# TWO-DIMENSIONAL MATERIALS: A PLATFORM FOR OPTO-ELECTRO-MECHANICS

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Two-dimensional (2D) materials (e.g., graphene, boron nitride and transition metal dichalcogenides) compose a unique toolkit of one or a few atom-thick building blocks, whose characteristics can be combined, protected and possibly enhanced by forming van der Waals heterostructures. 2D materials associate remarkable electronic properties and strong light-matter interactions, suitable for efficient optoelectronic devices. At the same time, 2DM are lightweight and sensitive nanomechanical systems that can be finely controlled electrically and/or optically.

This PhD project aims at demonstrating novel optoelectromechanical systems based on 2D materials (i) in which the light emission characteristics (photon energy, emission rate, coherence, polarization, photon statistics,…) are tuned electromechanically and (ii) capable of sensing local strain in 2D materials and near-field interlayer charge and energy transfer in van der Waals heterostructures. Meeting these technologically relevant challenges requires addressing the following fundamental questions:

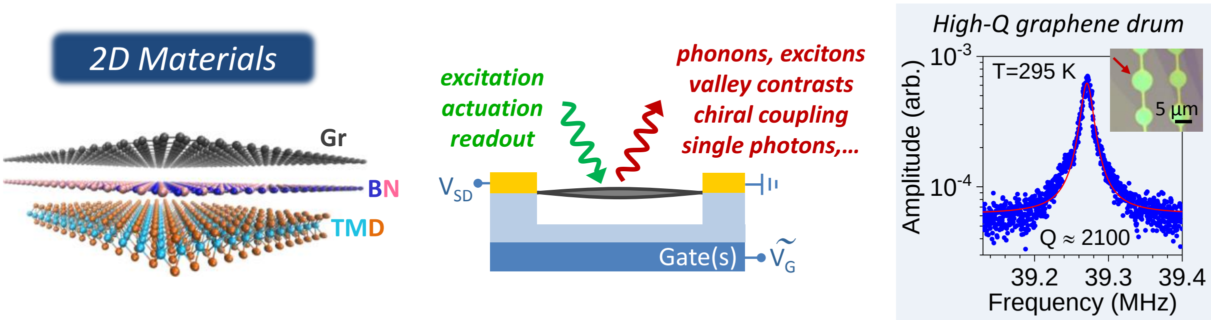


FIGURE 1 – (LEFT) CRYSTAL STRUCTURE OF SELECTRED TWO-DIMENSIONAL MATERIALS. (MIDDLE) SCHEMATIC OF AN OPTO-ELECTRO-MECHANICAL DEVICE BASED ON A SUSPENDED 2D MEMBRANE. (RIGHT) MECHANICAL RESPONSE OF AN ELECTROSTATICALLY ACTUATED MONOLAYER GRAPHENE DRUM (DATA: XIN ZHANG ET AL, IPCMS).

Are conventional descriptions of charge and energy transfer still valid in the case of angström-thick 2D heterointerfaces? How strong can static and dynamical strain-mediated coupling be in suspended 2D materials? Can one achieve strain-mediated control of near-field interactions between suspended 2D materials?

Our workhorse will be an optically addressable electromechanical resonator made from suspended 2D materials (see Figure 1). This system will be investigated in a multifunctional setup that combines sensitive optical spectroscopies with opto-electro-mechanical actuation, displacement readout and control.