

Center for Wireless and Microwave Information Systems

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

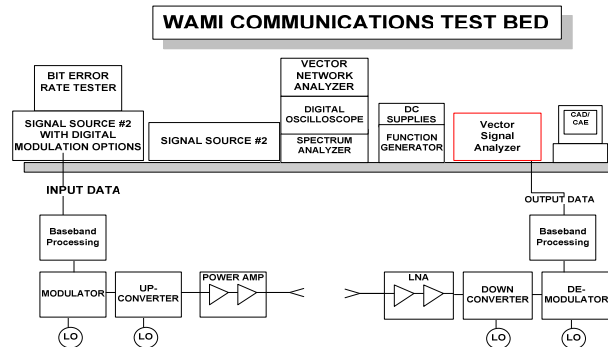
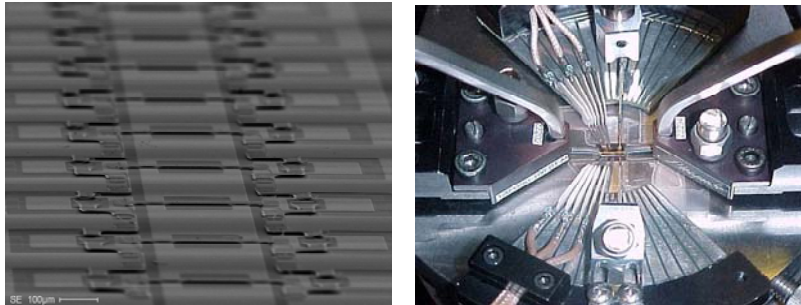
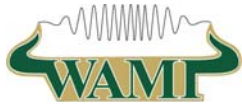
Annual Report 2010

Center Director – Dr. Thomas Weller

**Members: Dr. Adam Anderson, Dr. Huseyin Arslan, Dr. Lawrence Dunleavy, Dr. Rich Gitlin,
Dr. Sal Morgera, Dr. Gokhan Mumcu, Dr. Jing Wang**

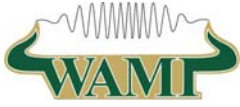
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The Center for Wireless and Microwave Information Systems conducts research across a broad range of technical areas that include device modeling and characterization, RF micro electromechanical systems, advanced materials and nanoscale devices, active antennas, cognitive radio and next generation wireless architectures. 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 2009/10 the Center supported 44 MS and PhD students and 10 undergraduate students. Center faculty submitted over 30 research proposals in the past year; of these 23 proposals were funded including 9 from government agencies. The WAMI faculty had more than 60 publications in journals, conferences and book chapters and gave 7 invited talks.



Newsworthy Notes

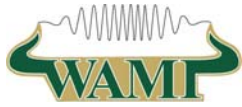
- In 2010 the WAMI Center received a planning grant from the National Science Foundation to pursue site membership in the **ASTREC Industry/University Cooperative Research Center**. The focus of ASTREC is R&D in the field of small satellite technology. The first planning meeting was held in November, 2010 at Harris Corporation in Melbourne, FL. The WAMI Center will be actively working to establish the industry partnerships needed to join ASTREC throughout 2011.
 - The **2010 Rudolf E. Henning Distinguished Mentoring Award** was presented to Dr. Peter M. Asbeck, University of California, San Diego at WAMICON 2011. One colleague of Dr. Asbeck told the Awards Committee, “Regarding innovation, the 2003 Sarnoff Award for his innovative work on HBT’s speaks volumes, but this is only the tip of the iceberg. Inventiveness is encouraged at every corner. Professor Asbeck is able to motivate and inspire individuals to strive for the best they can achieve”.
 - **The 11th annual IEEE Wireless and Microwave Technology (WAMI) Conference** was held in Melbourne Beach, FL on April 12-13, 2010. The conference technical program included two tracks over two days consisting of authors presenting state-of-the-art multidisciplinary research covering wireless RF and microwave technologies. This year a third track was added to accommodate five tutorials. Two hundred attendees came to the conference made up of academia, industry and government from the US/Canada, Europe, Asia, and Latin America.
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- The next **WAMI Advisory Board** meeting is planned for spring 2011 in association with the 2011 WAMICON. We are currently working on the best date for this event.
 - **Gokhan Mumcu**, Ph.D. from The Ohio State University, joined the WAMI Center as an Assistant Professor in fall 2009. Dr. Mumcu’s research is in the area of antenna miniaturization using metamaterial techniques and THz sensing for biomedical applications.
 - Special thanks to ITT and Raytheon for their contributions of financial support, which is used to provide supplemental funds for our students, support conference travel, and allow the WAMI Center to maintain its facilities. 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 Agilent Technologies, Ansoft/Ansys, Applied Wave Research and Sonnet for providing our students with access to their exceptional software tools.



Student Recognition

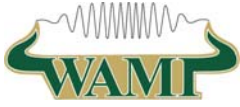
- **David Cure**, a WAMI Ph.D. student, received a NASA GSRP Fellowship in 2009 to support his research on conformal antennas for biomedical applications.
- **Quenton Bonds**, a WAMI Ph.D. student, received a NASA GSRP Fellowship in 2009 to support his research on biomedical radiometry. Quenton earned his Ph.D. in 2010 and is currently employed at NASA Goddard Space Flight Center.
- **Evelyn Benabe**, a WAMI Ph.D. student, received a Microwave Theory and Techniques Society Graduate Student Fellowship in 2009.
- **Cristian Castro** was selected as a 2010 College of Engineering Research Week Poster Award recipient. The title of his poster was “Marvel: A Miniature and Anchored Remote Robotic HD Videoscope for Expedited Laparoscopy.”
- **David Cure** was selected as a 2010 College of Engineering Research Week Poster Award recipient. The title of his poster was “2.45 GHz Low Profile End-Loaded Dipole Backed by a High Impedance Surface.”
- **Cesar Morales** was selected as a 2010 College of Engineering Research Week Poster Award recipient. The title of his poster was “Novel Magneto-Dielectric Polymer Nanocomposite for Miniaturization and Bandwidth Improvement of Microwave Antennas.”
- **Bojana Zivanovic** was selected as a 2010 College of Engineering Research Week Honorable Mention Poster Award recipient. The title of her poster was “Antenna Arrays for Unmanned Vehicles.”





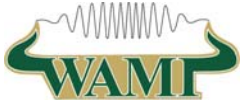
Research Highlights – Current & Recent Projects

- **Functional Magnetic Polymer Nanocomposite Films for Tunable RF Device Applications**, P.I. T. Weller, Co-P.I. H. Srikanth and J. Wang, Granting Agency: National Science Foundation. Development of nanocomposite polymer substrates for microwave applications. A provisional patent application was filed based on research performed in this project: *Magnetically Tunable Nanocomposite Polymer for Microwave Applications*, Provisional Patent Application filed 6/2010, USF Ref: 10A068PR.
- **Non-Linear Device Applications of Nano-Patterned Barium Strontium Titanate Thin Films**, P.I. T. Weller, Co-P.I. A. Kumar and M. Smith (Raytheon), Granting Agency: The National Science Foundation (ECS 0601536. Basic research on the fabrication and characterization of miniaturized (nano-scale) non-linear BST microwave devices. We are currently collaborating with the Center for Ultrafast Science (Dr. John Whitaker) at the University of Michigan to investigate electro-optic sampling of non-linear time domain waveforms resulting for large signal excitation of BST varactors.
- **GOALI – Flexible Ferroelectric-Based Antenna for Conformal Radiometric Imaging**, P.I. T. Weller, Co-P.I. A. Kumar and D. Hoff, Granting Agency: National Science Foundation. In this project the development of tunable conformal antennas and integrated radiometers are being investigated for biomedical sensing and monitoring applications. A provisional patent application was filed based on research performed in this project: *Flexible Low Profile Microwave Antenna*, Provisional Patent Application filed 10/2009, USF Ref. No.: 09B103PR
- **GOALI: Integrated Microwave Microneedle-Electrode System for Fine Scale Material and Device Characterization**, P.I. S. Bhansali, Co-P.I. T. Weller, Granting Agency: National Science Foundation. MEMS-based uni-axial and co-axial microneedles are being integrated with microwave electronics to develop miniature systems for microwave microscopy.
- **GOALI: COLLABORATIVE RESEARCH: Passive, Diamagnetic Inertial Sensing Integrated with High-Sensitivity Telemetry**, P.I. J. Wang, Co-P.I. T. Weller, Granting Agency: National Science Foundation. This is a collaborative project being conducted with the University of Vermont to develop passive sensor networks using high-sensitivity, MEMS-based diamagnetic accelerometers.
- **GOALI: COLLABORATIVE RESEARCH: Antenna-Coupled ALD-Enabled Metal-Insulator-Insulator-Metal Diodes for High Responsivity and High Resolution THz/Infrared Focal Plane Arrays**, P.I. J. Wang, Co-



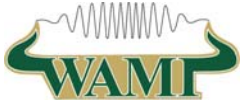
P.I. G. Mumcu, N. Kislov, Granting Agency: National Science Foundation. The objective of this research is to develop a new class of room temperature metal-insulator-insulator-metal tunnel diode detectors and monolithically integrate them within novel miniature antenna focal plane array configurations for high resolution and high responsivity THz/infrared imaging as well as energy harvesting.

- **Development of a High-Density Cylindrical Ion Trap Array Mass Spectrometer using Micro-Fabrication Techniques**, P.I. F. Amerom, Co-P.I. J. Wang, S. Bhansali, T. Short, T. Greely, Granting Agency: National Science Foundation. The objective is to develop high-density cylindrical ion-trap array mass spectrometers using micro-fabrication techniques. The devices will have lower system power and vacuum requirements, compared to more traditional mass spectrometer designs. The mass spectrometers will be used to analyze environmental water samples.
- **Virtually Transparent Epidermal Imagery**, P.I. Y. Sun, Co-P.I. A. Anderson. This work has recently been funded by the NSF as a Cyber-Physical System (CPS) award. The objective of this research is to develop a cyber-physical system capable of displaying the in vivo surgical area directly onto patients' skin in real-time high definition. This system will give surgeons an “x-ray” vision experience, since they see directly through the skin, and remove a spatial bottleneck and additional scarring caused by laparoscopes in minimally invasive surgery. The approach is to develop wireless micro-cameras that: occupy no space required for surgical tools, produce no additional scarring to the patient, and transfer wireless high-definition video images. A virtual view generating system will project the panoramic videos from all cameras to the correct location on the patient’s body with geometry and color distortion compensation. The results will be a potential paradigm shift in minimally invasive surgery.
- **Small Microwave Instrumentation Design**, P.I. A. Anderson. This project is related to a Phase I SBIR award received by Modelithics, Inc., USF, and the University of Florida (UF) that targets the design of miniaturized microwave instrumentation. Standard tabletop instruments (e.g. spectrum analyzer, vector network analyzer (VNA)) are bulky with possible expense ranges in the tens and even hundreds of thousands of dollars. The commercial goal of this SBIR is to first develop a miniature single-port VNA, roughly the same size as a standard USB “pen” drive, using chip-level circuits – hence “chipstruments” will be created to complement tabletop instruments.
- **Research and Training Internship for Enhanced Microwave Characterization and Circuit Design**, 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 for high frequency transistors.
- **Uncooled Nanoscale Infrared High-Speed Sensors for Missile Seeker Applications**, PI: J. Wang, subcontract to NanoCVD, Co. through US-Army SBIR



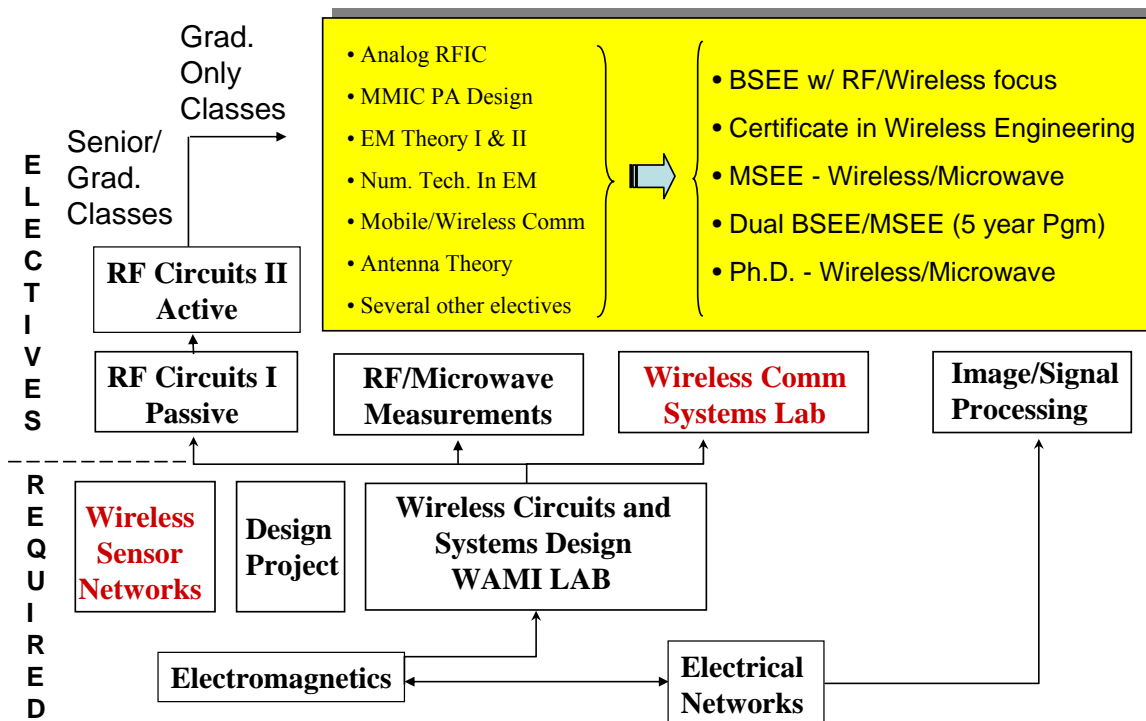
Phase II grant and Florida High Tech Corridor. Development of an uncooled infrared detectors consisting of a microscale antenna in conjunction with a nanoscale metal-insulator-metal tunnel diode (MIMTD). Successful development of uncooled nanoscale infrared high-speed sensors, in accordance with the proposed effort, will open up a variety of applications such as driver's night vision enhancement.

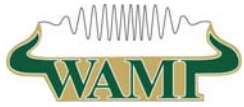
- **Implementation of miniaturized on-chip passives and antennas based on injection-moldable nanocomposites for multi-chip-module (MCM) technology**, PI: J. Wang, Co-PI: R. Toomey, H. Srikanth, Granting Agency: Draper Laboratory and Florida High Tech Corridor. The objective of this work is to advance the current state-of-the-art technology in the area of injection-moldable polymer nanocomposites with monodispersed dielectric/magnetic particles and minimal cure shrinkage for multi-chip module (MCM) assembly.
- **Development of Miniature On-Chip Low-Loss High-Q Filter Arrays**, PI: J. Wang, Granting Agency: Raytheon Company and Florida High Tech Corridor. The objective is to design, develop and demonstrate a new class of miniature on-chip low insertion-loss high-Q tunable filters with key emphasis on the manufacturability.
- **Miniature Metamaterial Antennas for High Resolution THz Imaging Arrays**, PI: G. Mumcu, New Researcher Grant, University of South Florida. Miniaturization of slot dipoles using metamaterial based miniaturization and antenna loading techniques. Conventional CPW fed slot antennas will be miniaturized by >50% to enable a significantly improved resolution for mm-wave and THz imaging applications.
- **Metamaterial based Antennas & Coupling reduction for Miniature Anti-Jam GPS Arrays**, PI: G. Mumcu, Raytheon IDEA Program and Florida High Tech Corridor. The proposed dual band miniature ($\leq \lambda/10 \times \lambda/10$) GPS antenna elements and their coupling reduction within a tightly packed array environment through the use of metamaterial structures will pave the way for realization of miniature anti-jam GPS arrays, potentially realizing performance of a 14" diameter Complex Radiation Pattern Antenna (CRPA) within <5" diameter Fixed Radiation Pattern Antenna (FRPA) size.



Selected Curriculum Activities

The WAMI faculty continues to advance the educational opportunities provided to undergraduate and graduate students in USF's Electrical Engineering Department. In *Educating the Engineer of 2020*, Charles Vested noted "We need to establish a proper intellectual framework within which to study, understand, and develop large, complex engineered systems." In addressing this call to action, the WAMI Center has participated in a multi-year project sponsored by the National Science Foundation to develop system-centric undergraduate curriculum. The project involves USF, the University of Vermont, Northern Arizona University and the University of Hawaii; the USF PI is Tom Weller. One product of this project is a collection of on-line modules constituting a course on wireless sensor networks, several of which were incorporated into USF's RF/Microwave Circuits I and II courses in the past year. An IEEE MTT-sponsored international video competition for systems-based capstone design projects was also conducted. Details on this project are available at <http://www.uvm.edu/~muse/#>.

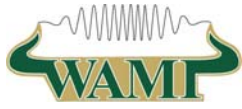




Professional Activities

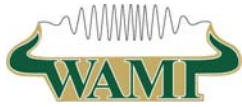
- **WAMI Advisory Board Meeting**
– The 12th meeting of the WAMI Center’s External Advisory Board was held in Melbourne, FL in April 2010 prior to 2010 WAMICON.
- **2014 International Microwave Symposium** – Drs. Dunleavy and Weller are chair and co-chair, respectively, for the IEEE MTT Society’s flagship conference that will be held in Tampa in 2014. While the event is still several years away, planning is already in progress!





Recent Publications and Presentations – 2009-10

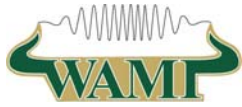
1. C. Morales, J. Dewdney, S. Pal, S. Skidmore, K. Stojak, H. Srikanth, T. Weller and J. Wang, "Tunable Magneto-Dielectric Polymer Nanocomposites for Microwave Applications," IEEE Transactions on Microwave Theory and Techniques, In Press, 2010.
2. S. Natarajan, D. Hoff and T. Weller, "Polyimide Core 3-D Rectangular Micro Coaxial Transmission Lines," accepted to Microwave and Wireless Component Letters, January 2010.
3. S. Baylis, S. Presas, and T. Weller, "Wide Bandwidth Varactor-Tuned Patch Antenna," IEE Electronics Letters, Vol. 45, Issue 16, pp. 816-818, July 2009.
4. Frolik, J.; Weller, T.M.; DiStasi, S.; Cooper, J. , "A Compact Reverberation Chamber for Hyper-Rayleigh Channel Emulation," Antennas and Propagation, IEEE Transactions on , vol.57, no.12, pp.3962-3968, Dec. 2009.
5. T. Weller, J. Wang, S. Hariharan, S. Pal, C. Morales, J. Dewdney and V. Carias, "Characterization of Dielectric and Magnetic Properties of Functionalized Polymer Nanocomposites for Microwave Device Applications", Proceedings of 2011 NSF Engineering Research and Innovation Conference, Atlanta, Georgia, January 2011.
6. Jeff Frolik, Tom Weller, Paul Flikkema, Carol Haden, "Implementing an Inverted Classroom using Tablet PCs for Content Development," 2010 WIPTE Conference, October 2010.
7. Ibrahim T. Nassar and Thomas M. Weller, "An Electrically Small Meandered Line Antenna with Truncated Ground Plane," accepted to Radio and Wireless Symposium, January 2011.
8. C. Morales, et al., "Magnetic Responsive Polymer Nanocomposites Thin Films: Synthesis, Characterization and Implementation in RF/Microwave Applications," AVS 57th International Symposium & Exhibition, June 2010.
9. J. Dewdney, C. Morales, S. Skidmore, T. Weller, and Jing Wang, "Field Dependence of Complex Permeability and Permittivity of Composite Materials Extracted by Nicholson-Ross-Weir Method with Improved Algorithm," 43rd International Symposium on Microelectronics, Oct. 31-Nov. 4, 2010.
10. C. Morales, J. Dewdney, S. Skidmore, S. Pal, K. Stojak, H. Srikanth, T. Weller, Jing Wang, "Functionalized Magneto-Dielectric Polymer Nanocomposites for High Performance RF and Microwave Device Applications," 43rd International Symposium on Microelectronics, Oct. 31-Nov. 4, 2010.
11. Paul Flikkema, Rhonda Franklin, Jeff Frolik, Carol Haden, Wayne Shiroma, and Tom Weller, "MUSE – Multi-University Systems Education Mini-Workshop," 2010 Frontiers in Education Conference, October 2010.
12. "Magnetic polymer composites with tunable microwave properties" –K. Stojak, S.Pal, H. Srikanth, S. Skidmore, C. Morales, J. Dewdney, J. Wang and T. Weller, APS March meeting, Portland OR (March 15 – 19, 2010).
13. T. Price, E. Benabe, T. Weller, Y. Emirov and A. Kumar, "Sub-Micron Gap Capacitors using Ferroelectric Thin-Films," ISIF2010 Symposium, San Juan, June 2010.
14. P. Flikkema, J. Frolik, W. Shiroma, T. Weller and C. Haden, "Experiential Learning of Complex Engineered Systems in the Context of Wireless Sensor Networks," 2010 ASEE Conference, Louisville, KY, June 2010.



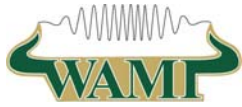
15. D. Cure, S. Melais, T. Weller, P. Herzig and R. Roeder, "2.45 GHz End-Loaded Dipole Backed by a High Impedance Surface," 2010 IEEE AP-S, Toronto, July 2010.
16. C. Morales, et al., "Magnetically Tunable Nanocomposites for Microwave Applications," IEEE International Microwave Symposium, Anaheim, June 2010.
17. J. McKnight, B. Zivanovic, T. Weller and C. Costas, "A Series-Fed Coplanar Waveguide Slot Antenna Array," IEEE WAMICON, April 2010.
18. C. Morales, J. Dewdney, S. Chandra, S. Pal, K. Stojak, H. Srikanth, T. Weller and Jing Wang, "Magnetic Polymer Nanocomposites for RF and Microwave Applications," Proceedings Advanced Technology Workshop and Tabletop Exhibition on Printed Devices and Applications, Orlando, FL, May 6-7, 2010
19. Q. Bonds, T. Weller, B Roeder and P. Herzig, "A Tunable Cavity Backed Slot Antenna (CBSA) for Close Proximity Biomedical Sensing Applications," 2009 COMCAS, July 2009.
20. Scott Skidmore, Tom Weller, Hariharan Srikanth, Susmita Pal, Kristen Stojak, and Antonije R. Djordjevic, "Characterization of Functional Magnetic Polymer Nanocomposite Films for Tunable RF Device Applications," Virginia Tech's Annual Symposium Wireless Communications, Blacksburg, VA, June 2009.
21. T. Weller, H. Srikanth, J. Wang, C. Morales, J. Dewdney, S. Skidmore, S. Pal, S. Chandra, K. Stojak, "Microwave Characterization of Magnetic Polymer Nanocomposites using Transmission-line and Microwave Resonator Based Test Structures," 2009 CMMI Grantees Conference, Honolulu, HA, June 2009
22. Charles Baylis, Lawrence Dunleavy, Steven Lardizabal, Robert J. Marks II, and Alberto Rodriguez, "Efficient Optimization Using Experimental Queries: A Peak-Search Algorithm for Efficient Load-Pull Measurements," Accepted September 2010 for publication in *Journal of Advanced Computational Intelligence and Intelligent Informatics*.
23. L. Dunleavy, C. Baylis, II, W. Curtice, and R. Connick, "Modeling GaN: Powerful but Challenging," *IEEE Microwave Magazine*, pp82- 96, October 2010.
24. S. Meena, C. Baylis, L. Dunleavy, M. Marbell, "Duty Cycle Dependent Pulsed IV Simulation and Thermal Time Constant Model Fitting for LDMOS Transistors," *74th ARFTG Symposium Dig.*, Boulder, CO, Dec. 2009.
25. C. Baylis, J. Perry, M. Moldovan, R. Marks II, and L. Dunleavy, "Voltage Transient Measurement and Extraction of Power RF MOSFET Thermal Time Constants," *74th ARFTG Symposium Dig.*, Boulder, CO, Dec. 2009.
26. C. Baylis, L. Dunleavy, R. Connick, "Modeling Considerations for GaN HEMT Devices," pp1-2, 10th IEEE WAMICON 2009, April 2009.
27. D. Sosa-Martin, R. Connick, and L. Dunleavy, "Software Automation for Measurement-Based Behavioral Models," 10th IEEE WAMICON 2009, pp1-5, April 2009.
28. R. Connick, L. Dunleavy, "Surface Mount Switch Modeling with System Data Models," 10th IEEE WAMICON 2009, pp1-3, April 2009.
29. L. Dunleavy, "Understanding Noise Parameter Measurements," *Microwave Journal*, January 2009.
30. Daniel Sosa martin, Lawrence Dunleavy, "Program Calibrates VNAs for Broadband Accuracy," *Microwaves & RF*, January 2009.
31. Cesar A. Morales-Silva, Lawrence Dunleavy, Rick Connick, "Noise Parameter Measurements Verification By Means Of Benchmark Transistors," *High Frequency Design Magazine* January 2009.



32. G. Mumcu, K. Sertel, and J. L. Volakis, "Lumped Circuit Models for Degenerate Band Edge and Magnetic Photonic Crystals," *IEEE Microwave and Wireless Components Letters*, vol. 20, no. 1, pp. 4-6, Jan. 2010.
33. L. Zhang, K. Shqau, H. Verweij, G. Mumcu, K. Sertel, and J. L. Volakis, "A Viable Route for Dense TiO₂ with a Low Microwave Dielectric Loss," *Journal of the American Ceramic Society*, vol. 93, no. 4, pp. 969 – 972, 2010.
34. G. C. Trichopoulos, G. Mumcu, K. Sertel, H. L. Mosbacker, and P. Smith, "A Novel Approach for Improving Off-axis Pixel Performance of THz Focal Plane Arrays," *IEEE Transactions on Microwave Theory and Techniques*, vol. 58, no. 7, pp. 2014 – 2021, July 2010.
35. N. Apaydin, E. Irci, G. Mumcu, K. Sertel, and J. L. Volakis, "Miniature Antennas Based on Printed Coupled Lines Emulating Anisotropy," *IET Microwaves, Antennas and Propagation*, vol. 4, no. 8, pp. 1039 – 1047, Aug. 2010.
36. O. Ajayi, G. Mumcu, and J. Wang, "Antenna-Coupled ALD based Metal-Insulator-Metal Diodes focal plane imaging array for high sensitivity direct detection of excised tissue characteristics," presented in *IEEE Antennas and Propagation Society Symposium*, Toronto, Ontario, Canada, July 2010.
37. S. Gupta and G. Mumcu, "Miniature Dual-band and Wideband Antennas Based on Printed Circuit Emulation of Anisotropy," *IEEE Antennas and Propagation Society Symposium Proceedings*, pp. 1 – 4, Toronto, Ontario, Canada, July 2010 (student paper competition finalist – selected among the top 15 out of ~150 competing papers).
38. G. Mumcu and J. L. Volakis, "Negative Refractive Index Metamaterial and Electromagnetic Band Gap Based Antennas," in *Small Antennas Miniaturization Techniques & Applications* by J. L. Volakis, C-C. Chen, and K. Fujimoto: Mc Graw Hill, 2010.
39. G. Mumcu, K. Sertel, and J. L. Volakis, "Antenna Miniaturization Using Magnetic Photonic and Degenerate Band Edge Crystals," in *Small Antennas Miniaturization Techniques & Applications* by J. L. Volakis, C-C. Chen, and K. Fujimoto: Mc Graw Hill, 2010.
40. J. Dewdney, I-T. Wu, M. Wei, and Jing Wang, "Reduction of Impedance and Feedthrough Parasitics of RF Micromechanical Resonators," *Proceedings of the 11th Topical Meeting on Silicon Monolithic Integrated Circuits in RF Systems*.
41. O. Ortiz, A. Vidyasagar, Jing Wang and R. Toomey "Surface Instabilities in Ultrathin, Cross-linked Poly(N-isopropylacrylamide) Coatings," *Langmuir*, 2010, Vol. 26, no. 22, pp. 17489–17494.
42. I. Rivera, R. Joshi, Jing Wang, "Graphene-Based Ultra-Sensitive Gas Sensors," accepted by the *IEEE Sensors 2010 Conference*, November 1-4, 2010.
43. Mohamed A. S. Aly, and Jing Wang, "Design and Simulation of Mechanically-Coupled Filters Based on ZnO Piezoelectrically Transduced Contour Mode Ring Resonators," *Proceedings of the International Conference on Nanotechnology: Fundamentals and Applications*, Ottawa, Ontario, Canada, 4-6 Aug. 2010.
44. I-Tsang Wu, Nikolai Kislov, and Jing Wang, "Metal-insulator-metal tunneling diode for uncooled infrared high-speed detectors," *Proceedings SPIE 7679*, 2010.
45. Kosol Son, Nikolai Kislov, and Jing Wang, "Development of infrared detector with slot antenna-coupled microbolometer," *Proceedings SPIE 7660*, 2010.
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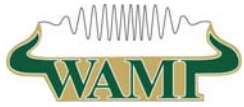


47. Mian Wei, Mingke Xiong, I-Tsang Wu and Jing Wang, "Fabrication and Material-Centric Design of Atomic Layer Deposition (ALD) Enabled Micromechanical Resonators," *Nanoscience and Nanotechnology Letters*, Vol. 2, pp. 157–162, 2010.
48. I-Tsang Wu, Nikolai Kislov, and Jing Wang, "Fabrication of Thin-Film Nano-Scale Metal-Insulator-Metal (MIM) Tunnel Diode using Conventional Photolithography," *Nanoscience and Nanotechnology Letters*, Vol. 2, no. 2, pp. 144-149, June 2010.
49. C.L. Frewin, C.Locke, Jing Wang, P.Spagnol and S.E.Saddow, "Growth of cubic silicon carbide on oxide using polysilicon as a seed layer for micro-electro-mechanical machine applications," *Journal of Crystal Growth*, Vol. 311, No. 17, pp. 4179-4182, August, 2009.
50. P. Khanna, N. Ramachandran, J. Yang, Jing Wang, A. Kumar, M. Jaroszeski and S. Bhansali, "Nanocrystalline diamond microspikes increase the efficiency of ultrasonic cell lysis in a microfluidic lab-on-a-chip," *Diamond and Related Materials*, Vol. 18, No. 4, pp. 606-610, April, 2009.
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