Seminar Talk

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3:00 p.m. KH 224

Title: The Efficacy of Programming Energy Controlled Switching of Resistive Random Access Memory (RRAM)

Abstract:
Resistive Random Access Memory (RRAM) has gained allot of attention as a possible candidate for future high density non-volatile memory. The memory state of an RRAM cell is based on the cell resistance which can be modulated by appropriate electrical stimuli. Coupled with its simple structure and scalability, RRAM excels in key performance markers such as endurance, write/erase speed, and low current operation. However, variability and instability associated with the inherent stochasticity of the resistive switching mechanism, and the filamentary nature of the conductive path, represent serious impediment to its commercialization.
We propose and demonstrate a program-verify technique named Compliance-free Ultra-short Smart Pulse Programming (CUSPP), designed to tackle cycling failures caused by this intrinsic randomness in RRAM. CUSSP has a unique new current-compliance strategy which limits programming current duration and minimizes the energy delivered per pulse. This approach promotes gradual resistance tuning and suppresses over-programming – a major cause of switching failure. With these features, we demonstrate high endurance 108 with state verification and propose a feasible solution to achieve high endurance yield across an RRAM memory chip. In doing so, we demonstrate the high-speed performance of RRAM in terms of write/erase speed (100 ps) and high cycling rate (500 kHz).
In addition, we investigated the short-term (μs regime) stability of RRAM using an unconventional read operation with enhanced time resolution. We determined that although both state relaxation and fluctuations are present, fluctuations dominate the filament behavior immediately after programming. Consequently, the fluctuations degrade the resistance window obtained by program-verify. These findings have very practical implications, as it suggests that instability will eventually limit the scalability of RRAM.

Bio:
David Nminibapiel is currently a PhD candidate in the Electrical and Computer Engineering (ECE) Department at Old Dominion University (ODU). He holds a BS and MS in Electrical Engineering, both obtained at ODU in 2010 and 2012, respectively. His current research work focuses on the

high-speed switching performance of Resistive Random Access Memory (RRAM). This work is solely performed in the Engineering Physics Division at the National Institute of Standards and Technology (NIST), Gaithersburg, Md.