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Engineering nanoporous graphene with atomic precision

Nanosize pores can turn semimetallic graphene into a semiconductor [1, 2] and from being impermeable into the most efficient molecular sieve membrane [3, 4]. However, scaling the pores down to the nanometer, while fulfilling the tight structural constraints imposed by applications, represents an enormous challenge for present top-down strategies.
Here we report a bottom-up method to synthesize nanoporous graphene comprising an ordered array of pores separated by ribbons, which can be tuned down to the one nanometer range [5]. The size, density, morphology and chemical composition of the pores are defined with atomic precision by the design of the molecular precursors. Our DFT-STS study reveal a highly anisotropic electronic structure, where orthogonal one-dimensional electronic bands with an energy gap of ~1 eV coexist with confined pore states that might sense passing ions and molecules. The semiconducting character of the nanomaterial has been further confirmed by fabricating field-effect transistors with state of art on/off ratios. The combined structural and electrical properties makes this nanoporous 2D material a highly versatile semiconductor for simultaneous sieving and electrical sensing of molecular species.

References

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[4] S. P. Koenig, L. Wang, J. Pellegrino, J. S. Bunch, Nat. Nanotechnol. 7, 728–732 (2012).
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Figures

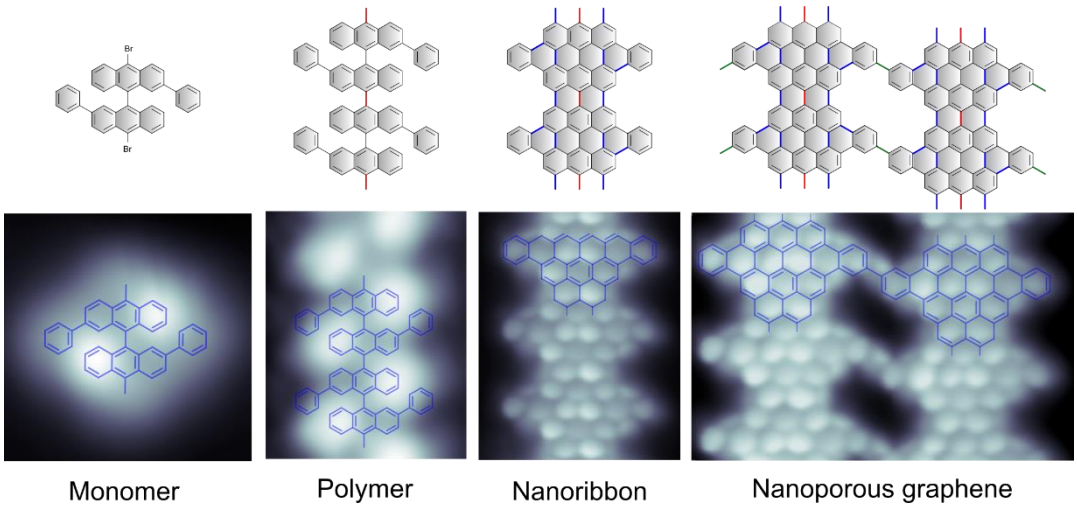

Figure 1: STM images (bottom) and schematic representation (top) of the precursor, intermediates and final product of the hierarchical synthesis of nanoporous graphene.