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]. Experiments are supported by Density Functional and model calculations of graphene on stepped surfaces. 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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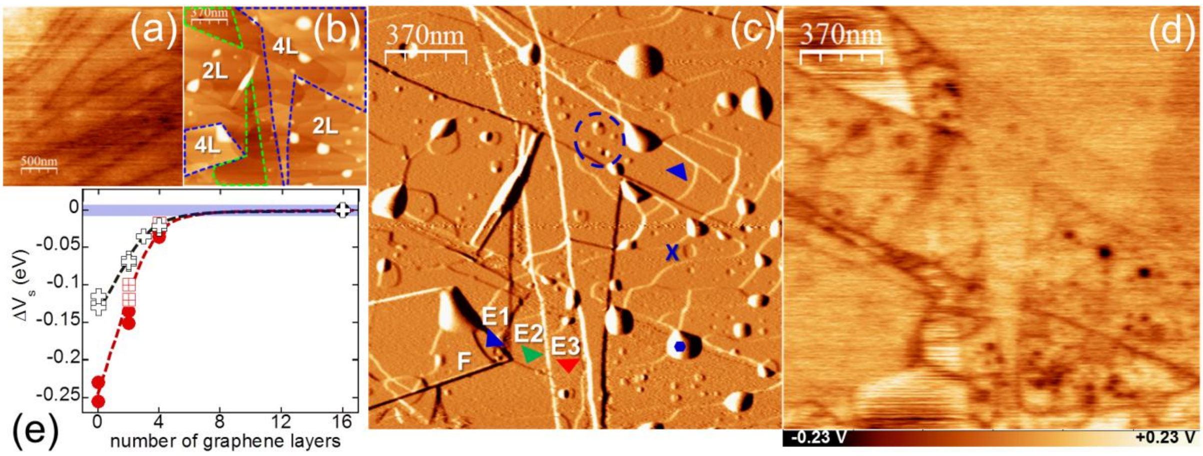
Figures



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FLG flake on a terraced ionic surface investigated by KP microscopy. (a) KP of the bare ionic substrate. Steps induce sharp variations in the surface potential. (b) Topography, with boundaries of FLG domains and substrate highlighted: green, substrate regions; blue, four-layer graphene; bi-layer graphene, between the two. (c) Amplitude image of the FLG. Labeled representative features: step edges (triangle), pits (cross), protrusions (encircled. (d) Surface potential image corresponding to (c). Bilayer domains are more strongly perturbed by the underlying nanostructures of the substrate than the 4-layer ones. (e) Surface potential originating from edges (crosses), and pits/protrusions (circles/squares), as a function of number of graphene layers, measured with the tip several nm away from surface. Band around 0 marks the noise level of the KP measurement.