Neuromorphic functions achieved by atomic switches

Tsuyoshi Hasegawa, Tohru Tsuruoka and Masakazu Aono
International Center for Materials Nanoarchitectonics, National Institute for Materials Science, 1-1 Namiki, Tsukuba, Ibaraki 305-0044, Japan, HASEGAWA.Tsuyoshi@nims.go.jp

Key words: Atomic Switch, Cation-based ReRAM, Synapse,

ABSTRACT

In developments of neuromorphic systems, functions such as a synaptic function have been emulated by a circuit consisting of CMOS devices and analog devices, limiting the large-scale integration of neuromorphic functions. Recently, various nonvolatile memories, such as PCMs, ReRAMs, and FeRAMs, have achieved synaptic functions by a single device, enabling a large-scale integration of nueromorphic functions.

Atomic switch is one of the nonvolatile memories, which is operated by controlling formation/annihilation of a metal filament using solid electrochemical reactions. Among various atomic switches, a gap-type atomic switch shows unique neuromorphic functions because of its unique operation mechanism. That is, multiple phenomena occur in the operation of a gap-type atomic switch. Namely, diffusion of metal cations in a solid electrolyte such as Ag_2S, their reduction/oxidation processes at a surface, diffusion of precipitated metal atoms on a surface. This multiplicity enables learning based on sensory, short-term, long-term memorization depending on the frequency of input pulses, which is observed in human brain when learning something.

In the symposium, neuromorphic functions achieved by atomic switches are introduced with a brief introduction of neuromorphic functions achieved by other memory devices.