Printable memristive solar cells based on Lead-free perovskites for self-powered artificial synapses and neurons

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High-performance halide-based perovskite memory devices have been developed exhibiting a variety of synaptic [1-4] and neuronal functions based on non-volatile, and volatile or threshold switching, memristors, respectively. [5] However, a key ingredient in these perovskite-based systems is the presence of the highly toxic lead, which hinders their further development and commercial use. A lead-free perovskite approach for memristive applications could enable sustainable devices opening the path for practical applications, despite the current performance gap compared to lead-based systems. Herein, we present our recent data on the fabrication and characterization of printable non-volatile and volatile memristors based on Lead-Free Perovskites for artificial synapses and neurons emulation, respectively. [6]

Our approach is based on solution-processed manufacturing using all-inorganic, sustainable perovskites (Bismuth based) compounds. Depending on the metal contact type being either silver or gold, devices exhibit either non-volatile or volatile memristive switching. The non-volatile memristors exhibit an ON/OFF ratio of $>10^2$ while demonstrating very good retention and cycling endurance characteristics exceeding 1000 seconds and 1000 cycles, respectively.[7] Typical volatile devices exhibit an ON/OFF ratio of $> 10^3$ and require a low switching voltage of few volts. Furthermore, linear long-term potentiation protocols accompanied by an abrupt resistance suppression under depression protocols are demonstrated to be also tunable by light illumination. The on-demand selection of the operation mode by tuning the metallic contact type, offers a unique materials system based on lead-free perovskites opening the path for implementing artificial synapses and neurons emulation on a single chip.

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