Creating new devices that emulate human biological synapses

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Engineers at the University of Massachusetts Amherst are leading a research team that is developing a new type of nanodevice for computer microprocessors that can mimic the functioning of a biological synapse—the place where a signal passes from one nerve cell to another in the body. The work is featured in the advance online publication of *Nature Materials*.

Such neuromorphic computing in which microprocessors are configured more like human brains is one of the most promising transformative computing technologies currently under study.

J. Joshua Yang and Qiangfei Xia are professors in the electrical and computer engineering department in the UMass Amherst College of Engineering. Yang describes the research as part of collaborative work on a new type of memristive device.

Memristive devices are electrical resistance switches that can alter their resistance based on the history of applied voltage and current. These devices can store and process information and offer several key performance characteristics that exceed conventional integrated circuit technology.

"Memristors have become a leading candidate to enable neuromorphic computing by reproducing the functions in biological synapses and neurons in a neural network system, while providing advantages in energy and size," the researchers say.

Neuromorphic computing—meaning microprocessors configured more like human brains than like traditional computer chips—is one of the most promising transformative computing technologies currently under intensive study. Xia says, "This work opens a new avenue of neuromorphic computing hardware based on memristors."

They say that most previous work in this field with memristors has not implemented diffusive dynamics without using large standard technology found in integrated circuits commonly used in microprocessors, microcontrollers, static random access memory and other digital logic circuits.

The researchers say they proposed and demonstrated a bio-inspired solution to the diffusive dynamics that is fundamentally different from the standard technology for integrated circuits while sharing great similarities with synapses. They say, "Specifically, we developed a diffusive-type memristor where diffusion of atoms offers a similar dynamics and the needed time-scales as its bio-counterpart, leading to a more faithful emulation of actual synapses, i.e., a true synaptic emulator."

The researchers say, "The results here provide an encouraging pathway toward synaptic emulation using diffusive memristors for neuromorphic computing."

The title of the article is "Memristors with diffusive dynamics as synaptic emulators for neuromorphic computing."

More information: Zhongrui Wang et al. Memristors with diffusive dynamics as synaptic emulators for neuromorphic computing, *Nature Materials* (2016). DOI: 10.1038/nmat4756