Surface Potential Variations in Graphene Induced by Crystalline Ionic Substrates

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Controlling and modulating the surface potential of the graphene sheet is important for producing on-sheet junctions and superlattices. Such electronic structures are predicted to play an important role in building devices that exploit the novel Dirac nature of carriers in graphene, such as electron guides [1] and electron-beam supercollimators [2]. Graphene regions with different doping levels and, hence, surface potentials have to date been produced by electrostatic gates [3] or through chemical functionalization [4], both strategies requiring complex top-down lithographic procedures.

We used Electrostatic Force (EFM) and Kelvin Probe (KP) microscopies to investigate few-layer graphene (FLG) domains on top of ionic crystals [5]. Step edges, pits and protrusions within the ionic surface create sizeable and local perturbations of the surface potential of graphene overlayers. These were within the eV range in FLG with up to three layers, and become considerably screened in thicker layers. Such nanostructures could pave the way towards bottom-up creation of on-sheet p-n junctions and superlattices, as well as provide a test bed for studying local screening in graphene.

References

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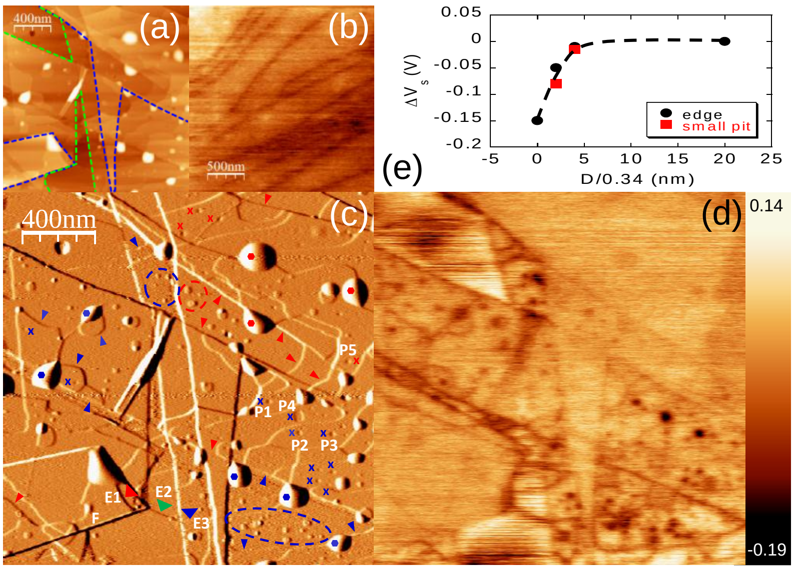
Figures



(a) Topography, with the edges of various FLG domains and substrate highlighted by a coloured overlay: green, substrate edges; blue, edges of 4-layer graphene domain; the regions in between the two are bi-layer graphene. (b) KP image of a bare ionic substrate: step edges induce sharp variations in the surface potential. (c) Amplitude image of the FLG, corresponding to (d), surface potential image (scale bar, in V). Bilayer domains are more strongly perturbed by the underlying nanostructures of the substrate than the 4-layer ones. (e) Representative potential steps values extracted from (d) and associated with nanostructured features described in the text, taken with the tip several nanometers away from the surface.