CVD graphene on polymer substrate under tension

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Abstract

In general, CVD is suitable to apply highly dense and pure graphene based coatings such as pristine graphene on a substrate [1]. The CVD processes generally utilize transition metal surfaces for growth of Graphene nanosheets (GNS) using hydrocarbon gases as GNS precursors at the deposition temperature of about 1000 ºC. Ruoff et al. [2] reported a CVD method for large-area synthesis of high-quality and uniform GNS films on copper foils using a mixture of methane and hydrogen as precursors. One of the major benefits of their process is that it could be used to grow GNS on 300 mm copper films on Si substrate and this GNS film could also be easily transferred to alternative substrates, such as SiO_2/Si or glass. Bae and coworkers [3] reported a roll-to-roll production of 30 inch graphene films using the CVD approach. Similarly, Skakalova et al. [4] have studied the growth mechanism of graphene sheets using the CVD method in order to fabricate high-quality large-area graphene sheet while a characterization regarding structure, electrical, optical and mechanical properties took place. As for the latter, plenty of work has been done over the last years [5-7] in order to investigate its behavior on external loading (tension and/or compression) in different substrates.

In this work, Raman spectroscopy has been employed to monitor the deformation mechanics of monolayer CVD graphene on a poly(ethylene terephthalate) substrate (CVD graphene/PET) where the PET film is flat but the graphene is wrinkled. It is found that upon deformation of the film, the shift of the Raman 2D band with strain for the graphene and the band broadening behavior is quite different from that of exfoliated monolayer graphene flakes. It is shown that the wrinkles have the effect of separating the graphene mechanically into isolated islands, with each island being similar in size to the Raman laser spot.

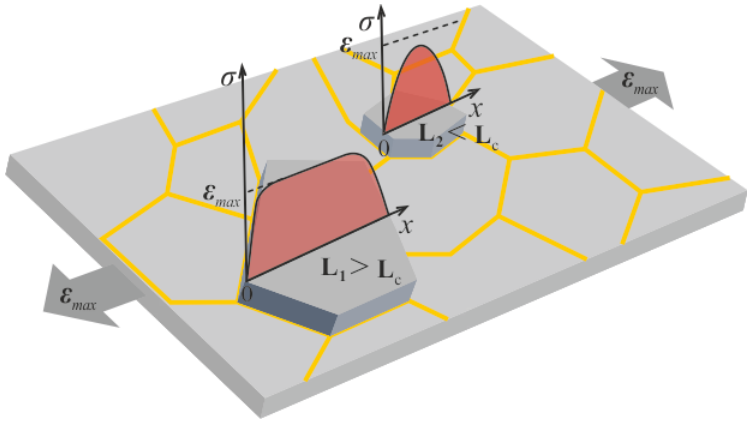

Figure 1: Graph explaining the proposed stress transfer mechanism (L_i is the length of the *i*-crystallite and L_c the critical transfer length)

It is demonstrated that inside each island the stress will be transferred non-uniformly from the PET to the graphene and this allows the unusual Raman band shift and broadening behavior to be explained.

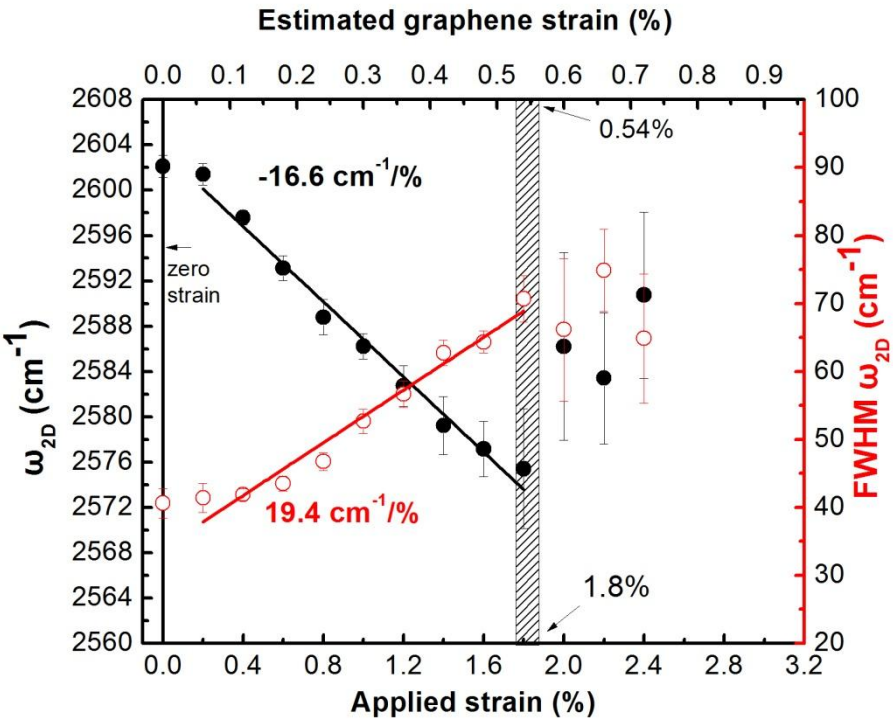

Figure 2 : Pos(2D) and the corresponding FWHM(2D) as a function of the applied and the extracted actual strain for the graphene membrane on the PET substrate

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