MAP-fis Essay Proposal, 2013-2014

(*please write in English*)

Supervisor

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Title

Memristor Based Adaptive Neural Networks

Area

(*Materials, Optics, Condensed Theory, High Energy Theory,....*);

Materials, Nanotechnology

Summary of Proposal

The proposed work plan aims to develop electronic synapses based on memristor nanostructures. This proposal is driven by the discovery that memristors are capable of adapting their electrical conductance in a similar manner to the connection strength adjustments between neurons in biological systems. This fascinating feature makes this device an ideal tool to mimic a biological synapse.

One will start by optimizing the deposition and resistive switching properties of metal-insulator-metal (MIM) thin films based on TaO (which has been shown to display a switching endurance of up to 10^{10} cycles) and Ag_2S (whose dynamic properties resemble short-term plasticity and long-term potentiation). We will then demonstrate that memristors display electrical characteristics similar to those of neural synapses, focusing on the most relevant plasticity rules known from biology: the Hebb model and spike time dependent plasticity (STDP).

This will pave the way for the implementation of an adaptive neural network (NN). The proposed formulation can be seen as mapping sets of inputs into specific output patterns, so that information will be encoded in the form of patterns of activity. As in biological neurons, the information stored in these maps allows both data storage and computation in the same substrate. Finally, we expect to demonstrate the first functional adaptive NNs based on memristor nanodevices.

(c*ontinue if necessary*)

References

(to allow students first look at topic)

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