A Neuro-inspired Memristive Organic-Nanoparticles Synapse-Transistor (SYNAPSTOR)

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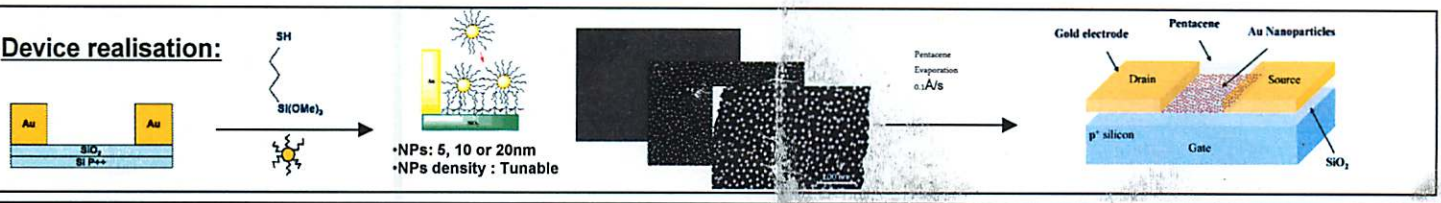
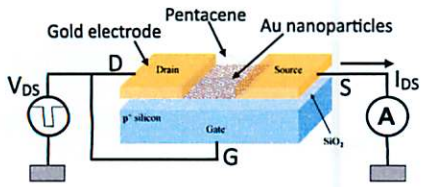
A large effort is now devoted to the research of new computing paradigms associated to innovative nanotechnologies that should complement the classical Von Neumann/CMOS association. Among various propositions, spiking neural networks (SNN) seem a valid candidate. A key element for the realization of such networks is the implementation of the synaptic connection and its associated functionalities (synaptic plasticity) with nanoscale devices.

Device realisation:



Memory effect characterization: A memristive model adapted to a « volatile » memory

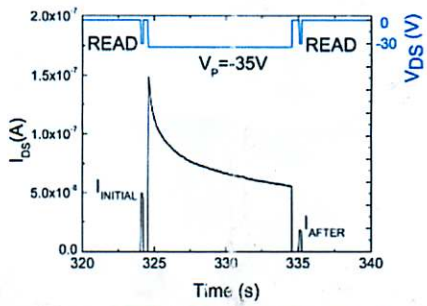


$$I_{DS}(t) = G(Q_{NP}(t),\ V_{DS}(t),\ t)V_{DS}(t)$$

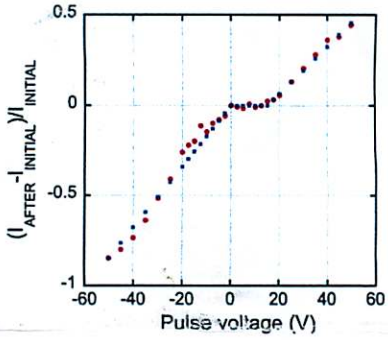
$$\dot{Q}_{NP}(t) = g(Q_{NP}(t),\ V_{DS}(t),\ t)$$

F. Alibart et al., *Adv. Func. Mater.* 20, 330 (2010)

O. Bichler et al., *IEEE Trans. Elec. Dev.* 57, 3115 (2010)



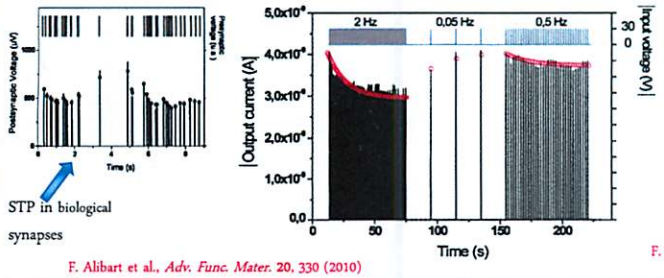
F. Alibart et al., *Adv. Func. Mater.* 22, 609 (2012)



Synaptic Plasticity: Implementation of STP and STDP

Short Term Plasticity :

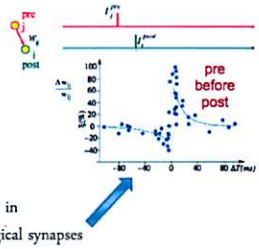
Weight depends on input pulses frequency



STP in biological synapses

F. Alibart et al., *Adv. Func. Mater.* 20, 330 (2010)

Spike Timing Dependent Plasticity: Weight depends on temporal correlation between input and output pulses



STDP in biological synapses

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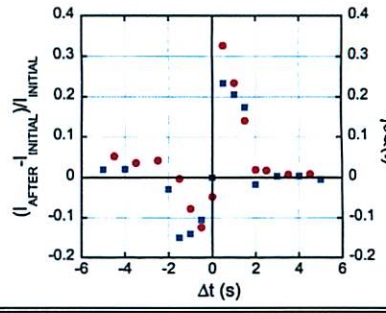
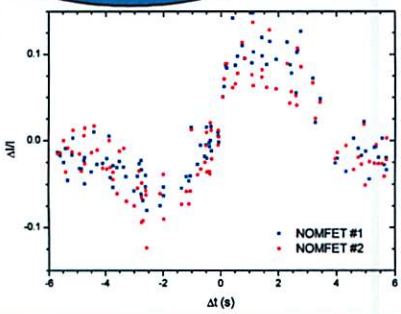
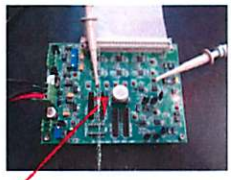


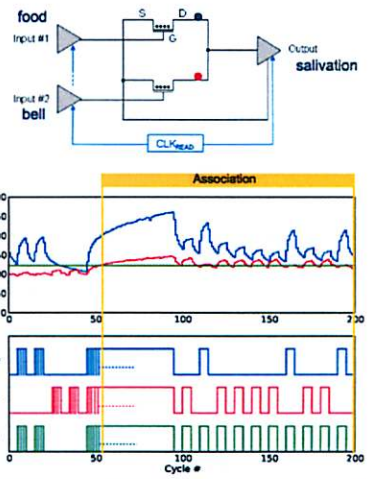
Hybrid CMOS/Synapstor for neuromorphic computing

STDP as a learning algorithm



Pavlov Associative Memory





O. Bichler et al., *Neural Computation* (submitted)

PROJECT NABAB
Nanocomputing Building Blocks with Acquired Behaviour