Bottom-up synthesis of porphyrin based graphene nanoribbons and nanomeshes

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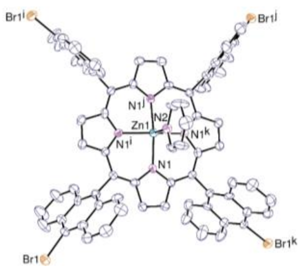
The outstanding properties of graphene strongly inspire the scientific community at both the fundamental and applicative levels for high performance electronics, low power spintronics, renewable energy, composites materials and biomedicine. However, along this way several key scientific issues have to be addressed and one of the main challenges is the control and modification of graphene electronic properties, and notably the controlled opening of a sizable bandgap. This can be achieved by quantum confinement, by means of the fabrication of nano-objects with a precise control of the topology, edge-effects... As a consequence, two main graphene forms have emerged for electronic applications, Graphene NanoRibbons (GNR) and Graphene NanoMeshes (GNM). For the last decade, a great attention has been paid to the fabrication of GNRs [1] and GNMs [2] using conventional top-down approach (lithography, etching, thermal treatments). However, this approach does not allow manipulating the material at the atomic scale. In order to truly control the morphology and the composition of the materials and of its edges, the bottom-up approach is the relevant way to proceed.[3] Recently, graphene incorporating porphyrin molecules have been designed either by the groups of Barth [4] and Fischer.[5]

Here we report on the synthesis of porphyrin derivatives that can lead to nitrogen doped GNR and GNM. The strategy we applied was to design building blocks based on porphyrins with halogens connectors and polymerize them on metallic surface under Scanning Tunnelling Microscope (STM). We succeeded in the synthesis of two original porphyrins with reasonable yield. The first one is a tetrabromoanthracenyl porphyrin (BrTAP, Fig. 1) with four connectors for the formation of a 2D nanostructure and a second, a bis-bromoanthracenylporphyrin (BrBAP) with two connectors GNR. Preliminary STM image for BrTAP on Ag (111) is shown Fig. 1 and other catalytic surfaces are under investigation to form GNR and GNM.



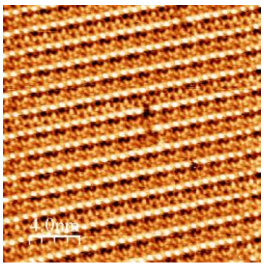


Fig. 1: X-ray structure of BrTAP (left) and STM image of BrTAP on Ag (111) (right).

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