DISCOVERY PARK
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Road to Ultra-low Switching Energy Memories to Artificial Neurons

Monday, December 3
1:30 - 2:30 p.m.
Burton D. Morgan Center, Room 121

Memory devices are responsible for a significant fraction of the energy consumed in electronic systems — typically 25% in a laptop and 50% in a server station. Reducing the energy consumption of memory devices is an important goal. For the evolving field of artificial intelligence the compatible devices must simulate a neuron. We are working on three different approaches towards these problems — one involving an organic metal-centred azo complex, the other involving oxide-based ferroelectric tunnel junctions, and the last involving real live neuronal circuits.

In the organic memristors that we have built on oxide surfaces the device performance exceeds the ITRS roadmap specification, significantly demonstrating the viability of this system for practical applications. More than that, these organic memories exhibit multiple states arising from interplay of redox states and counter-ion location studied by in-situ Raman and UV-Vis measurements, leading to the possibility of neuronal systems. This organic family of molecule systems is extremely stable and reproducible — a significant departure from conventional organic electronics. On the oxide front the significant results are that ferroelectricity is seen even in two atomic layers of $BaTiO_3$ or $BiFeO_3$. Oxygen vacancy motion can also play an important role in changing the device characteristics leading to synaptic characteristics. Last but not least, oxide surfaces can be utilized to force neurons to grow at specific places on a surface giving the potential for fabricating live neuronal circuits.

Prof. T. Venkatesan is currently the Director of the Nano Institute at the National University of Singapore (NUSNNI) where he is a Professor of ECE, Physics, MSE and NGS. He wore various hats at Bell Labs and Bellcore before becoming a Professor at the University of Maryland. As the inventor of the pulsed laser deposition (PLD) process, he has more than 750 papers and 30 patents and is globally among the top one hundred physicists (ranked at 66 in 2000) in terms of his citations (Over 43,000 with a Hirsch Index of 106-Google Scholar). He has graduated more than 45 PhDs, 35 Post Docs and 35 undergraduates. He is also the founder and Chairman of Neocera, a company specializing in the area of PLD and magnetic field imaging systems. Close to 10 of the researchers (PhD students and Post Docs) under him have become entrepreneurs starting more than 17 different commercial enterprises. He is a Fellow of the APS, winner of the Bellcore Award of excellence, Guest Professor at Tsinghua University, Winner of the George E. Pake Prize awarded by APS (2012), President's gold medal of the Institute of Physics Singapore, Academician of the Asia Pacific Academy of Materials, Fellow of the World Innovation Forum, was a member of the Physics Policy Committee (Washington DC), the Board of Visitors at UMD, and the Chairman, Forum of Industry and Applications of Physics at APS. He was awarded the outstanding alumnus award from two Indian Institute of Technologies — Kanpur (2015) and Kharagpur (2016), India.

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