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Atomically Precise Bottom-up Fabrication of Graphene Nanoribbons

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Graphene nanoribbons (GNRs) – narrow stripes of graphene – are predicted to exhibit remarkable properties making them suitable for future electronic applications. Contrary to their two-dimensional (2D) parent material graphene, which exhibits semimetallic behavior, GNRs with widths smaller than 10 nm are predicted to be semiconductors due to quantum confinement and edge effects. Despite significant advances in GNR fabrication using chemical, sonochemical and lithographic methods as well as recent reports on the successful unzipping of carbon nanotubes into GNRs, the production of sub-10 nm GNRs with chemical precision remains a major challenge. In this talk, we will present a simple GNR fabrication method that allows for the production of atomically precise GNRs of different topologies and widths [1]. Our bottom-up approach consists in the surface-assisted coupling of suitably designed molecular precursors into linear polyphenylenes and their subsequent cyclodehydrogenation, and results in GNRs whose topology, width and edge periphery are defined by the precursor monomers. By means of STM and Raman characterization, we demonstrate that this fabrication process allows for the atomically precise fabrication of complex GNR topologies. Furthermore, we have developed a reliable procedure to transfer GNRs fabricated on metal surfaces onto other substrates. It will for example be shown that millimeter sized sheets of crosslinked GNRs can be transferred onto silicon wafers, making them available for further processing, e.g. by lithography, prototype device fabrication and characterization.

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