Physically Compliant 3D and Multi-Dimensional CMOS Electronics for Internet of Everything Applications: From Concept to Pragmatic and Robust Manufacturing

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In the coming age of Internet of Everything (IoE) where people-process-device-data will be seamlessly connected, CMOS Electronics will play critical enabling role. Beyond performance-power-area-cost, what might be the featuring characteristics for such electronics? What would be the role of CMOS technology? What new applications may emerge beyond computation-communication-display-IoT applications?

To address these important questions, inspired by nature, we are redesigning conventional CMOS electronics into physically fully compliant electronics to redefine their purposes. We integrate heterogeneous materials (classical crystalline and novel 1D/2D) and processes (state-of-the-art CMOS technology, emerging inkjet for interconnects, 3D printing for encapsulation, electrochemical deposition (ECD) for through polymer via (TPV), automated transfer, Lego like lock and key assembly) through robust manufacturable processes for high volume production of physically flexible, stretchable and reconfigurable 3D-IC and multi-dimensional (MD-IC) CMOS electronics (including roll-to-roll processes of flexible silicon based CMOS electronics). Next, we are using machine learning to incorporate AI and actuators (like microfluidics, responsive materials, etc.) into these electronic systems to make them interactive. Finally, we are particularly focus on affordability and safety of these electronics. By introducing sustainable materials and processes (like non-functionalized paper based electronics, biocompatible and biodegradable encapsulations, DIY assembly, etc.), we envision to take these democratized (easy to learn, simple to build and use and affordable) electronics to masses to let them access advanced electronic technologies for personalized healthcare, safety, mobility, automation and sustainability. We have successfully used these electronics from lab testbed to commercial products as wearable for human, marine species, plants and objects to gradually realize Internet of Everything.

Bio: Mustafa (PhD, ECE, UT Austin, Dec 2005) is currently a Visiting Professor of EECS, UC Berkeley. He is also a Professor of Electrical Engineering, KAUST. He was Program Manager in SEMATECH (2008-2009) and Process Integration Lead for 22 nm node FinFET CMOS in Texas Instruments (2006-2008). His research is focused on futuristic electronics which has received support from DARPA, Boeing, Lockheed Martin, GSK-Novartis, Saudi ARAMCO and SABIC. He has authored 350+ research papers and patents. His students are working in MIT Media Lab, Stanford, Caltech, UC Berkeley, Harvard, UCLA, Intel, TSMC, and DOW Chemicals. He is a Fellow of American Physical Society and Institute of Physics (UK), a distinguished lecturer of IEEE Electron Devices Society, and an Editor of IEEE T-ED. His research has been extensively highlighted by international media (CNN, Fox News, Washington Post, WSJ, IEEE Spectrum, etc.) including being featured by Scientific American as one of the top 10 world changing ideas in 2014.