

VAN DER WAALS 2D MATERIALS FOR SUB-PICOSECOND ULTRASONICS

LABORATORY : Institut Lumière Matière

LEVEL : M2
TEAM(S) : FEMTO-NANO

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SCIENTIFIC CONTEXT :

Picosecond ultrasonics is a research field with many applicative purposes from material science to biology for non-invasive, high-resolution, structural characterization [1]. The technique relies on the combination of a nanoscale thin film and delay-controlled optical laser pulses, forming an opto-acoustic transducer for the launching and the detection of ultrashort coherent acoustic phonon wavepackets. This scheme stands in good analogy with the well-known medical ultrasound echography technique, but with a strikingly higher spatial (down to several tens of nanometers) and temporal resolutions (frequencies in the 100 GHz range).

This research is set in the frame of the 2023 ANR JCJC project entitled WAALRUS (2D van der WAALS layeRs for sub-picosecond UltraSonics).

MISSIONS :

The project aims at developing novel opto-acoustic transducers based on van der Waals 2D materials, such as graphene, boron nitride (hBN), dichalcogenides (TMDCs) and their stacks [2]. As sheets reduced to the fundamental atomic thickness with no dandling out-of-plane bond, these materials enable the confinement of the opto-acoustic processes to the ultimate sub-nanometer atomic resolution [3]

The intern/PhD student will associate state-of-the-art nanofabrication of van der Waals heterostructures [4] with pump-probe optical measurements with femtosecond pulsed lasers [5] to demonstrate the superior figures of merit (THz frequency, quality factor...) of these novel nano-mechanical oscillators. The large variety of 2D materials quantum properties and the versatility of their combination in heterostructures will be taken advantage of. From understanding the basic opto-electro-mechanical processes involved and further optimizing the transducer designs, this will lay the foundation for a new experimental platform for sub-picosecond ultrasonics.

OUTLOOKS :

A fully funded PhD position will be proposed following the internship (ANR JCJC WAALRUS).

BIBLIOGRAPHY :

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