Bottom-up fabrication of porous graphene and graphene nanoribbons

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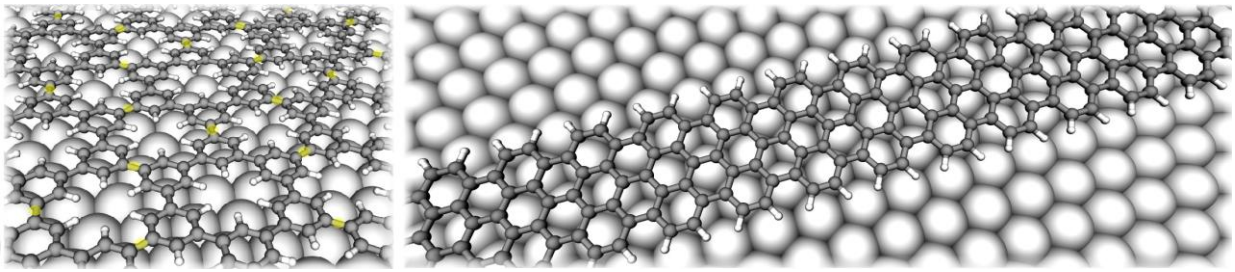
Its remarkable properties make graphene attractive for use in nanoscale devices[1]. However, graphene is semimetallic and thus not directly suitable for most electronic or optoelectronic devices, which require a semiconductor with a specific, finite bandgap. This can be overcome by structuring graphene on the nanometer scale, which opens a bandgap suitable for room-temperature applications[2]. Experimentally, nanostructured graphene and graphene-related materials are accessible via lithographic techniques or chemical treatment, but both methods are limited with respect to their ultimate resolution and precision. In this presentation, I will review our recent attempts to overcome these limitations by a bottom-up strategy allowing for the atomically precise fabrication of graphene-related materials[3-7].



Our surface-chemical method involves the deposition of suitably designed halogen-functionalized molecular precursors onto single crystal metal surfaces under ultrahigh vacuum conditions, and relies on three basic steps: *(i)* surface-catalyzed dehalogenation during adsorption of the precursor monomers, *(ii)* polymer formation by covalent interlinking of the dehalogenated intermediates, and *(iii)* establishement of fully aromatic □-systems by thermally induced cyclodehydrogenation. Using experimental methods such as scanning tunneling microscopy, Raman and photoelectron spectroscopies, which are complemented by density functional theory calculations, we have studied these elementary steps and the resulting graphene-related materials. It will be shown that under suitable conditions the surface-chemical route allows for the fabrication of surface-supported porous graphene or graphene nanoribbons with atomic accuracy. Finally, critical issues such as the balance between mobility and reactivity of the dehalogenated intermediates and the extension of the approach to technologically relevant substrates will be addressed.

References

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