

Artificial Lotus Effect: Carbon nanotubes with nanoscopic paraffin coating form superhydrophobic, self-cleaning surfaces

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Never wash your car again? Never clean your windows? These may well become reality if it becomes possible to produce the right coatings—coatings that imitate the self-cleaning effect of the lotus blossom.

A research team led by Ayyappanpillai Ajayaghosh at the National Institute for Interdisciplinary Science and Technology (Trivandrum, India) has made significant progress toward this goal. As they report in the journal *Angewandte Chemie*, these scientists have successfully produced a superhydrophobic, self-cleaning surface. Their success results from carbon nanotubes having a nanometer-thick paraffin coating with the help of a rigid aromatic molecule called para-phenylenevinylene.

The lotus plant has given its name to a natural self-cleaning mechanism: The extremely water-repellent (superhydrophobic) surface of its leaves causes drops of water to form spheres, which roll off the leaf, sweeping any dirt away. The lotus leaf is equipped with 3 to 10 μm “bumps” that are in turn coated with a nanoscopic water-repellent coating.

The bumpy structure minimizes the area with which the water can come into contact and the water-repellent coating keeps water from getting into the valleys between the bumps. The water cannot coat the leaf and simply rolls off.

The researchers started with carbon nanotubes—long, hollow fibers made of carbon atoms in a honeycomb-like arrangement. Using a self-assembly process, they attached organic molecules to the exterior of the tubes. These molecules consist of a short backbone of aromatic six-membered carbon rings that supports several long hydrocarbon chains.

The aromatic rings attach themselves firmly to the honeycomb structure of the nanotubes; the hydrocarbon chains act like a paraffin-like coating. The research team applied a dispersion of these adducts to glass, metal, and mica surfaces. Once dry, the result was a water-repellent coating with stable self-cleaning properties.

Electron microscopic images show that the coating does not have a regular structure like the leaves of the lotus, but does have comparable nanoscale roughness. Water has as much trouble coating these artificial surfaces as the lotus leaf. A tilt angle of 2° is sufficient to cause water droplets to roll off. Like the lotus, any dust is removed from the surface by the water droplets.

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