

Substrate and environment roles on the high pressure tuning of carbon low-dimensional system's properties

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Carbon based materials such as graphene and carbon nanotubes came under the spotlight due to their extremely promising properties and potential, for technological advancements. Moreover, their properties are extremely tuneable by applying external perturbations such as external electric, strain and doping [1-3]. Largely less explored is the use of pressure as a tuning parameter. When low-dimensional materials are submitted to high-pressure their physical properties can be drastically modified, as in the case of phase transitions [4], as well as smoothly altered by tweaking their strain and doping levels [5,6]. Environment has a massive impact in the pressure response of those materials at the point that their behaviour can be desirably controlled by pressure environment engineering.

We will present here a series of experiments where we explored the environmental effects on the pressure response of carbon nanotubes, graphene and graphene stackings. Raman spectroscopy as well as optical microscopy allowed to probe the samples during the high pressure runs. For what concerns graphene and graphene stackings we showed that the substrate plays a fundamental role governing the dynamics of phase transitions as well as establish a fine equilibrium with graphene and the surrounding environment. We discovered in our recently published work [7] that, using SiO₂ substrates, it is possible to detach graphene from its substrate depending on the environment that envelops it. On the same line phase transitions can be induced by selecting different environments in graphene stacks or carbon nanotubes. In order to get the unaltered environmental response, we engineered micrometric substrates for graphene suspension compatible with high pressure experiment and studied the pure graphene environment interaction.

References

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Figures

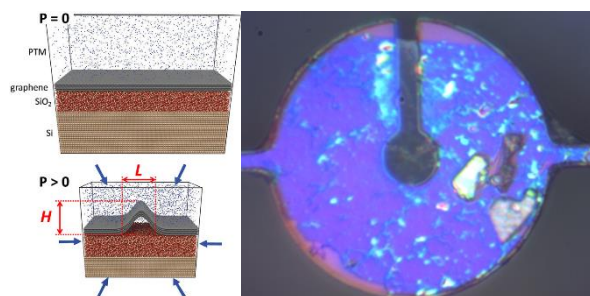


Figure 1: On the left, schematic representation of the environment mediated multilayer graphene detachment with pressure. On the right, a sample of bilayer graphene deposited on a substrate for high pressure suspended measurements.