PLANT-DERIVED METAMATERIALS FOR ULTRASONIC ENERGY HARVESTING

LABORATORY : Institut Lumière Matière
IN COOPERATION WITH : iLM

TEAM(S) : BIOPHYSIQUE

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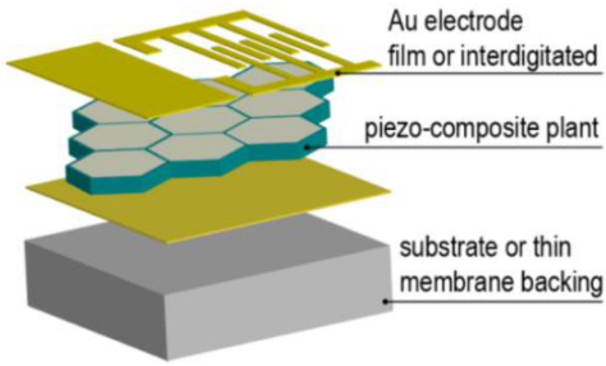
KEYWORD(S) : biobased materials / optoacoustics / piezoelectricity

SCIENTIFIC CONTEXT :



Schematic design of a plant-based ultrasonic harvester

Ultrasonic energy harvesting has lately been introduced as a promising wireless energy transfer solution to power miniaturized wearable and implantable electronic devices for wireless communication and sensing, remote health monitoring, and ultrasound-induced therapies. However, most current ultrasonic energy harvesters operate using bulky, lead-based piezoelectric materials, which still present major limitations. For instance, they are brittle, inflexible, and contain toxic elements, which limits their wearability and biomedical applications. Moreover, the production and disposal of these inorganic materials pose serious environmental and sustainability challenges. Plants present a bio-based materials' platform to overcome these challenges due to their piezoelectric behavior. Our aim is to design plant-based materials, with enhanced piezoelectricity, for efficient energy harvesting of ultrasonic waves. In this context, the proposed PhD will focus on identifying phononic features for ultrasonic energy localization in plant-based composite materials and converting plant-based composites into efficient energy harvesters.

MISSIONS :

As part of this, the candidate will help implement the necessary tools to:

1) Fabricate micro-structured cell membranes made from decellularized plant scaffolds.

2) Characterize structural features in the plant samples using microscopy, nanometrology (i.e. profilometry, AFM, SEM), and image processing.

3) Measure and analyze the propagation of MHz ultrasonic waves in the plant-derived samples using opto-acoustic setups and signal processing

4) Model and evaluate the energy harvesting performance of the designed materials via experimental characterization and numerical modeling of their phononic and piezoelectric behavior

OUTLOOKS :

Scheduled to start on October 2024, for a duration of 3 years

BIBLIOGRAPHY :

Abi Ghanem, M., Khoryati, L., Behrou, R., Khanolkar, A., Raetz, S., Allein, F., Boechler, N., and Dehoux, T. "Growing phenotype-controlled phononic materials from plant cells scaffolds." Applied Materials Today 22 (2021): 100934.

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