IEEE EDS Vancouver Mini-colloquium, Date: Oct 2nd, 2017, 9:30 am -4:30 pm
Location: ASB 9896, Simon Fraser University, Burnaby, BC, Canada

Dr. Meyya Meyyappan
NASA Ames Research Center
Moffett Field, CA 94035

Title: Something Different: Nanoscale Vacuum Electronics

Abstract: We have been fabricating nanoscale vacuum tubes over the last three years using entirely and exclusively silicon technology. Vacuum is superior to any semiconductor in terms of electron transport, in addition to being immune to all radiations. We have combined the best of vacuum transport and silicon technology to fabricate surround gate nanoscale vacuum transistors on 8 " wafers with a channel dimension of 50 nm. These vacuum transistors, operating at a drive voltage of only 2 V, which is remarkable for vacuum devices, have the potential for THz electronics and several other applications. This talk will also provide an overview of our recent activities in printable electronics including gas sensors, antennas and triboelectric nanogenerators. To enable a one-step printing without the need for post-deposition thermal treatment, we have developed an atmospheric pressure plasma jet printing technology. This is an alternative to inkjet printing for depositing conducting, semiconducting, insulating and other materials on a variety of flexible substrates. The author thanks Jin-Woo Han, Ram Prasad Gandhiraman, Jessica Kohene, Dongil Moon, Myeonglok Seoul, Sunjin Kim, Daniel Kim, Kyung Jean Yoon, Furman Thompson and Niki Werkheiser.

Biography: Meyya Meyyappan is Chief Scientist for Exploration Technology at NASA Ames Research Center in Moffett Field, CA. Until June 2006, he served as the Director of the Center for Nanotechnology. He is a founding member of the Interagency Working Group on Nanotechnology (IWGN) established by the Office of Science and Technology Policy (OSTP). The IWGN is responsible for putting together the National Nanotechnology Initiative.

Dr. Meyyappan has authored or co-authored over 360 articles in peer-reviewed journals and made over 250 Invited/Keynote/Plenary Talks in nanotechnology subjects across the world and over 200 seminars at universities. His research interests include carbon nanotubes, graphene, and various inorganic nanowires, their growth and characterization, and application development in chemical and biosensors, instrumentation, electronics and optoelectronics. Dr. Meyyappan is a Fellow of the Institute of Electrical and Electronics Engineers (IEEE), Electrochemical Society (ECS), American Vacuum Society (AVS), Materials Research Society (MRS), Institute of Physics (IOP), American Institute of Chemical Engineers (AIChE), American Institute of Mechanical Engineers (ASME), National Academy of Inventors, and the California Council of Science and Technology. He is currently the IEEE Electron Devices Society (EDS) Distinguished Lecturer, and was the Distinguished Lecturer on Nanotechnology for both the IEEE Nanotechnology Council and ASME. For his contributions and leadership in nanotechnology, he has received numerous awards including: a Presidential Meritorious Award; NASA's Outstanding Leadership Medal; Arthur Flemming Award given by the Arthur Flemming Foundation and the George Washington University; IEEE Judith Resnick Award; IEEE-USA Harry Diamond Award; AIChE Nanoscale Science and Engineering Forum Award; Distinguished Engineering Achievement Award by the Engineers' Council; Pioneer Award in Nanotechnology by the IEEE-NTC; Sir Monty Finniston Award by the Institution of Engineering and Technology (UK); Outstanding Engineering Achievement Merit Award by the Engineers' Council; IEEE-USA Professional Achievement Award; AVS Nanotechnology Recognition Award; IEEE Nuclear and Plasma Sciences Society Merit Award; Distinguished Grumman Project Engineering Award by the Engineers' Council. For his sustained contributions to nanotechnology, he was inducted into the Silicon Valley Engineering Council Hall of Fame in 2009. He received an Honorary Doctorate in 2015 from the University of Witwatersrand, Johannesburg, South Africa for his scientific contributions. For his educational contributions, he has received: Outstanding Recognition Award from the NASA Office of Education; the Engineer of the Year Award (2004) by the San Francisco Section of the American Institute of Aeronautics and Astronautics (AIAA); IEEE-EDS Education Award; IEEE-EAB (Educational Activities Board) Meritorious Achievement Award in Continuing Education.

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Dr. Paul R. Berger
Professor
The Ohio State University
Columbus, OH

Title: Highly repeatable room temperature negative differential resistance in AlN/GaN resonant tunneling diodes

Abstract: III-nitride RTDs have attracted a great deal of interest in recent years as they have potential to increase the power output and operating temperature of RTDs due to the large band offsets available in pseudomorphic and III-nitride heterojunctions (~2 eV for AlN/GaN). Subsequently, intraband tunneling could enable a new class of tunneling injection devices. For example, the combination of RTDs with plasmonic modes in a III-nitride HEMT structure could lead to power gain at high frequencies. AlN/GaN resonant tunneling diodes (RTD) grown on low dislocation density semi-insulating (SI) bulk GaN substrates via plasma-assisted molecular-beam epitaxy (MBE) will be reported here. The devices were fabricated using a six mask level, fully isolated process. Stable room temperature negative differential resistance (NDR) was observed. The NDR exhibited no hysteresis, background light sensitivity, or degradation of any kind after more than 1000 continuous up-and-down voltage sweeps. Results exhibited a ~90% yield of operational devices which routinely displayed an average peak current density of 2.7 kA/cm2 and peak-to-valley current ratio (PVCR) of ~ 1.15 across different sizes.

Biography: Paul R. Berger (S'84 M'91 SM'97 F'11) is a Professor in Electrical & Computer Engineering at Ohio State University and Physics (by Courtesy). He is also a Distinguished Visiting Professor at Tampere University of Technology in Finland. He received the B.S.E. in engineering physics, and the M.S.E. and Ph.D. (1990) in electrical engineering, respectively, all from the University of Michigan, Ann Arbor. Currently, Dr. Berger is actively working on quantum tunneling devices, printable semiconductor devices & circuits for IoT, bioelectronics, novel devices, novel semiconductors and applied physics. Formerly, he worked at Bell Laboratories, Murray Hill, NJ (1990-'92) and taught at the University of Delaware in Electrical and Computer Engineering (1992-2000). In 1999, Prof. Berger took a sabbatical leave while working first at the Max-Planck Institute for Polymer Research, Mainz, Germany while supported by Prof. Dr. Gerhard Wegner and then moved on to Cambridge Display Technology, Ltd., Cambridge, United Kingdom working under Dr. Jeremy Burroughes. In 2008, Prof. Berger spent an extended sabbatical leave at IMEC (Interuniversity Microelectronics Center) in Leuven, Belgium while appointed as a Visiting Professor in the Department of Metallurgy and Materials Engineering, Katholieke Universiteit Leuven, Belgium. And more recently he took a sabbatical leave in 2015-2016 at Tampere University of Technology with the Prof. Don Lupo in the Printed and Organic Electronics Group. He has authored over 110 articles, 5 book sections and been issued 22 patents with 6 more pending from 60 + disclosures with a Google Scholar H-index of 33. Some notable recognitions for Dr. Berger were an NSF CAREER Award (1996), a DARPA ULTRA Sustained Excellence Award (1998), a Lumley Research Award (2006, 2011), a Faculty Diversity Excellence Award (2009) and Outstanding Engineering Educator for State of Ohio (2014). He has been on the Program and Advisory Committees of numerous conferences, including the IEDM, ISDRS, EDTM meetings. He currently is the Chair of the Columbus IEEE EDS/Photonics Chapter and Faculty Advisor to Ohio State's IEEE Student Chapters. He is a Fellow and Distinguished Lecturer of IEEE EDS and a Senior member of Optical Society of America.

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Dr. Mina Rais-Zadeh
Associate Professor
University of Michigan
Ann Arbor, Michigan

Title: Gallium Nitride Based Integrated Microsystems

Abstract: In the last few years we have seen rapid growth of III-V semiconductors geared towards a variety of applications where silicon performance falls short. GaN, a III-V semiconductor, is proven to be the material of choice for high-frequency, high-power, and high-temperature applications. GaN also offers a number of excellent mechanical properties, making it a suitable material for MEMS. This talk discusses the application of GaN micromechanical devices in timing and integrated sensing.

Biography: Mina Rais-Zadeh received the B.S. degree in electrical engineering from Sharif University of Technology and M.S. and Ph.D. degrees both in Electrical and Computer Engineering from Georgia Institute of Technology in 2005 and 2008, respectively. From 2008 to 2009, she was a Postdoctoral Research Fellow at Georgia Institute of Technology. In 2009, she joined the University of Michigan, Ann Arbor, as an Assistant Professor of Electrical Engineering and Computer Science (EECS). Since 2014, she has been an Associate Professor in EECS with courtesy appointment in the Department of Mechanical Engineering. She is currently at NASA JPL and on leave of absence from U. of Michigan.

Dr. Rais-Zadeh is the recipient of the NSF CAREER Award (2011), IEEE Electron Device Society Early Career Award (2011), NASA Early Career Faculty Award (2012), the Crosby Research Award from the University of Michigan (2013), National Academy of Engineering Frontiers of Engineering (2013), ONR Young Investigator Award (2014), IEEE Sensors Council Early Career Technical Achievement Award (2015), and University of Michigan EECS Outstanding Achievement Award (2016). Together with her students, she received the best poster award at the Transducers conference (2013), the best paper award at the IEEE SiRF conference (2014, 2016), honorable mention at the IEEE IMS (2014), and was the finalist in student paper competitions at the SiRF (2007) and IMS (2011) conferences. She is an associate editor for the IEEE Journal of Microelectromechanical Systems (JMEMS) and on editorial board of Nature Scientific Reports. Her research interests include electron devices for wireless communication and sensing applications and the related device physics, resonant micromechanical devices, RF MEMS, gallium nitride MEMS, and micro/nano fabrication process development.

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Dr. Héctor J. De Los Santos
NanoMEMS Research, LLC
Irvine, California 92604 USA

Title: Theory of Nano-Electron-Fluidic Logic (NFL): A New Digital "Electronics" Concept

Abstract: As predicted by Gordon Moore more than 40 years ago, the number of transistors able to fit on a computer chip has doubled approximately every 18 months. But if the trend is to continue for the years to come, it will have to be with technology other than the conventional CMOS design. As the size of transistors gets down to the nanoscale, CMOS devices begin to suffer from several issues, in particular, increased resistance, decreased channel mobility, and increased manufacturing costs. To overcome the challenges involved with scaling, researchers from around the world have begun to look for alternatives to CMOS technology. Our recently introduced concept, called nano-electron-fluidic logic (NFL), is based, not on electron particle transport, but on the generation, propagation, and manipulation of surface plasma waves (plasmons) in an electron fluid. NFL gates are projected to exhibit femtojoule power dissipations and femtosecond switching speeds at finite temperatures, while taking full advantage of established semiconductor manufacturing infrastructure. NFL represents a paradigm shift in digital technology, and is poised as a strong candidate for "beyond-CMOS" digital logic. This talk presents the theory, physics and design principles of NFL.

Biography: Héctor J. De Los Santos received the Ph.D. degree in electrical engineering from Purdue University, West Lafayette, IN, in 1989. He founded NanoMEMS Research, LLC, Irvine, CA, a company engaged in Nanoelectromechanical Quantum Circuits and Systems (NEMX) and RF MEMS (NanoMEMS) research, consulting, and education, where he focuses on discovering fundamentally new devices, circuits and design techniques. Prior to founding NanoMEMS in 2002, he spent two years as a Principal Scientist, RF MEMS, at Coventor, Inc., Irvine, CA. From 1989 to 2000, he was with Hughes Space and Communications Company, Los Angeles, CA, where he served as Principal Investigator and the Director of the Future Enabling Technologies IR&D Program. Under this program he pursued research in RF MEMS, quantum functional devices and circuits and photonic bandgap crystal devices and circuits. He holds over 30 U.S., European, German and Japanese patents and is author of bestseller textbooks, including, *Introduction to Microelectromechanical (MEM) Microwave Systems,* Norwood, MA: Artech House, 1999 [This book was the first in the RF MEMS field and has become an Artech House classic, now being in their IPF® (In-Print-Forever®) program], *RF MEMS Circuit Design for Wireless Communications,* Norwood, MA: Artech House, 2001, and *Principles and Applications of NanoMEMS Physics*, Dordrecht: The Netherlands: Springer, 2005. His most recent book, *Radio Systems Engineering: A Tutorial Approach*, was published by Springer, New York, in 2014. His research interests include, theory, modeling, simulation, design and demonstration of emerging devices (electronic, plasmonic, nanophotonic, mechanical systems in the quantum regime, etc.), and wireless communications. During the 2010-11 academic year he held a German Research Foundation (DFG) *Mercator Visiting Professorship* at Institute for High-Frequency Engineering and Electronics, Karlsruhe Institute of Technology/University of Karlsruhe, Germany, where his activities included teaching, and conducting research on his DFG-funded project "Nanoelectromechanical Interferometric Tuning with Non-Equilibrium Cooling for Microwave and mm-Wave Electronics". From 2001-2003 he lectured worldwide as an IEEE Distinguished Lecturer of the Microwave Theory and Techniques Society. Since 2006 he has been an IEEE Distinguished Lecturer of the Electron Devices Society. He is a member of Tau Beta Pi, Eta Kappa Nu and Sigma Xi. He is an IEEE Fellow.