VAN DER WAALS 2D MATERIALS FOR SUB-PICOSECOND ULTRASONICS

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SCIENTIFIC CONTEXT :

Picosecond ultrasonics is an innovative 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 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], with the potential to overcome current technologies. The project covers both fundamental and applicative aspects.

The intern/PhD student will associate nanofabrication of van der Waals heterostructures [4] with pump-probe optical measurements using 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 explored and taken advantage of. From the understanding of the fundamental opto-electro-mechanical processes involved and the optimization of the transducer designs, this work will lay the foundation for a new experimental platform for sub-picosecond ultrasonics.

OUTLOOKS :

The PhD position is fully funded with a start in Autumn 2024. A master internship in spring is open.

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