp. 12133-12139, Sept. 2020.
- C. S. Smith, S. Savliwala, C. Rinaldi, and D. P. Arnold, "Electro-infiltrated nickel/iron-oxide and permalloy/iron-oxide nanocomposites for integrated power inductors," *J. Magn. Magn. Mat.*, vol. 493, 165718, 8 pages, Jan. 2020.
- K. Sondhi, S.G.R. Avuthu, J. Richstein, Z. H. Fan, T. Nishida, "Characterization of Bending, Crease, Aging and Immersion Effects on Flexible Screen-printed Silver Traces", *IEEE Transactions on Components, Packaging and Manufacturing Technology*, 10, 2020, 444-456.
- Spearman, Benjamin S., Cary A. Kuliasha, Jack W. Judy, and Christine E. Schmidt. "Integration of Flexible Polyimide Arrays into Soft Extracellular Matrix-based Hydrogel Materials for a



Tissue-Engineered Electronic Nerve Interface (TEENI)." *Journal of Neuroscience Methods* (2020): 108762.

- QAA Tanguy, O Gaiffe, N Passilly, JM Cote, G Cabodevila, S Bargiel, and H. Xie, "Real-time Lissajous imaging with a low-voltage 2-axis MEMS scanner based on electrothermal actuation," *Optics Express*, 28 (6), 8512-8527 (2020).
- P. Tiwari, N. Ferson, J. S. Andrew, Elucidating the Role of Electrophoretic Mobility for Increasing Yield in the Electrophoretic Deposition of Nanomaterials, *J. Colloid & Interface Sci.*, 570, 109, 2020.
- A. M. Uhl, S. C. Mills, J. S. Andrew, Synthesis of Cobalt Ferrite Nanoparticles via Electrospraying into a Liquid Collector, *J. Mater. Res.*, 35, 864, 2020.
- A. M. Uhl, J. S. Andrew, Sol-Gel Based Electrospray Synthesis of Barium Titanate Nanoparticles, *IEEE Trans. Nanobiosci.*, 19, 162, 2020.
- M. Unni; J. Zhang; T. J. George; M. S. Segal, Z. H. Fan, C. Rinaldi, "Engineering magnetic nanoparticles and their integration with microfluidics for cell isolation," *Journal of Colloid and Interface Science*, 564, 2020, 204–215.
- G. Walters, A. Shekhawat, S. Moghaddam, J. Jones, and T. Nishida, "Effect of in situ hydrogen plasma on the ferroelectricity of hafnium zirconium oxide films," *Applied Physics Letters*, vol. 116, issue 3, 032901, 2020.
- M. Wan, X. Jiang, J. Nie, Q. Cao, W. Zheng, X. Dong, Z. H. Fan, W. Zhou, "Phosphor powders-incorporated polylactic acid polymeric composite used as 3D printing filaments with green luminescence properties", *Journal of Applied Polymer Science*, 137, 2020, 48644 (10 pages).
- Yang R, Qian J, Feng PXL, "Electrodynamic Force, Casimir Effect, and Stiction Mitigation in Silicon Carbide Nanoelectromechanical Switches", *Small* 16 (51), 2005594 (2020).
- Z. Zhao, N. Garraud, D. P. Arnold, and C. Rinaldi, "Effects of particle diameter and magnetocrystalline anisotropy on magnetic relaxation and magnetic particle imaging performance of spherical nanoparticles," *Phys. Med. Biol.*, vol. 65, no. 2, 025014, 16 pages, Jan. 2020.
- Dong Zheng, Dingkan Wang, YK Yoon, and Huikai Xie, "A Silicon Optical Bench-based Forward-view Two-axis Scanner for Microendoscopy Applications," *Micromachines* 2020, 11 (12), 1051.
- Zheng XQ, Kaiser T, Feng PXL, "Electromechanical Coupling and Motion Transduction in  $\beta$ -Ga<sub>2</sub>O<sub>3</sub> Vibrating Channel Transistors", *Applied Physics Letters* 117, 243504 (2020).
- Zhou L, Yu X, Feng PXL, Li J, Xie H, "A MEMS Lens Scanner Based on Serpentine Electrothermal Bimorph Actuators for Large Axial Tuning", *Optics Express* 28 (16), 23439-23453 (2020).
- Zhou, H. and Sheplak, "A MEMS-Based Fast-Response Five-Hole Probe With Optical Pressure Transducers," *J. Microelectromech. Syst.*, Vol. 29, No. 5, 960-965, Oct. 2020.

### Conference Publications (25)

- Renuka Bowrothu, Todd Schumann, Haein Kim, Kyoung Tae Kim, Sunghyun Hwang, Yoonseok Lee, and Yong Kyu Yoon, "Integrated Phosphate and pH Sensing System for Water Quality Monitoring," *International Conference of IEEE Micro Electro Mechanical Systems*, Jan. 18-22, 2020, Vancouver, Canada, pp. 713 – 716.
- Renuka Bowrothu, Haein Kim, and Yong Kyu Yoon, "3D Integrated Through Fused Silica Via Based Array Antenna for mm Wave Communications," *IEEE 70th Electronic Components and Technology Conference (ECTC)*, Buena Vista, FL, May 26 – 29, 2020 (6 pages), Virtual

- Sheng-Po Fang, Gloria J. Kim, Anuj Chauhan, and Yong Kyu “YK” Yoon, “Drug-loaded Microbeads Sandwiched between Nanofiber Layers for Extended Linear Release,” *International Conference of IEEE Micro Electro Mechanical Systems*, Jan. 18-22, 2020, Vancouver, Canada, pp. 42 – 45.
- Feng PXL, “Resonant Nanoelectromechanical Systems (NEMS): Progress and Emerging Frontiers”, Proc. 33rd IEEE Int. Conf. on Micro Electro Mechanical Systems (MEMS 2020), 212-217, Vancouver, Canada, January 18-22 (2020). (Invited)
- M. Ghatge, G. Walters, T. Nishida, and R. Tabrizian, “A high-Q 30nm-thick MFM Resonator using Ferroelectric Hafnium Zirconium”, 2020 IEEE 33rd International Conference on Micro Electro Mechanical Systems (MEMS), Vancouver, BC, Canada, 2020, pp. 953-956.
- F. Hakim, S. Rassay, M. Ramezani, and R. Tabrizian, “A Non-Reciprocal Lamb-Wave Delay Line Exploiting Acoustoelectric Effect in Single Crystal Germanium,” *Proc. IEEE International Conference on Micro Electro Mechanical Systems (MEMS ‘20)*, pp. 1246 - 1249, January 2020.
- Kyle R. Gluesenkamp, Navin Kumar, Ahmad Abu-Heiba, Viral K. Patel, Zhiyao Yang, Saeed Moghaddam, RohitBhagwat, Sidharth Sanadhya, Michael Schmid, Richard Rode, Basil Anab-tawi, "Semi-open Absorption Water Heater: Experimental Results," The 13th International Energy Agency Heat Pump Conference, 2020, Jeju (Virtual), Korea.
- M. A. Halim, A. Rendon-Hernandez, and D. P. Arnold, “An electrodynamic wireless power receiver ‘chip’ for wearables and bio-implants,” Proc. 2020 IEEE PELS Workshop on Emerging Technologies: Wireless Power Transfer (WoW 2020), Seoul, Korea, Nov. 2020, pp. 271-274.
- M. A. Halim, J. M. Samman, S. E. Smith, and D. P. Arnold, “A high-performance electrodynamic micro-receiver for low-frequency wireless power transfer,” Proc. 33rd IEEE Intl. Conf. Micro Electro Mechanical Systems (MEMS 2020), Vancouver, Canada, Jan. 2020, pp. 590-593.
- Islam A, Lee JS, Feng PXL, “Black Phosphorus NEMS Resonant Infrared (IR) Detector”, Proc. 33rd IEEE Int. Conf. on Micro Electro Mechanical Systems (MEMS 2020), 826-829, Vancouver, Canada, January 18-22 (2020).
- Hae-in Kim, Renuka Bowrothu, and Yong-Kyu Yoon, “Tri-axis polarized loop antenna for mmWave wireless inter/intra chip communications,” *IEEE 70th Electronic Components and Technology Conference (ECTC)*, Buena Vista, FL, May 26 – 29, 2020 (6 pages), Virtual
- Woosol Lee, Haein Kim, and Yong-Kyu Yoon, “Metamaterial-inspired dual function loop antenna for wireless power transfer and wireless communications,” *IEEE 70th Electronic Components and Technology Conference (ECTC)*, Buena Vista, FL, May 26 – 29, 2020 (6 pages), Virtual
- Li, S., Ukeiley, L.U., and Sheplak, M., “PIV Measurements and Reduced-Order Characterization of a Mach 0.3 Axisymmetric Jet”, AIAA Scitech 2020 Forum, AIAA Paper 2020-2039, Orlando, FL, Jan. 6-10, 2020
- C. Manzanos, X. Jiang, J. A. Lednicky, Z. H. Fan, “Development of Ball-Enabled Miniaturized Valves for Sample Preparation and Microheaters for Pathogen Detection”, in Proceedings of the ASME 2020 Fluids Engineering Division Summer Meeting (FEDSM2020), Jul. 12-16, 2020, Orlando, FL, FEDSM2020-20379 (5 pages)
- Mills, D., Patterson, Freidkes, B., and Sheplak, M., “Temperature Sensitivity Reduction of a Capacitive Wall Shear Stress Sensor System for Low-Speed Wind Tunnels,” AIAA Scitech 2021 Forum, AIAA Paper 2020-022, Orlando, FL, Jan. 4-8, 2021
- Mills, D.A., Chen, T.A., Horowitz, S., Patterson, and Sheplak, M., “A Novel, High-Frequency, Reciprocal Calibration Method for Dynamic Pressure Sensors Used in High-Speed Flow”, AIAA Scitech 2020 Forum, AIAA Paper 2020-2213, Orlando, FL, Jan. 6-10, 2020

- A. Qamar, M. Ghatge, R. Tabrizian, and M. Rais-Zadeh, "Thermo-Acoustic Engineering of GaN SAW Resonators for Stable Clocks in Extreme Environments", *Proc. IEEE International Conference on Micro Electro Mechanical Systems (MEMS '20)*, pp. 1211 - 1214, January 2020.
- S. Rassay, F. Hakim, and R. Tabrizian, "Al<sub>0.7</sub>Sc<sub>0.3</sub>N Acoustically Coupled Filters with Large Bandwidth and Frequency Tunability," *IEEE International Frequency Control Symposium & European Frequency (IFCS 2020)*, pp. 1-4, July 2020.
- S. Rassay, F. Hakim, V. Felmetsger, and R. Tabrizian, "Acoustically Coupled Wideband RF Filters with Bandwidth Reconfigurability using Ferroelectric Aluminum Scandium Nitride Film," *Proc. IEEE International Conference on Micro Electro Mechanical Systems (MEMS '20)*, pp. 1254 - 1257, January 2020.
- P. Rustogi and J. W. Judy. "Electrical Isolation Performance of Microgasket Technology for Implant Packaging." In 2020 IEEE 70th Electronic Components and Technology Conference (ECTC), pp. 1601-1607. IEEE, 2020.
- C S. Smith, and D. P. Arnold, "Screen-printed inductive silver ink strain sensor on stretchable TPU substrate," *Proc. 2020 IEEE 70th Electronic Components and Technology Conference (ECTC 2020)*, Lake Buena Vista, FL, May 2020, pp. 2325-2329.
- K. Sondhi, S. G. Reddy Avuthu, N. Richards, Z. H. Fan and T. Nishida, "Effect of a Backing Material on the Bendability of Flexible Substrates with Passive SMD components," 2020 IEEE 70th Electronic Components and Technology Conference (ECTC), 2020, pp. 1542-1547.
- Y. Wang, B. Y. Jimenez, and D. P. Arnold, "100- $\mu$ m-thick high-energy-density electroplated CoPt permanent magnets," *Proc. 33rd IEEE Intl. Conf. Micro Electro Mechanical Systems (MEMS 2020)*, Vancouver, Canada, Jan. 2020, pp. 558-561.
- Wang Y, Jia H, Feng PXL, "Design of Integrated Photonic Devices on SiC-on-Insulator (SiCOI) Platform for Quantum Applications", *Frontiers in Optics, FW1D.2*, Washington DC, Online, September 14-17 (2020).
- Zheng XQ, Lee JS, Feng PXL, "Beta Gallium Oxide ( $\beta$ -Ga<sub>2</sub>O<sub>3</sub>) Vibrating Channel Transistor", *Proc. 33rd IEEE Int. Conf. on Micro Electro Mechanical Systems (MEMS 2020)*, 186-189, Vancouver, Canada, January 18-22 (2020).

### Patents Issued (14)

- K. D. Allen, J. P. Dobson, E. G. Yarmola, Z. Kaufman, and D. P. Arnold, "Magnetic Apparatus and Methods of Use," U.S. Patent 10,695,036, Jun. 30, 2020.
- D. P. Arnold and O. D. Oniku, "Mitigation of Contamination of Electroplated Cobalt-Platinum Films on Substrates," U.S. Patent 10,614,953, issued Apr. 7, 2020.
- D. P. Arnold, S. Cheng, and V. R. Challa "Wireless Power Transfer via Electrodynamic Coupling," U.S. Patent 10,541,558, issued Jan. 21, 2020.
- Barnard, C.A., Meloy, J.C., and Sheplak, M., "MEMS Capacitive Shear Stress Sensor System Having an Interface Circuit," United States Patent 10,859,448, issued 12/8/20.
- N. Garraud, C. Rinaldi, and D. P. Arnold, "Magnetic Nanoparticle Spectrometer," U.S. Patent 10,634,742, issued Apr. 28, 2020.
- Seahee Hwangbo and Yong Kyu Yoon, "Glass Interposer Integrated Antenna for Intrachip, Interchip and Board Communications," US Patent No. 10,756,416, issued Aug. 25, 2020.
- John E. Rogers, Mark Sheplak, Yong K Yoon, and Jack Judy, "Passive Wireless Pressure Sensor for Harsh Environments," US Patent No. 10,794,777, issued Oct. 6, 2020.
- Reagan, T.N., Sheplak, M., and Alexander, D.P., "Flush-Mount Micromachined Transducers," United States Patent 10,737,933, issued 8/11/2020.

- Sheplak M., and Keane, C.B., “MEMS Capacitive Wall Shear Stress Vector Measurement System,” United States Patent 10,533,905, issued 1/14/20.
- P. G. Traynor, D. P. Arnold, W. N. Scaife, C. Peeters, and C. V. Cuervo, “Detecting Counterfeit Magnetic Stripe Cards Using Encoding Jitter” U.S. Patent 10,803,261, issued Oct. 13, 2020.
- C.Y. Wu, X. Jiang, M. Pan, J. Lednicky, A. D. Theodore, Z. H. Fan, N. A. Mohajer, “Bioaerosol detection systems and methods of use”, U.S. Patent 10,859,473, issued in May 2020.
- Yong-Kyu Yoon and Sheng-Po Fang, “Magnetic Nanoparticle Embedded Nanofibrous Membrane,” US Patent No. 10,653,818, issued May 19, 2020.
- Yong-Kyu Yoon, “Low Ohmic Loss Superlattice Conductors,” US Patent No. 10,650,937, issued May 12, 2020.
- Yong Kyu Yoon and Arian Rahimi, “Magnetic Field Effect Transconductors,” US Patent No. 10,586,918, issued March 10, 2020.

### Patent Applications (8)

- J. B. Allen, J. S. Andrew, N. D. Ferson, B. D. James, “DNA-Collagen Complexes and Magnetoelectric Janus Materials for Biomedical Applications,” Provisional Patent filed 63/077,229, 2020.
- J. S. Andrew, M. Bauer, and D. P. Arnold, “Magnetoelectric Nanowire Based Antennas,” PCT Patent Application PCT/US2020/019426, filed February 24, 2020.
- D. P. Arnold, A. Garraud, N. Garraud, “Tunable Electrodynamic Wireless Power Receivers,” PCT Patent Application, PCT/US2020/060200, filed Nov. 12, 2020.
- D. P. Arnold and O. D. Oniku, “Mitigation of Contamination of Electroplated Cobalt-Platinum Films on Substrates,” U.S. Patent Application 16/801,978, filed Feb. 26, 2020.
- D. P. Arnold, “Wireless Rechargeable Battery Systems and Methods,” PCT Patent Application PCT/US2020/019463, filed February 24, 2020.
- D. P. Arnold, S. Cheng, and V. R. Challa “Wireless Power Transfer via Electrodynamic Coupling,” U.S. Patent Application 16/735,437, filed Jan. 6, 2020.
- H. O. Fasanya, D. W. Siemann, Z. H. Fan, P. J. Dopico, “Use of ganglioside 2 and 3 for circulating sarcoma cell detection”, PCT application filed in Sep. 2020.
- C.Y. Wu, X. Jiang, M. Pan, J. Lednicky, A. D. Theodore, Z. H. Fan, N. A. Mohajer, “Bioaerosol detection systems and methods of use”, filed in Nov. 2020.