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Latest News

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BIOMIMETIC MATERIALS

Dry Run

Desert beetle wings inspire high-tech, liquid-controlling surfaces

Ivan Amato

As they stoically position themselves, heads down, in the moist, intermittent, gale-force winds of the Namib Desert in Southern Africa, dime-sized *Stenocara* beetles harvest enough water with their ingeniously textured wing surfaces to survive in their otherwise bone-dry setting. When Massachusetts Institute of Technology materials researchers Robert E. Cohen and Michael F. Rubner first learned about this feat of insect survival a few years ago, they knew these beetles had a thing or two to teach them about surface chemistry and water control.

Courtesy of Andrew Parker

BEETLE BUMPS
The water-attracting bumps and water-repelling

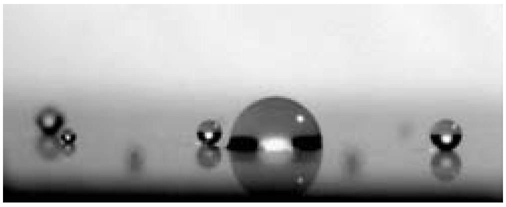
gulleys between bumps enable some desert beetles to harvest water from fog.

Now these scientists and their colleagues report that they have emulated the pattern of water-attracting (hydrophilic) and water-repelling (hydrophobic) wing regions that enable *Stenocara* beetles to snatch moisture out of the air, collect it into drops, and then shun the drops mouthward (*Nano Lett.,* published online May 2, dx.doi.org/10.1021/nl060644q).

Among the applications the researchers have in mind are large-area, fog- and dew-harvesting materials to improve drinking water supplies and irrigation in some desperately dry areas. The materials could also be used in microfluidic chips in which tiny amounts of liquids need to be precisely shunted between and among minuscule chambers to carry out diagnostic tests, molecular identifications, and other tasks.

“I am pleased to see that the beetle’s surface has been mimicked accurately,” says Andrew Parker, a zoologist at Oxford University, who with Chris Lawrence of the defense technology firm QinetiQ in Farnborough, England, first described the surface dynamics underlying the *Stenocara* beetle’s fog-harvesting abilities. Materials bearing synthetic versions of such surfaces could lead, in Parker’s words, “to replace the nets currently used for fog harvesting in 22 different countries.”

“We are going beyond the beetle now by incorporating antibacterial agents,” Rubner notes. “As water is accumulating, it can be self-decontaminating,” he suggests, laying out another way the patent-pending technology could be developed for safely harvesting underutilized sources of drinking water such as dew and fog.



Courtesy of Michael Rubner

SPOT ON A water drop sticks to a single superhydrophilic spot on a superhydrophobic background on which water beads up and can roll around like ball bearings.

For many years, Rubner and coworkers have been developing techniques for making multifunctional materials by depositing sequences of molecular layers with different chemical and physical properties.

In this case, the researchers use a micropipette to superimpose submillimeter islands of superhydrophilic materials atop a superhydrophobic background. The key innovation, says Rubner, was to formulate a polyelectrolyte solution [poly(acrylic acid) and 2-propanol] that can infiltrate and electrostatically bind to an underlying superhydrophobic layer that has been rendered porous with a structural component based on silica nanoparticles. This way the electrolyte deposited with the pipette can become anchored in the superhydrophobic layer, yet still have plenty of charged chains sticking upward, enabling the researchers to render specific overlying regions superhydrophilic. It ought to be possible to create a diversity of patterned surfaces by ink-jet printing and other more automated techniques, the researchers say.

“Nature has evolved these marvelous structures,” says Rubner, who points to the water-repelling lotus leaf surface, the light-reflecting moth eye, and the color-morphing microstructure of hummingbird wings as other natural innovations worth emulating.

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