Convergent Fabrication of a Perforated Graphene Network with Air-Stability

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Abstract
The strategic synthesis of two-dimensional organic nanostructures has emerged in recent years[1] as one of the most actively pursued topics in nanotechnology[2-3]. Two-dimensional (2D) porous frameworks synthesized at a surface under conditions of ultra high vacuum (UHV) have drawn special attention due to the potentially different properties that they may possess with respect to their hermetic counterparts such as the ability to open a bandgap as well as the occurrence of flat bands leading to magnetic behavior[4]. Of particular interest are efforts towards the generation of a fully carbon backbone, such as porous graphene, through covalent self assembly, i.e through a bottom-up approach, where the size and shape of the pore can be uniformly controlled by reacting precursor molecules together at a surface. This strategy is a versatile way to produce different assemblies, for instance the long-sought after graphene antidot lattice[4], as well as in applications where size selectivity is crucial (e.g. for catalysis or optical absorption). Nevertheless, the applicability of these constructs is limited by their stability at higher temperatures (up to 700K) and atmospheric pressure (exposure to air). Herein we report a new synthesis procedure based on a convergent approach via a triple aldolisation, which we use to create nanoporous networks of graphene on Au(111) under UHV[5]. Using UHV scanning tunneling microscopy (STM) and density functional theory (DFT) calculations, we show that a nanoporous graphene network fully covers the surface and we identify intermediate states in the growth process. In addition the network is stable up to 800K under UHV. Finally, we have successfully demonstrated that the network is stable at higher pressures, including argon backed pressures of 10^{-5} mbar, but most remarkably, without a protective layer, the structure remains intact after exposure to air.

References
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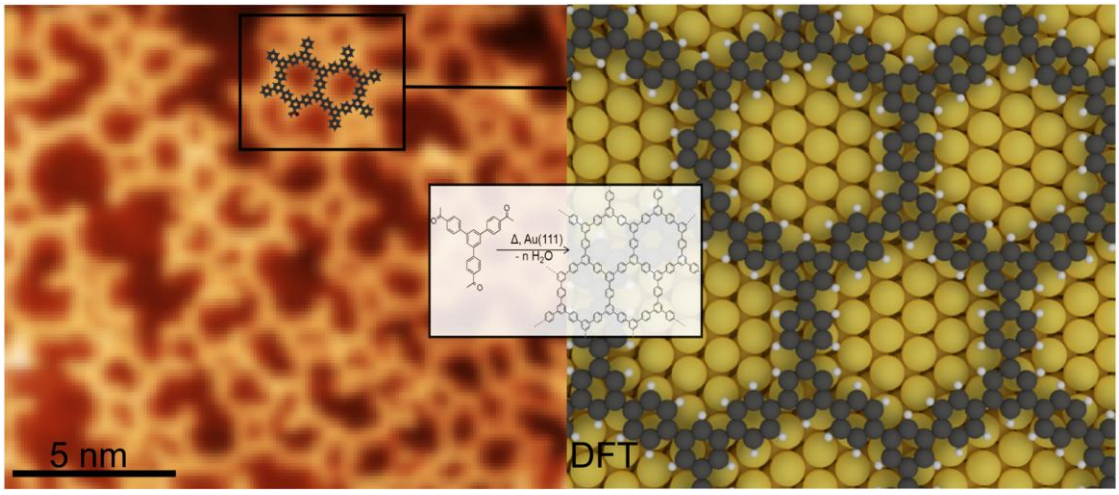

Figure 1: (Left) Scanning tunnel microscopy (STM) topograph of a fully conjugated carbon network synthesized on Au(111). (Right) Density functional theory (DFT) calculations showing the stable structure on Au(111). Middle inset shows the reaction based on a novel convergent approach via triple aldolisation.