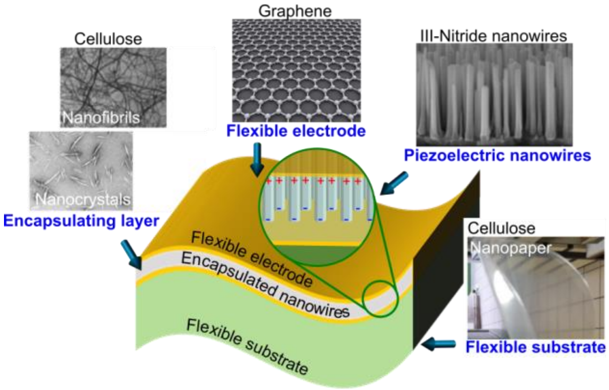
INSTITUT NÉEL Grenoble

Topic for Master 1 internship – Academic year 2023-2024

III-Nitride nanowire-nanocellulose composites for flexible piezo energy harvesters

General Scope:

As a promising route toward small-scale smart electronics/sensor networks, nanowire piezoelectric harvesters offer inherent flexibility and stretchability for integration with relevant soft surfaces in biomedical, wearable, and human interactive applications. Driven by environmental concerns, next-generation electronics should be bio-degradable/compatible and use fewer toxic elements. The challenging question is how this technology can be continuously developed, without affording the environmental degradation in terms of electronic waste and energy consumption, and without compromising its functionalities. Therefore, this project aims at synthesizing inorganic-organic flexible piezoelectric hybrid films as an alternative building block for future piezo harvesters.



Research topic and facilities available:

We will explore the combination of three nanomaterials: piezoelectric nitride nanowires, plant-based nanocelluloses, and graphene flake. Piezoelectric III-Nitride nanowires are used as an active element to harvest mechanical energy into usable electrical one. A typical way to fabricate nanowire devices is to embed the nanowires into insulating polymers to improve their stability and processability while preserving their mechanical compliance. The encapsulated nanowires are usually transferred on flexible plastic sheets which are easier integrated with various surfaces than rigid substrates. These plastic substrates cause ecological problems since they are based on non-renewable petrochemical products and cannot be decomposed through biodegradation as organic materials. Here, the eco-unfavourable passive components will be replaced by eco-friendly materials, that is, using plant-based cellulose nanopapers and graphene to substitute plastic substrates and metallic electrodes.

The student will involve with the fabrication process and characterization of inorganic-organic composite flexible films. He/she will intensively study the encapsulating and transferring process of the high-density III-Nitride nanowires on nanopapers, as well as transfer graphene sheets as flexible electrodes for nanowire piezo-harvesters. Together with the team, the student will contribute to the large-scale characterization of electrical and electromechanical properties to gain essential information associated with the device's key parameters such as output power, sensitivity, detection limit, linearity, response time, stability, etc. The fabrication process will be readjusted according to the effective output signal. The intern will join regular meetings with the staff involved in the project.

The experiments will be performed at Néel/Grenoble and strongly collaborate with CERMAV teams. The student will have an opportunity to access the facilities for nanofabrications (metal evaporation, chemical bench, lithography, etc.), as well as electrical, structural, and optical characterizations (scanning electron microscopy, atomic force microscopy, etc).

Possible collaboration and networking: Néel (NPSC, Hybrid, and Optima), CERMAV
Required skills: Nanofabrications, Semiconductors, Nanomaterials, Solid State Physics
Starting date: February/March 2024 (The starting date is flexible)

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