A hybrid Nanoporous Graphene or an atomically-sharp superlattice heterojunction?

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Bottom-up synthesis has shown to be a very efficient method to build graphene nanoarchitectures with atomic precision. The most illustrative example is the plethora of graphene nanoribbons (GNR) that have been created practically *à la carte*. Despite such impressive advances in 1D homostructures, going beyond in structural complexity has turned to be a tough challenge. In particular, the synthesis of heterostructures has been limited to 1D, with no control on size and distribution of fusing components [1]. Here we report a novel synthetic strategy to fabricate atomically precise, lateral superlattice heterojunctions built in a Nitrogen-doped nanoporous graphene structure. For that we harness our ability to create parallely-aligned graphene nanoribbons superlattices [2] in order to guide the synthesis of a second GNR component, in this case an N-doped isostructural counterpart, within the empty channels of the superlattice. The final step consists on fusing laterally [3] the components alternatively into a hybrid nanoporous graphene (h-NPG). The electronic structure is that of a superlattice of type-II heterojunctions whose atomically sharp stepped potential, at the ultimate limit of a single carbon-carbon bond unveils the presence of in-gap tunnelling states and interface quantum dipoles. Our hierarchical strategy overcomes three-in-one breakthroughs: the two dimensional long range order of graphene nanoarchitectonics, the heterogeneous nanopores doped with atomic precision, and the superlattice of atomically-sharp graphene-based heterojunction. We expect to seed new initiatives to synthetize other complex graphene nanoarchitectures with atomic precision.

[1] J. Cai et al., Nat. Nano., 9 (2014) 896-900
[2] C. Moreno et al., Chem. Comm., 54 (2018) 9402-9405
[3] C. Moreno et al., Science, 360 (2018) 199-203

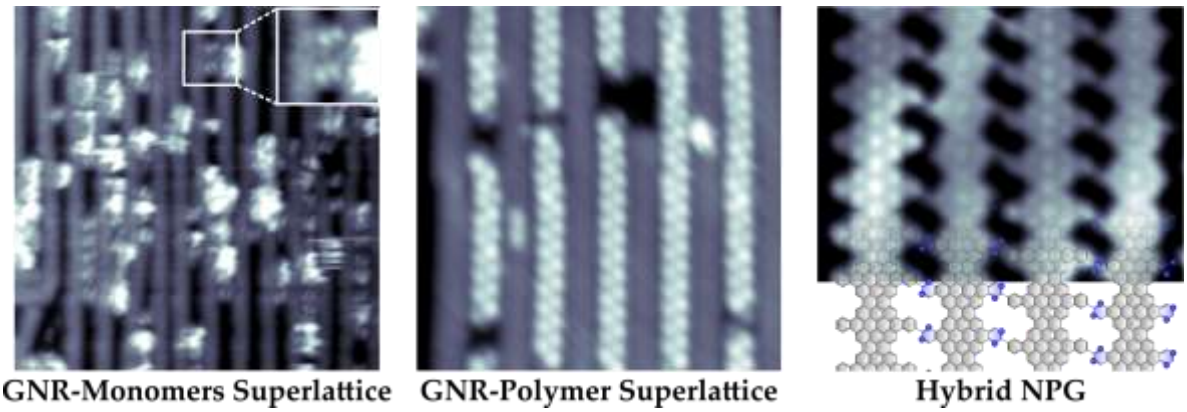

Figure 1: Thermally-induced reaction pathway towards the on-surface synthesis of h-NPG.