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PhD Position
Realization and optimization of synapses based on Mott insulator

Context

For half a century, the revolution in information technology has been closely associated with the computers development. However, all computers are built according to a so-called Von Neumann architecture, where processors and memory are separate blocks. This results in high-energy consumption for processing massive data. Researchers are working on alternative architectures to develop a more energy-efficient artificial intelligence. The most promising one is based on the mammalian brain, which can be 10,000 times more energy efficient than current computers. Currently, intense international competition is developing to achieve hardware artificial neural networks using artificial neurons and synapses made from innovative materials. In this context, a team of IMN researchers has discovered a new property of Mott insulators. This property allows realizing a new type of multi-level non-volatile memories (similar to artificial synapses) and an artificial neuron of the Leaky-Integrate-and-Fire (LIF) type with these materials. The IMN team has very recently obtained a regional funding for two PhD students and two Post-Doc to create the first demonstrator of neural network based on Mott insulators. This project aims at laying the foundations for an artificial intelligence energy-efficient hardware using these innovative materials.

PhD objectives

The thesis will focus on an important part of this project. The main objective is to realize artificial synapse devices based on Mott insulators and to control their multi-level resistance in a reproducible way. The thesis will be composed of three parts. 1) Influence of thin film deposition parameters on the multilevel resistance: the student will deposit thin films by reactive magnetron sputtering and characterize them by electrical transport, SEM, TEM, Raman, AFM and DRX… 2) Electrical characterization of devices: the student will have to define the most suitable sequence of pulses for the reversible and reproducible control of a continuum of resistive states and to characterize the spike timing dependent plasticity (STDP). These tests will be carried out on existing IMN equipment and on the probe station purchased as part of the project. 3) Integration design: The student will optimize the design of the artificial synapse, towards its integration into the final neural network. The micro/nano-fabrication steps will be carried out by external national technological center (Renatech Network).

Candidate profile

The candidate must be graduated from an engineering school and/or with a Master 2 Research degree whose training focuses primarily on solid state physics, materials science, chemistry, nano/micro-electronics or related fields. The PhD subject requires a large part of experimental work and a good scientific level in solid state physics, physico-chemistry and characterization techniques.

We are looking for a highly-motivated student with a strong interest and capacities in materials science. Interpersonal skills, dynamism, rigor and teamwork abilities associated to a rapid work in autonomy will be appreciated. Candidates should be fluent in English and/or in French. In addition, well-written English will be highly appreciated. A previous internship experience in materials sciences research and/or electrical characterizations is expected.

Scientific environment

The candidate will work mainly at IMN laboratory in Nantes. Equipment for deposition and annealing are available at IMN, in addition with numerous characterization techniques (XRD, MEB, HR-TEM, XPS, electrical measurements at the single chip level).

Salary

Net salary will be around 1555€ per month.

Keyword

Solid state physics, Material science, Artificial intelligence, Artificial neural network

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