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2D materials under high pressures: strain transfer, adhesion and synthesis of novel structures

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Plenary: Raman spectroscopy is a versatile nondestructive tool widely used to characterize two-dimensional (2D) systems such as graphene and MoS2, among others. Since electrons and phonons are specially coupled to each other due to the reduced dimensionality, this technique provides detailed information about the structure and electronic properties of theses layered systems thus allowing one to probe in the phonon spectra many features such as the numbers of layers and their interactions with the environment. Most of these 2D materials are sitting on substrate and the understanding on how the substrate affects the physical properties of these atomic thickness layers is a key point for fully characterizing and understanding the materials as well as to exploit them in different applications. In this regard, strain is an important variable to consider because the adhesion of the 2D material, which is basically surface, depends on the nature of the substrate. One key question is how the strain is transferred from the substrate to the 2D material. The use of hydrostatic pressure has been an effective method to modulate the interactions between the 2D materials with substrates and environment and Raman spectroscopy has been important for investigating these strained 2D nanomaterials because the Raman cross section for these systems is very large, even for a single layer. In this talk, we discuss results obtained using high-pressure Raman studies of graphene and MoS2 sitting on different substrates. Depending on the pressure transmitting medium, number of layers, and compressibility of the substrate, the analysis of the Raman modes tells us how the stress is transferred from the substrate to the 2D material, thus allowing us to propose a model for studying the adhesion of the 2D systems by using high-pressure Raman technique. We also present the synthesis of novel 2D nanostructures under high-pressure conditions.