Make Like a Leaf: Next-Gen Paint Could Strike Lotus Pose

Alexis Madrigal

Lotus leaves stay dry by using the natural vibrations of their environments to shake off water, and manmade materials should be able to mimic the water-repelling technique.

New research published today in *Physical Review Letters* by Duke materials scientist Chuan-Hua Chen has solved a long-standing puzzle: how lotus leaves stay dry in the wild, but not in the lab.

Chen, who grew up surrounded by lotus plants in his hometown of Honghu in central China, had an intuition that perhaps the leaves used the vibrations induced by the wind to stay dry, but that had never been shown in the lab.

So, Chen and his graduate student, Jonathan Boreyko, stuck lotus leaves, on which they'd condensed water, atop the woofer of a $20 Radio Shack speaker to vibrate the leaf at about 100 hertz — and recorded what happened with a very high-speed camera. Just as in their natural state, the leaves stayed dry.

"People have observed that condensation forms every night on the lotus leaf. When they come back in the morning the water is gone and the leaf is dry," Chen said in a press release. "The speaker reproduced in the lab what happens every day in nature, which is full of subtle vibrations, especially for the lotus, which has large leaves atop long and slender stems."

Lotus leaves are the canonical example of a hydrophobic, or water-hating, material. When drops of water fall on the plants, they roll off. They cannot be wet. At the microscopic level, the surfaces are actually quite rough: Tiny fiber-covered pillars hold up the water droplets, creating a cushion of air that prevents them from sticking to the leaves. If water gets into that air cavity though, the property of the material reverses and starts to love water.

Dew, which forms inside the air cavities presented a major problem for researchers looking for hydrophobic coatings for vehicles, say. They worried their materials would be ruined by actual field usage.

"Much remains to be done to achieve genuine antidew materials," summarized French materials scientist David Quere, in a 2008 article in the Annual Review of Materials Research (.pdf).

The real problem, though, was that the leaves had not been allowed to move as they would in natural conditions. Now, with the discovery that simple

vibration can force every drop of water off the leaf, a roadblock has been cleared for hydrophobic materials.

"This finding has direct applications because vibration is everywhere," Chen told Wired.com. "Your computer has fans, it keeps vibrating. Your power plants, your automobile or your spacecraft all have vibrations."

Materials, then, can be built to scavenge the tiny amounts of energy in their environments to dry themselves off.

You can watch the process at work in the video below. At first, the water molecules are subtly impaled on the tiny spikes of the lotus leaf. As the vibration commences about halfway through the video, the water droplets at first struggle to break free — and then actually do so. In the language of materials science, the leaf's surface has gone from a Wenzel state, where it's not hydrophobic, to a Cassie state, where it is. And that's the very first time that's ever been observed in the lab.

Image: flickr/tapperboy

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