project summary

The ability to perform low-power, extreme-scale, robust neuromorphic computing, inspired by a biological brain, has eluded the scientific community for a long time. A major roadblock lies in achieving the stringent “power vs. area” requirement for nanoelectronic devices to implement biologically inspired computational paradigms manifested by biological synapses on a silicon chip. The proposed research aims to develop ultra-low power synaptic memory devices based on doped transition metal oxide that can mimic the transient and steady-state dynamics of a biological synapse. This research will present a platform device technology to achieve dynamic synaptic response in two-terminal devices fabricated using transition metal oxides by selective defect engineering through controlled doping, provide a fundamental understanding of the characteristic of defects responsible for synaptic behavior and device models, and extend the application of these device for synaptic computation and learning in neural circuits, neurophysiology, and finally the neuroengineering. On educational front, the proposed research will train graduate and undergraduate students in the areas of micro/nano-electronic device fabrication, electrical testing, and data analysis and involve high-school girls in research through summer internship programs. The successful completion of this project will have transformative impact towards enabling low-power extreme-scale computing inspired by the massive parallelism of a biological-brain that has been identified as a scientific grand challenge by the US Department of Energy and National Academy of Engineering. This project will strengthen collaborations with local small businesses and Semiconductor companies, which will have a significant impact on graduate and undergraduate training, workforce development, transition of research into advanced technology product, and regional economic growth.

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