Graphene nanoarchitectonics: building beyond 1D homostructures.

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Bottom-up nanoarchitectonics has demonstrated the capability to control structural parameters of nanomaterials with atomic precision. The surface-assisted synthesis of graphene-based one-dimensional nanostructures à la carte distinctly illustrates the power of this concept. However, despite impressive advances in the synthesis of 1D homostructures, advancing in structural complexity faces major challenges. The functionalization of edges in nanoribbons, an effective strategy to tailor their electronic properties and chemical interactions, is a clear example. The concept of inserting the desired functional groups or dopants in the molecular precursor often fails due to their lack of stability during the reaction path. The fabrication of heterostructures is a second example, where the challenge lies on the control of the size and distribution of their components. A third one is extending the on-surface strategy to two-dimensional structures, where examples of long-range ordered nanoarchitectures are very limited.

I will present different strategies that we developed to overcome each one of this challenges. Regarding edge functionalization, we recently demonstrated the synthesis of amino [1] and fluorine [2] functionalized graphene nanoribbons, both of them showing to be effective for tailoring the electronic band structure. We have also developed a method to synthesize a 2D nanoporous graphene, where the long-range order is achieved by the sequential growth of 1D building blocks and their posterior coupling [3]. Most recently, we have synthesized a similar nanoporous graphene structure that electronically behaves as a 2D superlattice heterostructure [4]. The particular electronic properties of the heterocomponents and the interface structure results in atomically sharp band discontinuities that host subnanometer quantum dipoles, altogether enabling the realization of 1 nm scale superlattice heterojunctions.

References

[1] J. Li et al., ACS Nano. 14, 1895–1901 (2020).
[2] M. Panighel et al., ACS Nano. 14, 11120–11129 (2020).
[3] C. Moreno et al., Science 360, 199–203 (2018).
[4] M. Tenorio et al., submitted.

Figures

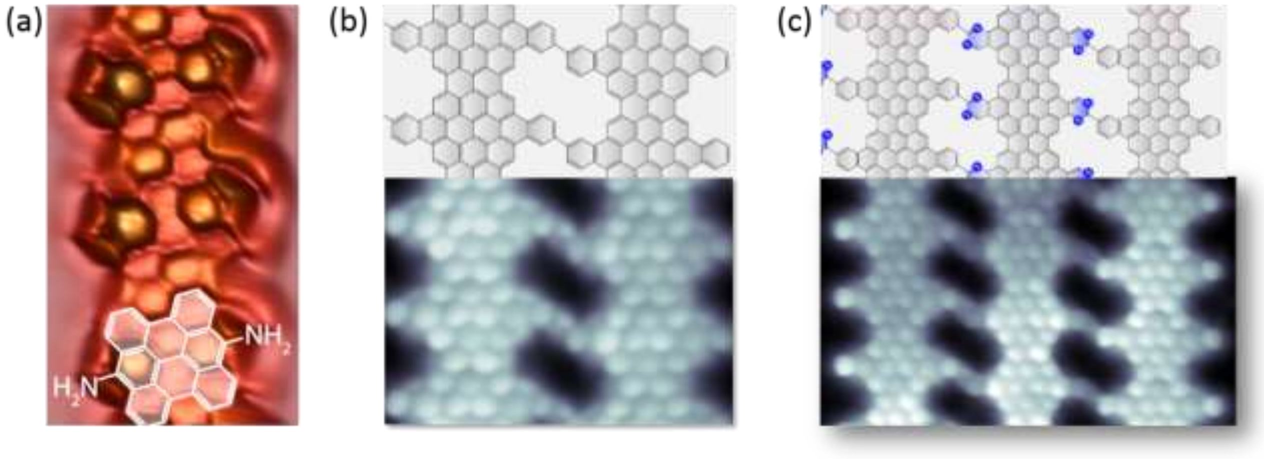

Figure 1. STM images of: (a) Amino functionalized graphene nanoribbon. (b) Nanoporous graphene homostructure. (b) Nanoporous graphene heterostructure.