Department of Electrical and Computer Engineering
UNIVERSITY OF WISCONSIN-MADISON

SEMINAR NOTICE

Monday, March 5, 2018
4:00 – 5:00pm, RM 1610 EH

Professor Peter Ma

Unipolar CMOS Logic and Ferroelectric Memory: Two Emerging Technologies that Help to Defy the Demise of Moore's Law

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Abstract - It is widely accepted that the traditional Moore's Law based on scaling is about to run its course, although there is unwavering incentive to maintain the benefits of the Moore's Law in terms of improved performance and power consumption, as well as reduced cost. This talk will introduce two emerging technologies, of which one is named the Unipolar CMOS Logic technology while the other is named the 1-T Ferroelectric Memory technology. Both promise to maintain the performance/power/cost advances that one might expect from extrapolation of the Moore's Law without further scaling.

Both of the aforementioned technologies benefit from the emergence of novel materials that possess the enabling electronic properties. More specifically, the Unipolar CMOS Logic technology is designed to benefit the use of emerging transistor materials, such as III-V and 2D semiconductors that are difficult (if not impossible) to fabricate conventional CMOS IC's with matching P- and N-channel transistors on the same substrate. This is because the Unipolar CMOS technology requires only P or N-channel transistors to realize CMOS-like logic functions without sacrificing the standby power. Meanwhile, the 1-T Ferroelectric Memory technology is enabled by the emergence of the HfO_2-based ferroelectric gate stack engineered on top of a transistor channel to form the single-transistor memory cell that can behave either as DRAM or as Flash, depending on the programming strength. Compared to DRAM, the 1T ferroelectric memory has the advantage of orders of magnitude longer retention and astonishingly lower power consumption, while compared to Flash, it operates at strikingly higher write/erase speed with much lower power consumption. The most intriguing feature of the 1-T Ferroelectric Memory is the possibility of realizing the so-called "Versatile Memory" that can be programmed to emulate DRAM, Flash, or anything in between simply by tailoring the programming strength. Some relevant experimental results will be presented along with some key simulation results.

Biography - **T. P. Ma** is Raymond J. Wean Chair Professor of Electrical Engineering at Yale University, where he has been a faculty member since 1977. He has serves as a Co-Director of Yale Center for Microelectronics, and a Co-Director of the Yale-Peking Joint Center for Microelectronics and Nanotechnology. He was Chairman of the Department of Electrical Engineering at Yale University between 1991 and 1995, and between 2001 and 2007.

He is a member of the National Academy of Engineering (NAE) in USA, a foreign member of the Chinese Academy of Sciences, an Academician of the Academia Sinica in Taiwan], and a Life Fellow of the Institute for Electrical and Electronic Engineering (IEEE).

In 1974 he graduated from Yale University with a Ph.D. degree in Engineering and Applied Science before joining IBM, where he did research work on advanced silicon device technology and ionizing radiation effects in MOS devices before he returned to Yale University as a faculty member in 1977.

His research and teaching at Yale have focused on semiconductors, MOS interface physics, ionizing radiation and hot electron effects, advanced gate dielectrics (including high-k gate dielectrics), flash memory device technology, ferroelectric memory technology, and unipolar CMOS technology.

He received an Honorary Doctor's Degree from the National Chiao Tung University, Taiwan, ROC in 2016, the 2015 Yale Science and Engineering Award, the 2014 Outstanding Alumnus Award from National Taiwan University, the 2008 Connecticut Medal of Technology, the 2006 SIA (Semiconductor Industry Association) University Researcher Award, the 2005 IEEE Andrew S. Grove Award, a 2005 Pan Wen-Yuan Research Award, a 1998 IEEE EDS Paul Rappaport Award, and the 1991 Connecticut Yankee Ingenuity Award.

He is an Honorary Professor at the Chinese Academy of Sciences, Tianjin University, and National Chiao Tung University, and an Honorary Guest Professor at Peking University, and Tsinghua University.