SIMULATION OF THE CLASSIFYING NEURAL NETWORK BASED ON THE NANOCOMPOSITE PARYLENE MEMRISTORS

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Further development of the conventional transistor-based computer architectures will face inevitable challenges in the nearest future, e.g., a physical limit of the transistors dimensions miniaturization will be reached.[1] Therefore, the development of new computation models is a crucial research topic. One possible way to exceed the efficiency of the conventional computing architecture is to create a brain-inspired neuromorphic system (NS) consisting of neurons and their connections - synapses. NSs have numerous neurons as well as synapses, each of which demands several transistors for hardware implementation.[2] Thus, such transistor-based systems are limited as well, and synapses should be implemented by some new element, which combines information processing, storage functions and good scalability.

An aspiring candidate for the role of a synapse is a so-called memristor - a metal-insulator-metal structure, the resistive state of which can be controlled by the applied voltage pulses. Moreover, the obtained resistive state of the memristor can be stored for an extended period after voltage removal.3 This way resistive state of the memristor emulates synaptic weight of the biological synapse. Although various memristive structures have already been demonstrated, there is still no ideal memristor for the NSs applications. Memristors operating via the electrochemical metallization (ECM) mechanism are particularly interesting in this context. Such memristors switching relies on the metallic bridge creation (disruption) in a dielectric matrix. This mechanism is biologically plausible and similar to the synaptic one.4 Nevertheless, the high stochasticity of the ECM memristors is a limiting factor for their usage in the NSs.5

In this work, a promising ECM memristor based on nanocomposite parylene is studied.6 Introduction of nanoparticles into the parylene layer leads to a significant decrease in the resistive switching stochasticity of such memristors, meaning that these memristors are of particular interest for the NS application.7 First, main characteristics of the nanocomposite parylene memristors were studied: switching voltages, variation of characteristics, plasticity (number of stable resistive states), potentiation/depression curves, etc. A formal neuromorphic network was simulated based on the obtained memristive characteristics and studied in detail. The results offer hope for the successful utilization of the nanocomposite parylene memristors in the energy-efficient NSs.

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