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The missing core element for neuromorphic computers found

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Companies are building in-memory chips (“neuromorphic” chips) and in-memory computers which have a power consumption reduced to 30% in comparison to classical digital computers in von Neumann architecture. The “neuromorphic” chips on the market are based on CMOS hardware, process digital data, have data transfer between processor and memory unit, and are NOT real-time capable. In those “neuromorphic” chips memristive devices are already being used as reconfigurable, non-volatile memory cells to emulate the functionality of biological synapses.

The future of semiconductors and information and communication technology (ICT) needs fundamental breaktroughs in analog hardware. Neuromorphic computers will solve the problem of global exponential increase of data and computer power and they will also solve the problem of increasing complexity of AI training algorithms.

However, the core element for real neuromorphic computers has been missing ever since. Here I will report on how we found the core element for neuromorphic computers [1-4] - the $BiFeO_3$ (BFO) memristor (Fig. 1).

The BFO memristor is the only functioning memristor which processes and stores information in the same cell. The BFO MEMRiSTOR is the basis for novel, highly innovative products (Fig. 2) and will enable the realization of Neuromorphic computers with energy consumption reduced by 90% to 10% and strongly reduced computing time compared to classical digital computers in von Neumann architecture.

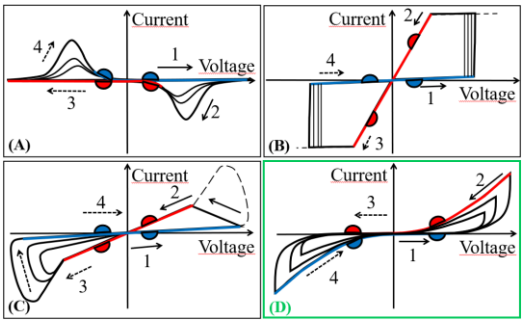

Fig. 1. Current-voltage (I-V) characteristics (A-C) of three different memristive devices and (D) of the $BiFeO_3$ (BFO) memristor. The reading current is read at the reading voltage (voltage at the semicircles) does not change the state of the memristor and depends on the polarity of the writing and reading voltage only for (D) BFO memristors. BFO memristors are operated in writing mode (branches 1 and 3) and in reading mode (branches 2 and 4) and allow to process and store analog data in the same cell. The I-V characteristics of memristors with (B) filamentary and (C) structural switching are crossed. The I-V characteristics of a memristive device with (A) ferroelectric switching show a maximum current when the applied voltage is close to the coercive voltage of the ferroelectric films.

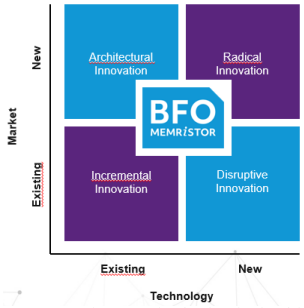

Fig. 2. The BFO MEMRiSTOR is the basis for highly innovative electrical and electronic products. © TECHiFAB GmbH

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