

# Phonons in 2D systems: an approach to optomechanics, optoelectronics and thermal transport

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The emergence of low dimensional systems opens up new possibilities for understanding phonon-phonon and phonon-electron interactions at the nanoscale. The reduction of dimensionality in the case of nanotube and graphene has revealed a breakdown of the Born–Oppenheimer adiabatic approximation due to the strong coupling between electrons and phonons. Experimentally, it has been demonstrated that this coupling can be easily modulated by an external electric field and play a major role in the current saturation measured in a nanotube or graphene-based transistor [1]. Moreover, this coupling can be seen as an opportunity to obtain a tunable superconductivity or optically activated devices [2,3,4]. Recently, the possibility of exfoliating a large number of layered 3D materials to obtain two-dimensional monolayer systems allows us to imagine and create a wide variety of heterostructures [5] with specific functionalities limited only by our imagination and our ability to fabricate them.

In this context, by developing original experimental setup to measure optical phonons and their coupling to the different particles or quasi-particle such as electrons and/or acoustic phonons, we have been able to be sensitive to and to understand various physical phenomena at the nanoscale such as mechanical resonances, strain fields engineering, [6], but also charge transfer and/or energy transfer processes in hybrid systems allowing molecular detection [4] and finally the existence of non-conventional thermal transport that need to be further explored [7,8,9].

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