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An optically tunable STDP synaptic plasticity memristor based on hybrid organic-inorganic materials

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Memristors are one of the most promising nanoscale candidates' technologies for future applications in data storage, logic and neuromorphic computing networks. Modulation of their electronic properties by optical stimuli provides a new level of functional control, enabling the development of new types of optoelectronic devices and circuits, such as photonic integrated circuits with memory elements controllable by light. Memristors too have important applications in neuromorphic computing, and in this context, the dynamic and spatial patterning by light opens the route to new optically configurable and tuneable synaptic circuits. Here, we demonstrate a novel optically controllable organic-inorganic hybrid memristor device consisting of vertically aligned ZnO nanorods embedded within an optically active polymer, poly (disperse red 1 acrylate) (PDR1A). Illumination by polarization- and wavelength-specific light induces trans-cis photoisomerization of the azobenzene molecules causing an expansion or contraction of the material, which modifies the resistance of the on/off states, their ratio and retention times. We demonstrate optical control of short-term and long-term memory and tunable learning through spike timing dependent (synaptic) plasticity. We believe, this has important applications in the dynamic patterning of memristor networks, whereby both spatial and temporal patterning via light allows the development of new optically reconfigurable neural networks, adaptive electronic circuits and hierarchical control of artificial intelligent systems.

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