Pattern Classification by Memristive Crossbar Circuits with Ex-situ and In-situ Training

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The development of artificial neural networks (ANNs) based on emerging non-volatile memory, such as metal oxide memristors, has attracted an increasing interest recently. In the simplest form of such ANNs, the neurons are implemented with conventional (complementary metal-oxide-semiconductor) technology and interconnected by memristors functioning as artificial synapses. We will first introduce the basic concepts of neuromorphic computing and review the different technological solutions for ANNs hardware implementation that has been proposed recently with an emphasis on metal oxide memristive technology. The second part of the talk will be dedicated to practical examples of neuro-inspired circuits implemented with TiO_2 memristive devices. We will present experimental demonstration of simple circuit such as multiply and accumulate operation and Hopfield associative memory for Analog to Digital conversion. Finally, we will demonstrate pattern classification by a single-layer perceptron network implemented with hybrid crossbar circuits. By taking advantage of the ability of the memristive devices to be set to a given conductance state by controlling the voltages across their terminals (i.e. equivalent to the modification of the synaptic weight in ANNs), 20Pt/TiO_{2-x}/Pt memristive devices with sub-20-nm-scale active region were successfully trained by ex-situ and in-situ method. In the first case, the appropriate [illegible]In tutdecau

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