Fabricating COF-Based Memristors for Neuromorphic Computing Systems

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Currently, conventional computing systems that follow Von Neumann architecture face limitations, as the memory and processing units are separated. The memristor has emerged as a promising candidate for artificial synapses due to its ability to store information through tunable resistance states. However, many existing memristive systems rely on inorganic materials. This work investigates a covalent organic framework(COF) material as an alternative for an electrically controlled memristive device, taking advantage of the COF’s ordered structure and properties. The device was fabricated with a metal/COF/metal architecture. The properties of the device were characterized, and the electrical switching behavior was analyzed using current-voltage(I-V) graphs and pulse-based electrical stimulation designed to emulate synaptic learning processes. Then a neural network was simulated to perform handwritten digit classification on the publicly available MNIST dataset. The memristor showed stable resistive switching, enabling controllable change of synaptic weights. It also showed potentiation and depression behavior, indicating the ability of the device to reproduce key characteristics of biological synaptic plasticity. Also having a high endurance of 500 cycles. Lastly, the memristor was able to simulate vector–matrix multiplication, enabling computation to occur directly where the information is stored. These results suggest that COF-based memristors are a promising platform for neuromorphic computing, as their ordered and tunable structures enable controllable charge transport and synaptic-like behavior. This highlights their potential to advance efficient, adaptable, and potentially more sustainable neuromorphic hardware used for edge AI & NN accelerators.

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