VAN DER WAALS HETEROSTRUCTURES

Turning two into one with carbon nanotubes

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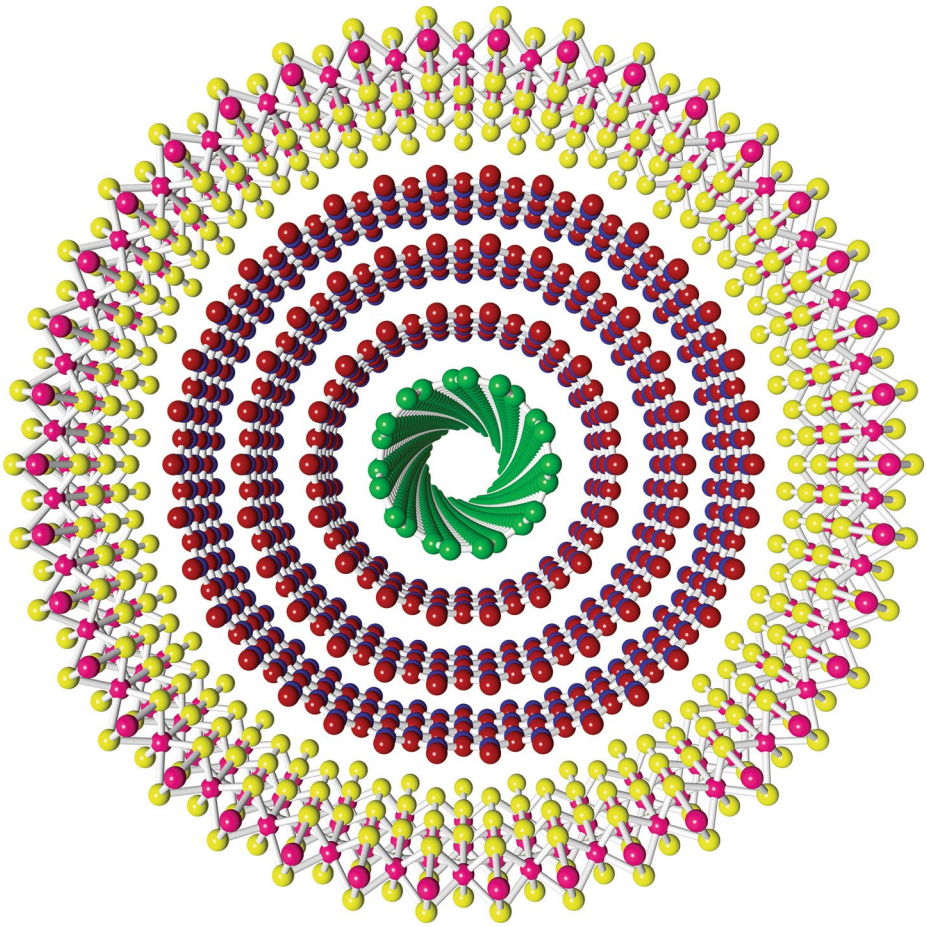

Credit: AAAS

Atomically thin crystalline layers of hexagonal boron nitride (hBN) and molybdenum disulfide (MoS_2) can be cleanly stacked in different combinations to construct van der Waals heterostructures, which offer unique electronic properties and functions. These two-dimensional (2D) heterostructures are typically fabricated by transferring whole layers or by growing (using, for example, chemical vapour deposition) each layer in turn. Rong Xiang, Shigeo Maruyama and colleagues have now created one-dimensional van der Waals heterostructures that consist of hBN and MoS_2 nanotubes.

The researchers — who are based at the University of Tokyo and other institutions in Japan, China, India, Finland and the US — used chemical vapour deposition to grow different nanotubes as shells around a core made from a single-walled carbon nanotube. Unlike previous attempts at coaxial 1D van der Waals heterostructures, the outer layers are single crystals. In addition to structures with a single monolayer of MoS_2 or hBN, the researchers fabricated heterostructures of trilayer hBN and an outer monolayer of MoS_2. This improves the yield as MoS_2 nanotubes have a minimum diameter of around 4 nm, while the average carbon nanotube diameter is only 1–2 nm. Xiang, Maruyama and colleagues also suggest that their approach could be extended to other 2D materials.

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