Conductive railways on graphene wrinkles

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Since its discovery, lot of effort has been devoted to harness the exotic properties of graphene with the quest of nanoscale engineering at the forefront. Graphene growth by Chemical Vapor Deposition (CVD) takes place mainly on top of metal catalytic substrates, but due to the high temperatures and the mismatch in thermal expansion coefficients of graphene and the growth substrate, out-of-plane deformations in the form of wrinkles are unavoidable [1]. Furthermore, in order to exploit graphene, it needs to be transferred onto other arbitrary substrates by the means of wet and dry methods, which induces further wrinkling. Wrinkles are commonly treated as defects which degrade the overall properties of graphene, hence routes for smoothening these structural glitches are under continuous investigation [2]. Nonetheless, the inevitable presence of wrinkles has offered many interesting pathways to be explored [3].

In the present work, we visualize for the first time the spatial distribution of local conductivity in monolayer graphene and its wrinkle network arising naturally from synthesis and subsequent transfer. Atomic force microscopy (AFM) tapping current measurements reveal that the conductivity of wrinkled graphene, on top of the wrinkle structure, is up to 2 *orders of magnitude* higher relative to that of flat graphene. Furthermore, we discuss the impact of the substrate on the electronic properties of graphene and electronic transport through wrinkles. Computations within the framework of density functional theory and theoretical treatment suggest that the observed contrasts of local conductivity qualitatively correlate with the off-plane electric susceptibility differences between wrinkled and flat graphene monolayers. The findings in this work unravel the implications of graphene wrinkles as electrical conduits, while establishing that we are still at infancy in grasping the possibilities of multifaced nanoscale engineering.

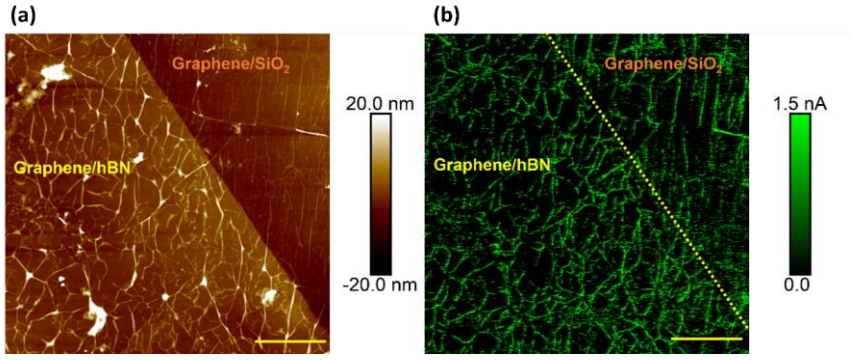

Figure: (a) Topography of CVD graphene transferred on top exfoliated 10-layer hBN through wet transfer. (b) Current mapping of CVD graphene on 10-layer hBN and SiO_2/Si areas. Dashed yellow line denotes the edge of the graphene/hBN heterostructure. Scale bars are 2 μm.

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