Nesting nanotubes to create 1-D van der Waals heterostructures

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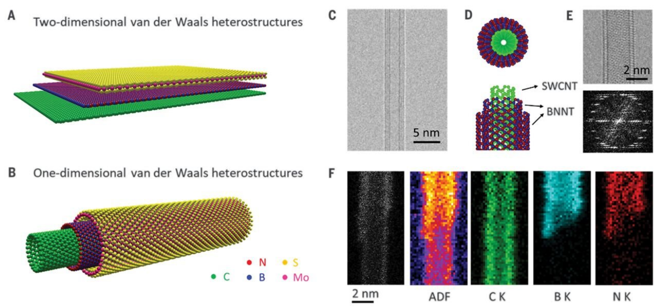

Overview of 1D vdW heterostructures. Credit: *Science* (2020). DOI: 10.1126/science.aaz2570

An international team of researchers has found a new way to create 1-D heterostructures—by nesting nanotubes. In their paper published in the journal *Science*, the group describes how they nested the nanotubes and the shapes they were able to create. Yury Gogotsi and Boris Yakobson with Drexel University and Rice University have published a Perspective piece on the work done by the team in the same journal issue.

In prior research efforts, scientists have developed methods for assembling heterostructures with crystalline two-dimensional materials such as graphene—generally by creating films and then putting them together, or by growing them in layers. In this new effort, the researchers have taken such work a step further by creating one-dimensional analogs of the same types of heterostructures.

The heterostructures created by the researchers were made by adding boron nitride or molybdenum disulfide shells onto single-walled carbon nanotubes using chemical vapor deposition—but the team improved on earlier attempts to do the same by creating outer shells that were seamless and in the shape of a cylinder. They also showed that the layers could be alternated to produce multiple cylinders of different sizes—one inside the other—held together by van der Waals forces. Gogotsi and Yakobson suggest the technique developed by the team is likely to open up a whole new class of 1-D heterostructures, noting that a wide variety of transition metals could be used to create different types of heterostructures. They even suggest such heterostructures could lead to the development of nanodevices or even nanomachines.

By using surface-to-surface templating, the researchers demonstrated 1-D tubular crystal growth without the use of a catalyst, an idea that could be applied to 2-D applications, as well, opening up new venues of research. Gogotsi and Yakobson also point out that the use of curvature introduces strain energy to the atoms as they are added—a factor that reduces growth on nanometer-thin tubes. Another positive characteristic of the tubes is that nesting allows for improving oxidation and chemical resistance—and because all of the materials used to create the heterostructures have long been used as solid lubricants, nested 1-D heterostructures might be used to create products with superlubricity.

More information: Rong Xiang et al. One-dimensional van der Waals heterostructures, *Science* (2020). DOI: 10.1126/science.aaz2570

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