Master 2 Internship Proposal 2023-2024

Mechanical strain-enhanced nanosupercapacitors based on Hafnium-Zirconium oxide ($Hf_{1-x}Zr_xO_2$)

Laboratory: INL (Institut des Nanotechnologies de Lyon) : inl.cnrs.fr
Keywords: supercapacitors, ferroelectric, antiferroelectric, electrical characterization
Location: INL, UMR CNRS 5270, 36 avenue Guy de Collongue, 69130 Ecully

Background, Context:
The discovery of ferroelectricity in hafnia and zirconia-based thin films has revolutionized the ferroelectrics field and the impact of these materials in electrostatic (ES) supercapacitors is still incipient. Promisingly, there are many possibilities for engineering these simple binary materials to achieve high-performance ES supercapacitors for a wide range of devices where the need for low-weight, small-size and fast-discharge ES devices is critical, e.g., in electric vehicles and beyond. The supercapacitors are an emerging technology for various ES systems, as they can offer higher power density than batteries and higher ESD over commercially available polymeric capacitors.

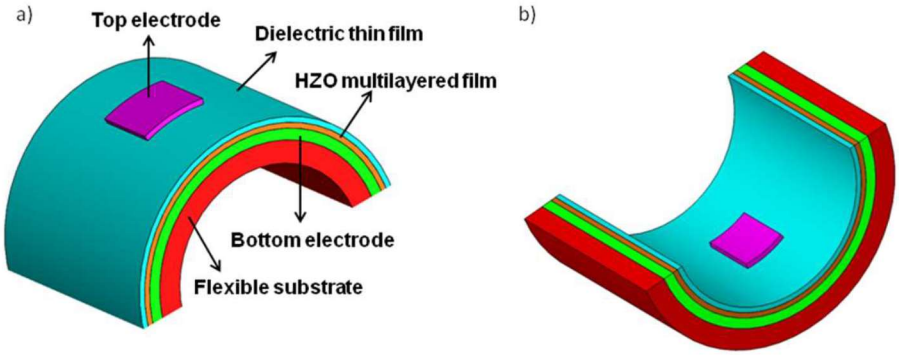

Figure 1. *Schematic representation of the flexible $Hf_xZr_{1-x}O_2$/dielectric multilayered capacitor under a) downward and b) upward bending [from NanOx4EStor Project].*

Research Subject:
The intern will work on the NanOx4EStor project. The aim of this project is to develop innovative and cost effective high-throughput technologies for the fabrication of advanced supercapacitors based on wake-up free (pseudo-)binary oxide thin films, with optimized ferroelectric and energy storage properties through (i) strain, (ii) interface and (iii) dead-layer engineering.
At INL, we have already developed several pathways to fabricate ferroelectric and antiferroelectric $Hf_{1-x}Zr_xO_2$-based capacitors. The role of the intern will be to further optimize the fabrication of the capacitors in order to fulfil industrial requirements defined in the NanOx4EStor project. Special emphasis will be placed on the fabrication of capacitors on flexible substrates for the purpose of their electrical characterization under mechanical stress.

Work plan:

- Deposition of $Hf_{1-x}Zr_xO_2$-based capacitors on diverse flexible substrates by various standard cleanroom processes: Atomic Layer Deposition (ALD), Physical Vapor Deposition (PVD), Chemical Solution Deposition, etc.
- Patterning of the capacitors by standard cleanroom processes: photolithography, physical etching, wet etching etc.
- Electrical Characterization of flexible capacitors under various stress: tensile and compressive stress and strain, bending, etc.

Candidate Profile:

The candidate should have a solid background in physics, material science and/or electrical engineering with a strong motivation for experimental work. Besides, fluency in English (spoken and written) together with good communications skills will be highly appreciated.

References:

https://inl.cnrs.fr/projects/nanox4estor/

Contacts / Send applications (CV+motivation letter) to :

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