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"Materials and Devices for Next-Generation AI Hardware and vice versa"

DEEP JARIWALA
Associate Professor
University of Pennsylvania

Bio: Deep Jariwala is an Associate Professor and the Peter & Susanne Armstrong Distinguished Scholar in the Electrical and Systems Engineering as well as Materials Science and Engineering at the University of Pennsylvania (Penn). Deep completed his undergraduate degree in Metallurgical Engineering from the Indian Institute of Technology in Varanasi and his Ph.D. in Materials Science and Engineering at Northwestern University. Deep was a Resnick Prize Postdoctoral Fellow at Caltech before joining Penn to start his own research group. His research interests broadly lie at the intersection of new materials, surface science and solid-state devices for computing, opto-electronics and energy harvesting applications in addition to the development of correlated and functional imaging techniques. Deep's research has been widely recognized with several awards from professional societies, funding bodies, industries as well as private foundations, the most notable ones being the Optica Adolph Lomb Medal, the Bell Labs Prize, the AVS Peter Mark Memorial Award, IEEE Photonics Society Young Investigator Award, IEEE Nanotechnology Council Young Investigator Award, IUPAP Early Career Scientist Prize in Semiconductors and the Alfred P. Sloan Fellowship. He has published over 150 journal papers with more than 21000 citations and holds several patents. He serves as the Associate Editor for ACS Nano Letters.

Abstract: Silicon has been the dominant material for electronic computing for decades and very likely will stay dominant for the foreseeable future. However, it is well-known that Moore's law that propelled Silicon into this dominant position is long dead. Therefore, a fervent search for (i) new semiconductors that could directly replace silicon or (ii) new architectures with novel materials/devices added onto silicon or (iii) new physics/state-variables or a combination of above has been the subject of much of the electronic materials and devices research of the past 2 decades. The above problem is further complicated by the changing paradigm of computing from arithmetic centric to data centric in the age of billions of internet-connected devices and artificial intelligence as well as the ubiquity of computing in ever more challenging environments. Therefore, there is a pressing need for complementing and supplementing Silicon to operate with greater efficiency, speed and handle greater amounts of data. This is further necessary since a completely novel and paradigm changing computing platform (e.g. all optical computing or quantum computing) remains out of reach for now.

The above is however not possible without fundamental innovation in new electronic materials and devices. Therefore, in this talk, I will try to make the case of how novel materials might present interesting avenues to

overcome some of the limitations being faced by Silicon hardware for application in AI. First, I will present our work on how new materials are breaking new ground in both logic and memory devices that enable AI hardware.

Then, I will focus on why AI is necessary to discover new materials for building better AI hardware and how these two seemingly disparate disciplines of AI driven computational materials science and devices for AI hardware together form a closed loop of innovations which could very well be the first example of a truly semi-autonomous research field.