From molecules to atomically precise graphene nanoarchitectures

C. Moreno, M. Vilas-Varela,1 B. Kretz,2 A. Garcia-Lekue,2,3 M. V. Costache, M. Paradinas, M. Panighel, M. Tenorio, G. Ceballos, S. O. Valenzuela,2, D. Peña,1 and A. Mugarza4

Catalan Institute of Nanoscience and Nanotechnology (ICN2), CSIC and The Barcelona Institute of Science and Technology, Campus UAB, Bellaterra, 08193 Barcelona, Spain.

1Centro de Investigación en Química Biolóxica e Materiais Moleculares (CIQUS) and Departamento de Química Orgánica, Universidade de Santiago de Compostela. Santiago de Compostela 15782, Spain.

2Donostia International Physics Center, Paseo M. de Lardizabal 4, 20018 San Sebastian, Spain.

3Ikerbasque, Basque Foundation for Science, 48013 Bilbao, Spain.

4ICREA Institució Catalana de Recerca i Estudis Avançats, Lluis Companys 23, 08010 Barcelona, Spain.

On-surface reactions, via programmed interactions of molecular building blocks, has recently emerged as a promising route to synthesize atomically precise materials from the ‘bottom-up’. This approach ensures exquisite atomic-scale control of the structural and chemical functionalization, allowing to design a vast number of carbon-based nanoarchitectures not available by traditional solution chemistry nor with the ‘top-down’ methodologies. In particular, graphene nanoribbons (GNRs) with different structures can be synthesized with atomic precision and fine-tuned electronic band gap.

In this talk, I will describe the recent advances in the on-surface synthesis field. Then, I will discuss our recent results to synthesize atomically precise nanoporous graphene [1], graphene nanoribbons and their chemical functionalization and how to organize them into superlattices [2,3].

At the end of the day, this talk will demonstrate the full path to synthesize a semiconducting graphene material with a bandgap similar to that of silicon, its atomic-scale characterization, and its implementation in an electronic device. Further potential applications include in photonics and highly selective molecular filtration and sensing systems.

Figure 1. STM images (bottom) and schematic representation (top) of the precursor, intermediates and final product of the hierarchical synthesis of nanoporous graphene.

