NANOSTRUCTURES

Precise pores give graphene a bandgap

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Credit: AAAS

In order to build useful electronic devices from graphene, it is important to open an energy bandgap in the material, which can be achieved by synthesizing nanostructures such as graphene nanoribbons or nanoporous graphene. These structures are typically fabricated using top-down methods that involve the etching of a graphene sheet, but such approaches struggle to provide the necessary nanoscale precision. César Moreno, Diego Peña, Aitor Mugarza and colleagues have now synthesized graphene structures with atomically precise pores using a bottom-up synthesis method.

The researchers — who are based at various institutes in Spain — used an on-surface reaction between halogenated molecular precursors to form structures in which ordered arrays of pores are separated by nanoribbons. The molecular precursors are first deposited on a gold surface

and, upon heating to 200 °C, undergo a polymerization reaction. Further heating to 400 °C leads to the formation of graphene nanoribbons, and finally, by heating to 450 °C, the nanoribbons fuse together to form nanoporous graphene sheets with pore sizes of around 1 nm.

Mugarza and colleagues show that the nanoporous graphene has a highly anisotropic electronic structure with an energy bandgap of around 1 eV. Furthermore, the material could be transferred onto a Si/SiO₂ substrate and used to fabricate transistors with good on/off ratios of around 10⁴ and with a high device yield of around 75%.

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