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Direct observation of self-similar contact line depinning from superhydrophobic surfaces ADAM PAXSON, KRIPA VARANASI, Massachusetts Institute of Tehcnology — The adhesion of a drop to a superhydrophobic surface, although very low, is never altogether eliminated. As the drop moves along the surface, the advancing portion of the contact line simply lies down onto the upcoming roughness features, contributing negligibly to adhesion. Instead, the pinning and contact angle hysteresis are governed by the depinning of capillary bridges formed at the receding portion of the contact line. We use environmental scanning electron microscopy to observe these depinning events at the microscale. After measuring the local receding contact angle of capillary bridges formed on a micropillar array, we find that these depinning events follow the Gibbs depinning criterion. We further extend this technique to two-scale hierarchical structures to reveal a self-similar depinning mechanism in which the adhesion of the entire drop depends only on the pinning at the very smallest level of roughness hierarchy. With this self-similar depinning mechanism we develop a model to predict the adhesion of drops to superhydrophobic surfaces that explains both the low adhesion on sparsely structured surfaces and the surprisingly high adhesion on surfaces whose features are densely spaced or tortuously shaped.

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