

Center for Wireless and Microwave Information Systems

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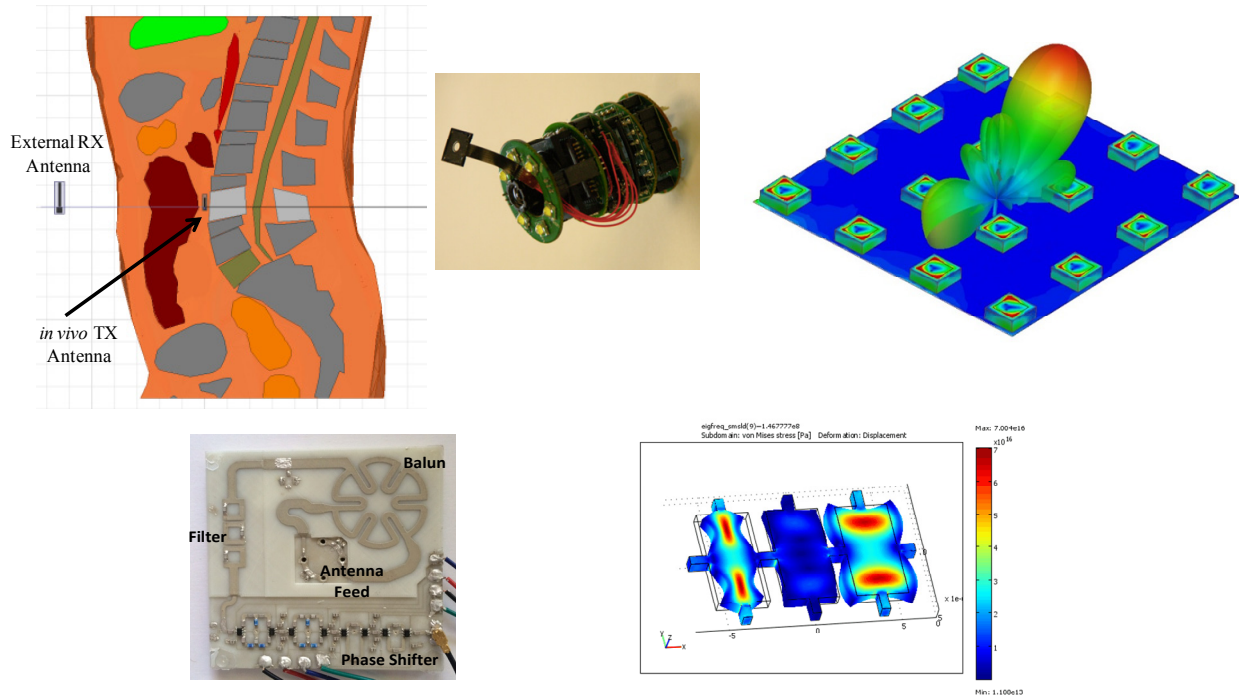
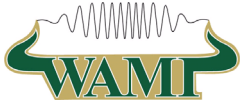
**Department of Electrical Engineering
University of South Florida**

Annual Report 2016

Members: Dr. Huseyin Arslan, Dr. Lawrence Dunleavy, Dr. Richard Gitlin, Dr. Gokhan Mumcu, Dr. Ismail Uysal, Dr. Jing Wang (Co-Director), Dr. Tom Weller (Co-Director)

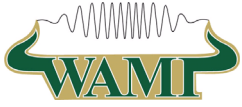
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The Center for Wireless and Microwave Information Systems conducts research across a broad range of technical areas that include device modeling and characterization, micro electromechanical systems, advanced materials and nanoscale devices, active antennas, cognitive radio, next generation wireless architectures and RF identification (RFID). Research projects focus on basic scientific development as well as applications such as biomedical sensing, communications, robotics and transportation. Active collaborations are pursued with multiple industry and university partners as well as several centers at the University of South Florida.

In 2015/16 the Center supported 42 MS and PhD students, 3 post-doctoral fellows and 10 undergraduate students. Center faculty submitted 37 research proposals in the past year; of these 11 proposals were funded. The WAMI faculty had more than 75 publications in journals, conferences and book chapters, 15 patents and gave 9 invited talks. The students and faculty received 11 awards and distinctions including best paper/poster awards and recognition for professional achievement.



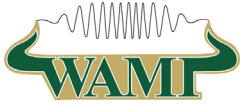
Newsworthy Notes

- The **2016 Rudolf E. Henning Distinguished Mentoring Award** was presented to Dr. Robert Trew at WAMICON 2016. Dr. Trew received the Ph.D. degree from the University of Michigan in 1975. He is currently the Alton and Mildred Lancaster Distinguished Professor of Electrical and Computer Engineering at North Carolina State University, Raleigh. He has served as Head of the Electrical and Computer Engineering Departments of NCSU and Virginia Tech and as Chair of the EEAP Department at Case Western Reserve University. From 2009-2013 Dr. Trew served as the Director of the Electrical, Communications, and Cyber-Systems (ECCS) Division in the Engineering Directorate of the National Science Foundation, and from 1997-2001 he served as Director of Research for the U.S. Department of Defense, with management oversight responsibility for the \$1.3 billion yearly basic research programs of DOD. Dr. Trew is a Life Fellow of the IEEE and a Fellow of the American Association for the Advancement of Science (AAAS). He served three terms as an elected member of the IEEE MTT Society ADCOM and was the 2004 MTT Society President. From 2007-2012 Dr. Trew served as Editor-in-Chief of the IEEE Proceedings, and previously served as Editor-in-Chief of the IEEE Transactions on Microwave Theory and Techniques, and was founding Co-Editor-in-Chief of the award winning IEEE Microwave Magazine. Dr. Trew has twice been named an IEEE MTT Society Microwave Distinguished Lecturer. Awards received by Dr. Trew include the 2014 IEEE MTT Society Pioneer Award, the 2001 IEEE-USA Harry Diamond Memorial Award, an IEEE Third Millennium Medal, the 1998 IEEE MTT Society Distinguished Educator Award, the 1991 Alcoa Foundation Distinguished Engineering Research Award, and a 1992 NCSU Distinguished Scholarly Achievement Award. He has authored or co-authored over 181 publications, 21 book chapters, and has lectured extensively both nationally and internationally, with over 421 presentations. Dr. Trew has twelve patents.



- The **17th annual IEEE Wireless and Microwave Technology (WAMI) Conference** was held in Clearwater, FL on April 11-13, 2016. The plenary talks were “Metamaterials-Enabled Ultra Low C-SWAP Radar for Commercial Airborne Sense and Avoid” (Dr. Tom Driscoll) and “5G: Opportunities, Challenges, and Technologies – The Internet of Tomorrow” (Dr. Rich Gitlin). A total of 12 invited papers from universities





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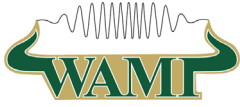
and industry together with 55 other presentations were given during the 3-day event. Consistent with WAMICON tradition, there was also an interactive Student Poster Session held in conjunction with a reception that preceded the conference banquet.

- **Special thanks to Raytheon for their continued financial support, which is used to provide supplemental funds for our students, support conference travel, and allow the WAMI Center to maintain its equipment.**

Another important use of these funds is to support the graduate student lab managers of the Microwave Measurements Lab, the Antenna Test Lab, the MEMS & Materials Lab and the Microwave Assembly Lab (pictured here). The assembly lab was renovated and reorganized in 2016, and now features capabilities for soldering, curing, inspection and image/video capture, and milling/machining. The lab also hosts the center's 0.1 – 1 THz Microtech Instruments spectroscopy system.



- Mini Circuits continues to be a strong supporter of the WAMI teaching laboratory by contributing microwave components. The Center also acknowledges the continuing strong support of Keysight Technologies, National Instruments and Modelithics for providing our students with no-cost access to their exceptional software tools.
- Masters and Ph.D. graduates from the WAMI Center in 2015/2016 are now working for Draper Laboratory, Harris Corporation, Lockheed Martin, Sandia National Lab, Qorvo and Qualcomm.



Student Recognition

- **Denise Lugo**, a WAMI Ph.D. student, received a **best poster award at the 2016 USF College of Engineering Poster Competition**. USF College of Engineering poster competition receives over 100 posters each year from a diverse body of graduate students across 6 departments performing research on externally funded research projects.



- **Michael Grady**, a WAMI Ph.D. student, received awards at the 2016 USF College of Engineering Poster Competition and in the Student Research Poster Competition at the 2016 Wireless and Microwave Technology Conference.



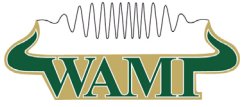
- **Abhishek Dey**, a former WAMI PhD student (currently with Qorvo) received the prestigious **IEEE Antennas and Propagation Society (APS) PhD Fellowship Award**. Each year, IEEE APS awards up to ten \$2,500 fellowships to encourage students to pursue a career in area of electromagnetics. This competition is announced in the IEEE APS magazine, APS webpage, and open to the graduate students across the world. Students are evaluated based on the creativity and quality of their research proposals, discussion of their technical interests, skills, publication tracks, and the recommendation letters they receive from their advisors.



- **Juan Castro**, a WAMI Ph.D. student, received a **best paper award at 2016 SHPE Engineering and Science Symposium** under the **Applied Physics/Electrical and Computer Engineering** category. Juan Castro also received the prestigious **IEEE Microwave Theory and Techniques Society (MTT-S) Microwave Engineering Graduate Fellowship Award**. Each year, IEEE MTT-S awards twelve \$6,000 fellowships to assist graduate students pursuing a graduate degree in microwave engineering (<https://www.mtt.org/graduate-fellowship-recipient>). Juan was awarded the **PHI KAPPA PHI Honor Society Dissertation Fellowship**. Every year, the Phi Kappa Phi awards ten \$10,000 fellowships in support awardee's dissertation research. It is announced in the *Chronicle of Higher Education*.



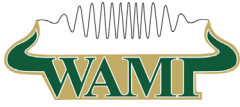
- **Enrique Gonzalez**, a WAMI PhD student, received an **Honorable Mention from the IEEE Antennas and Propagation Society (APS) International Symposium** with his



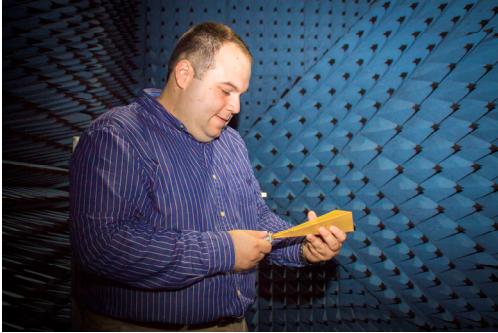
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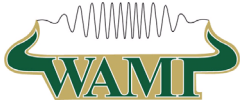
research paper submitted to the student paper competition. IEEE APS Symposium is the IEEE's flagship conference on electromagnetics and antenna technology annually receiving over 1000 paper submissions across the world. Honorable mention award also comes with a \$1,250 stipend to be used towards conference travel.

- **Di Lan** and **Adrian Avila**, who are WAMI Ph.D. students, both received the USF Dissertation Completion Fellowship in support of their dissertation research.



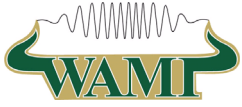
Research Highlights – Current & Recent Projects

- **Integrated Antenna System Design for High Clutter and High Bandwidth Channels Using Advanced Propagation Models**, P.I. P.I. T. Weller, Granting Agency: National Science Foundation. The objective is to investigate adaptive antenna systems for modeling for high clutter environments in machine-to-machine applications.
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- **Rapid Design of Optimal Digitally-Manufactured 3D Electrically-Small Antennas**, P.I. T. Weller, Granting Agency: Central Intelligence Agency. Investigate design and optimization tools for digitally manufactured small antennas.
 - **80-100 GHz Communications System**, PI T. Weller, Sponsor: Harris. The purpose of this project is to design and demonstrate a 80-100 GHz wideband communications system.
 - **Three-Dimensional (3D) Structural Radio Frequency (RF) Electronics**, P.I. T. Weller, Granting Agency: Air Force Research Lab. Investigate a 2.45 GHz phased array module using direct print additive manufacturing techniques.
 - **America Makes: Multimaterial 3D Printing of Electronics and Structures**, PI T. Weller and G. Mumcu, Granting Agency: America Makes (subcontractor to Raytheon). Characterization of 3D printed material systems.
 - **Printable Materials with Embedded Electronics and Radio Frequency Components**, PI T. Weller and G. Mumcu, Granting Agency: Army (subcontract through Sciperio, Inc.). Demonstrate 3D printed microwave components using additive manufacturing techniques.
 - **CAREER: Microfluidically Loaded Highly Reconfigurable Compact RF Devices**, PI: G. Mumcu, Granting Agency: National Science Foundation (NSF). This CAREER effort investigates the novel interdisciplinary concept of microfluidically loaded reconfigurability within the context of RF antennas, filters, and imaging systems. The project proposes unique RF device and imaging array implementations that provide unprecedented reconfigurability, high power handling capability, lower circuit complexity and cost-reductions as compared to the existing technologies.
 - **EAGER: Reconfigurable Textile Antennas and RF Electronics Using Microfluidic Techniques**, PI: G. Mumcu, Granting Agency: National Science



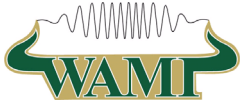
Foundation (NSF). This project focuses on a novel direction for efficient spectrum utilization of body worn RF front-ends by integration of highly functional textile antennas with microfluidics for reconfiguration.

- **High Capacity MM-Wave Wireless Communication Systems Using Spatially Adaptive Smart Antenna Arrays**, PI: H. Arslan and G. Mumcu, Granting Agency: National Science Foundation (NSF). This proposal introduces a novel wireless system adaptation strategy based on repositioning of mm-Wave antenna arrays during the system operation to control the wireless channel gain. The recent developments in the areas of microfluidic based reconfigurable RF devices and multi-dimensional (i.e. frequency, time, and spatial domains) dynamic spectrum access techniques are jointly investigated, for the first time, to significantly enhance wireless communication system performance.
- **Bio-inspired Design for Novel Brain Computer Interfaces** P.I. Uysal, Granting Agency: Southeastern Center for Electrical Engineering Education. To develop novel signal processing algorithms in controlling computers using EEG signals generated by brain activity.
- **Improving the Communications Performance and Reliability of *In Vivo* Wireless Medical Devices** –Gitlin. Initially funded by the NSF and with continued funding from Innovatia Medical Systems, this project has the goal of advancing novel wireless communications technologies that enable high performance, reliable communications, and the ability to overcome link and/or power failures among networked *in vivo* medical devices. A prototypical *MARVEL* robotic camera is being designed with high-definition video and OFDM digital communications to replace the earlier VGA video and analog communications device.
- **Channel Modeling and Optimized Radio Access Design for *In Vivo* Wireless Communication**---Arslan and Gitlin. Funded by QNRF. This project is directed towards developing reliable signal processing and wireless communications technologies and methodologies to address the major challenges of the *in vivo* communication channel that will be faced by emerging wireless body area networks. Channel models have been derived to describe the *in vivo* channel and reported on in many publications including a recently accepted survey paper in an IEEE publication and an invited book chapter is being finalized.
- **Holistically Application-Aware Multi-dimensional Cognitive Radio (HAMCR)** ---Arslan and Gitlin [and Haas (Cornell). Funded by NSF. HAMCR is an application-aware cognitive radio with new technology that enables substantial growth in the capacity of wireless networks, with support for diverse applications, without additional spectrum. HAMCR maximizes spectrum utilization by trading off the spectral resource allocations of connections for the application-level QoS, while still maintaining acceptable levels of QoS for the users of the underlying applications, thus satisfying an increased number of users in times of shortage of spectral resources. This work led to

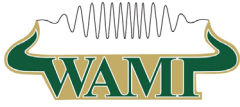


several papers and conference presentations and was the subject of Chao He's PhD dissertation.

- **Application of Photosynthetic Proteins in a Field-Effect Transistor for Low Light Intensity Detection**, P.I. A. Takshi, Co-P.I. J. Wang, Granting Agency: National Science Foundation. The goal is to employ proteins from photosynthetic cells to develop a field effect phototransistor. Due to the unique properties of photon absorption and charge separation in photosynthetic proteins, theoretically the proteins are more sensitive to photons than conventional semiconductors.
- **Development and evaluation at the laboratory level of biosensors for the diagnosis of all dengue virus serotypes based on the Non-Structural protein- 1 (NS-1)**, PI J. Wang, Granting Agency: the Administrative Department of Science, Technology and Innovation–COLCIENCIAS, Colombia. The aim of this work is to develop lab-on-a-chip devices that can be used as immunoassays for all dengue virus serotypes based on the Non-Structural protein-1 (NS-1) for accurate and early diagnosis of dengue infection.
- **Research and Training Internship for Enhanced Microwave and Millimeter-Wave Circuit Design, Characterization and Modeling**, PI: J. Wang, Granting Agency: Modelithics, Inc. and Florida High Tech Corridor. Research and training grant for development and verification of improved models as well as modeling and characterization techniques for high frequency transistors.
- **Pathways to Market of Piezoelectric Elastomer Composites for Additive Manufacturing of Flexible 3D Conformal Acoustic Emission and Ultrasonic Transducer Arrays**, P.I. J. Wang, Grant Agency: National Science Foundation. This program will conduct a thorough market analysis and assessment of piezoelectric-nanocomposite elastomer materials that enable customized design, injection molding or additive manufacturing and ease of deployment of a new class of flexible and 3D conformal ultrasonic transducer arrays. Due to the use of lightweight, low-cost, and piezoelectric composites, enhanced piezoelectric coupling efficiency, improved signal to noise ratio, and tailored frequency responses can be readily achieved for non-destructive structural health monitoring, wearable and point-of-care health diagnosis, and so on.
- **Remote Environmental Monitoring and Diagnostics in the Perishable Supply Chain** P.I. C. Nunes, Co-P.I. I. Uysal, Granting Agency: US Army Natick Soldier RD&E Center. Using RFID sensor technology to monitor freshness of army rations and develop smart distribution systems. This is a joint project with University of Florida.
- **Testing and Calibration of RF Temperature Sensors** P.I. I. Uysal, Granting Agency: RFID Innovative Solutions LLC. Testing and calibration of ISO18000-7 Temperature Sensors developed by RFID IS LLC.



- **Reducing Strawberry Waste and Losses in the Postharvest Supply Chain via Intelligent Distribution Management** P.I. I. Uysal, Co-P.I. C. Nunes, Granting Agency: Walmart Foundation. Temperature mapping of the cold chain with wireless sensors to enable smart distribution practices
- **Increasing Consumption of Specialty Crops by Enhancing their Quality and Safety** P.I. C. Nunes, Co-P.I. I. Uysal, Granting Agency: US Department of Agriculture. Algorithmic modeling of the effects of environmental variables like temperature and humidity on specialty crops.
- **Calibration and Validation of DeltaTrak's Product Emulation Model** P.I. I. Uysal, Granting Agency: DeltaTrak Inc. Testing a product temperature emulation model developed by DeltaTrak to predict product temperatures by measuring ambient temperatures. This is a joint project with University of Florida.
- **Time-temperature Indicator Characterization** P.I. I. Uysal, Granting Agency: DeltaTrak Inc. Characterizing environmental behavior of TTI labels to construct a temperature-stage curve for response analysis and time prediction.
- **Algorithmic prediction and recognition of human activity and falls from wireless accelerometer data** P.I. I. Uysal, Granting Agency: RFID Innovative Solutions LLC. To develop a machine learning algorithm which would automatically recognize falls and other human activity based on measured RFID accelerometer data.
- **Algorithmic estimation of product temperatures using wireless sensors** P.I. I. Uysal, Granting Agency: Deltatrack Inc. To develop and assess an algorithm to correlate ambient air temperatures with the product temperature for more accurate wireless monitoring.



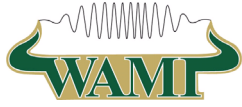
Selected Curriculum Activities

The WAMI faculty was engaged in several on-going and new activities in 2015/2016 aimed at improving the RF/microwave/wireless curriculum. These activities include:

- Dr. Gokhan Mumcu is developing innovative 3D visualization tools, first geared toward the undergraduate electromagnetics course, as part of his NSF CAREER Award. The aim of these tools is to help students grasp abstract concepts such as electromagnetic field propagation along transmission lines.
- Under Dr. Dunleavy's leadership Modelithics and Qorvo are partnering with the WAMI Center in supporting real-world high power GaN power amplifier design/fab/test projects as part of the RF & Microwave PA Design class which was offered in fall 2016.
- Through a partnership with Qorvo, the WAMI faculty has integrated the use of their GaAs process design kit into several of the RF/microwave courses.

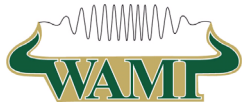
Professional Activities

- **2016 International Workshop on Antenna Technology (IWAT)** – Dr. Mumcu served as the Technical Program Chair for this conference held in Orlando, FL in February 2016.
- **2016 Wireless and Microwave Technology Conference** – Dr. Weller served as the Awards Chair and Student Paper Competition Chair for this conference, which was held in Clearwater Beach, FL in April 2016.
- **IMS 2016 Project Connect** – Dr. Weller served on the organizing committee for this NSF-sponsored project which brings undergraduate and first-year graduate students from under-represented groups to the International Microwave Symposium (San Francisco, May 2016) for professional development training.
- **International Journal of RF Technologies: Research and Applications** – Dr. Uysal was selected to the editorial board.
- **Dr. Gitlin** was appointed a faculty member of USF's Institute for Advanced Discovery & Innovation and gave a keynote on 5G at WAMICON 2016.
- **2017 IEEE International Conference on RFID** – Dr. Uysal will be serving as the Smart Cities Technical Program Co-Chair for the upcoming conference in Phoenix, Arizona in May 2017.

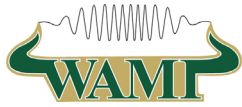


Publications

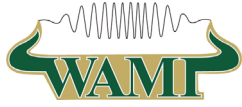
1. E. A. Rojas-Nastrucci, A. D. Snider and T. M. Weller, "Propagation Characteristics and Modeling of Meshed Ground Coplanar Waveguide," in *IEEE Transactions on Microwave Theory and Techniques*, vol. 64, no. 11, pp. 3460-3468, Nov. 2016.
2. J. Castro, E. Rojas, T. Weller and J. Wang, "High-Permittivity and Low-Loss Electromagnetic Comp Ba_{0.55}Sr_{0.45}TiO₃ or MgCaTiO₂ Micro-Fillers for Additive Manufacturing and Their Application to 3D-Printed K-Band Antennas," *the Journal of Microelectronics and Electronic Packaging*, accepted for publication May 8, 2016.
3. D. Hawatmeh; S. LeBlanc; P. Deffenbaugh; T. Weller, "Embedded 6 GHz 3D-Printed Half-Wave Dipole Antenna," in *IEEE Antennas and Wireless Propagation Letters*, vol. PP, no. 99, pp. 1-1.
4. Ketterl, T.P.; Vega, Y.; Arnal, N.C.; Stratton, J.W.I.; Rojas-Nastrucci, E.A.; Cordoba-Erazo, M.F.; Abdin, M.M.; Perkowski, C.W.; Deffenbaugh, P.I.; Church, K.H.; Weller, T.M., "A 2.45 GHz Phased Array Antenna Unit Cell Fabricated Using 3-D Multi-Layer Direct Digital Manufacturing," in *Microwave Theory and Techniques, IEEE Transactions on*, vol. 63, no. 12, pp. 4382-4394, Dec. 2015.
5. Deffenbaugh, P.I.; Weller, T.M.; Church, K.H., "Fabrication and Microwave Characterization of 3-D Printed Transmission Lines," in *Microwave and Wireless Components Letters, IEEE*, vol. 25, no. 12, pp. 823-825, Dec. 2015.
6. Nassar, I.T.; Wang, J.; Frolik, J.L.; Weller, T.M., "A High-Efficiency, Miniaturized Sensor Node With 3-D Machined-Substrate Antennas for Embedded Wireless Monitoring," *Sensors Journal, IEEE*, vol. 15, no. 9, pp. 5036, 5044, Sept. 2015.
7. I. T. Nassar and T. M. Weller, "A Novel Method for Improving Antipodal Vivaldi Antenna Performance," in *IEEE Transactions on Antennas and Propagation*, vol. 63, no. 7, pp. 3321-3324, July 2015.
8. R. Ramirez, D. Lan, J. Wang and T. Weller, "MMIC Packaging and On-Chip Low-Loss Lateral Interconnection using Additive Manufacturing and Laser Machining," accepted to 2017 International Microwave Symposium, December 2, 2016.
9. M. Golmohamadi, R. Ramirez, B. Hewgill, J. Frolik and T. Weller, "Characterization of a Geometrically Constrained Tripolar Antenna," accepted to 2017 EUCAP, November 2016.
10. J. Castro, E. Rojas-Nastrucci, T. Weller and J. Wang, "High-k and Low-Loss Electromagnetic Composites Based on Sintered Titanates for Fused Deposition Modeling of Ku-Band Antennas and Filters," 2016 SHPE Engineering Science Symposium, Seattle, WA, Nov. 4, 2016.
11. E. Rojas, J. Nussbaum, T. Weller and N. Crane, "Metallic 3D Printed Ka-Band Pyramidal Horn using Binder Jetting," accepted to 2016 Latin American Microwave Conference (LAMC), September 2016.
12. R. Ramirez, M. Golmohamadi, J. Frolik and T. Weller, "3D Printed On-Package Tripolar Antennas for Mitigating Harsh Channel Conditions," accepted to 2017 Radio and Wireless Symposium, July 2016.
13. J. Nussbaum, E. Rojas, T. Weller and N. Crane, "Binder Jetting Functional Metal Electronics," submitted to IMECE 2016, March 2016.
14. P. Nesbitt, H. Tsang, K. Church and T. Weller, "4 GHz 3D Printed Balun-fed Bowtie Antenna with Finite Ground Plane for Gain and Impedance Matching Enhancement," 2016 Wireless and Microwave Technology Conference, April 2016.



15. D. C. Lugo, R. A. Ramirez, Jing Wang and T. M. Weller, "Low permittivity cladding to improve the performance of dielectric rod waveguides and dielectric end-fire antennas," 2016 IEEE MTT-S International Microwave Symposium (IMS), San Francisco, CA, USA, 2016, pp. 1-3.
16. E. A. Rojas-Nastrucci, J. Nussbaum, T. M. Weller and N. B. Crane, "Meshed rectangular waveguide for high power, low loss and reduced weight applications," 2016 IEEE MTT-S International Microwave Symposium (IMS), San Francisco, CA, USA, 2016, pp. 1-4.
17. J. Castro, E. Rojas, A. Ross, T. Weller and J. Wang, "High-k and low-loss thermoplastic composites for Fused Deposition Modeling and their application to 3D-printed Ku-band antennas," 2016 IEEE MTT-S International Microwave Symposium (IMS), San Francisco, CA, USA, 2016, pp. 1-4.
18. Patrick Nesbitt, Harvey Tsang, Thomas Ketterl, Justin Nussbaum, Clayton Neff, Paul Deffenbaugh, Nathan Crane, Craig Lusk, Kenneth Church, and Thomas Weller, "3D Printing a 2-18 GHz Current Sheet Antenna: Electrical and Mechanical Characterization," IWAT 2016 – invited paper, Orlando, FL, February 2016.
19. R. A. Ramirez and T. M. Weller, "Dielectric-loaded end-fire slot antenna with low back-lobe radiation for UHF RFID applications," 2016 International Workshop on Antenna Technology (iWAT), Cocoa Beach, FL, 2016, pp. 186-188.
20. D. Hawatmeh, E. Rojas-Nastrucci, and T. Weller, "A Multi-Material 3D Printing Approach for Conformal Microwave Antennas," IWAT 2016.
21. Thomas Ketterl, Casey Perkowski, Paul Deffenbaugh, John Stratton, Joshua Stephenson, Kenneth Church, and Thomas Weller, "Direct Digital Manufacturing of a 2.45 GHz Phased Array," 2016 URSI Conference – invited paper, Boulder, Colorado, January 2016.
22. Eduardo A. Rojas-Nastrucci, Ramiro A. Ramirez, Sean T. Murphy, Mike Newton, and Thomas M. Weller, "A Direct Digital Manufactured RFID System Applied to Teaching Antenna Theory to Pre-College Students," 2015 IMAPS, October 2015.
23. J. Castro, E. Rojas, T. Weller and J. Wang, "Advanced Functional Materials for Additive Manufacturing of 3D Microwave Electronics," 2015 HENAAC, August 2015.
24. Juan Castro, Eduardo Rojas, Thomas Weller and Jing Wang, "Engineered Nanocomposites for Additive Manufacturing of Microwave Electronics," 2015 IMAPS, October 2015.
25. A. A. Gheethan, A. Dey, and G. Mumcu, "Passive Feed Network Designs for Microfluidic Beam-Scanning Focal Plane Arrays and Their Performance Evaluation," IEEE Transactions on Antennas and Propagation, vol. 63, no. 8, pp. 3452 – 3464, Aug. 2015.
26. A. Dey and G. Mumcu, "Microfluidically Controlled Frequency Tunable Monopole Antenna for High Power Applications," IEEE Antennas and Wireless Propagation Letters, vol. 15, pp. 226 – 229, 2016.
27. T. Palomo and G. Mumcu, "Microfluidically Reconfigurable Metallized Plate Loaded Frequency-Agile RF Bandpass Filters," IEEE Transactions on Microwave Theory and Techniques, vol.64, no.1, pp. 158 – 165, Jan. 2016.
28. A. Dey, R. Guldiken, and G. Mumcu, "Microfluidically Reconfigured Wideband Frequency Tunable Liquid Metal Monopole Antenna," IEEE Transactions on Antennas and Propagation, vol. 64, no. 6, pp. 2572 – 2576, June 2016.
29. B. Babayigit, E. Senyigit, and G. Mumcu, "Optimum Broadband E-patch Antenna Design with Taguchi Method," Journal of Electromagnetic Waves and Applications, pp. 1 – 13, 2016.
30. A. Dey and G. Mumcu, "Microfluidically Controlled Metalized Plate Based Frequency Reconfigurable Monopole for High Power RF applications," IEEE Antennas and Propagation Society Symposium, pp. 1 – 2, Vancouver, BC, Canada, July 2015.



31. G. Mumcu, "Microfluidic Based High Gain Beam-Scanning Antenna Arrays for MM-Waves and Beyond," presented in URSI - National Radio Science Meeting, Boulder, CO, USA, Jan. 2016 **(invited)**.
32. A. Dey and G. Mumcu, "Small Microfluidically Tunable Top Loaded Monopole," accepted to IEEE International Workshop on Antenna Technology (IWAT), pp. 148 – 149, Cocoa Beach, FL, March 2016.
33. E. Gonzalez and G. Mumcu, "A Microfluidically Switched Feed Network for Beam-Scanning Focal Plane Arrays," IEEE International Workshop on Antenna Technology (IWAT), pp. 5 – 6, Cocoa Beach, FL, March 2016.
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