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NEWS | JULY 16 2021

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Scilight 2021, 291103 (2021)
https://doi.org/10.1063/10.0005689

AIP Publishing

Scilight

13 July 2021

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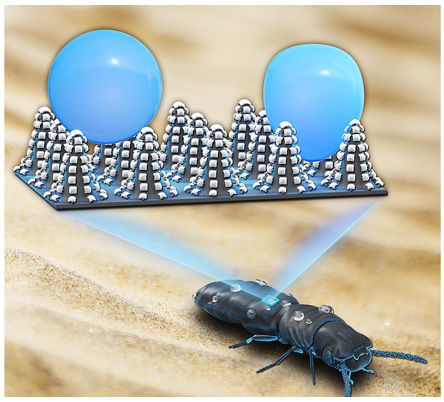
Differently sized structures on the bugs work together to allow both static and dynamic wetting resistance.



Water-resistant materials typically suffer from a tradeoff between static and dynamic liquid repellency, which depends on the roughness of the material's surface features. An exception to this rule is in the cuticles of springtails, a form of tiny arthropod. Springtails' cuticles are composed of tapered microscopic bumps and nanoscopic overhangs, which work together to enable both static repellency and dynamic pressure resistance.

Inspired by the hierarchical structures on these creatures, Sun et al. fabricated 3D structures capable of liquid repellency in both static and dynamic wetting conditions.

"Distinct from other works that seek to replicate the overhang structures of the cuticles of springtails to impart superior liquid repellency, we designed tapered posts with multilayered overhangs, which sustain a more robust liquid repellency, decoupling the requirements of static and dynamic liquid repellency on geometric features," said author Zuankai Wang.

In tests, the structures induced a stepwise wetting behavior, leading the authors to call them stepwise wetting structures (SWS). Fabricated with laser writing lithography, the SWS significantly improves the stability of the material's unwetted state by pinning droplets at the air-water interface, such that they cannot break through the pinning pressure, keeping the material dry until the droplets evaporate. Even at fast impact rates and in harsh environments, the infiltration of water into the material is slowed down immensely, if not completely stopped.

The applications SWS are vast, ranging from anti-icing to spill resistance, but fabrication is limited by 3D printing capabilities. The group anticipates advances in manufacturing techniques will help extend the uses of the design and is working on developing additional 3D printable materials to construct the complex patterns.

Source: "Robust liquid repellency by stepwise wetting resistance," by Jing Sun, Pingan Zhu, Xiantong Yan, Chao Zhang, Yuankai Jin, Xuan Chen, and Zuankai Wang, *Applied Physics Reviews* (2021). The article can be accessed at https://doi.org/10.1063/5.0056377.