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Metastability and roll-off behavior of droplets on superhydrophobic surfaces KRIPA VARANASI, NITIN BHATE, MING HSU, SHANNON OKUYAMA, TAO DENG, JUDITH STEIN, GE Global Research Center — We studied the wetting behavior of water droplets on arrays of hydrophobic square posts. To determine the droplet wetting state, we measured static contact angles and compared the results to predictions for equilibrium Cassie and Wenzel states. These comparisons showed that there are three wetting regimes: equilibrium Cassie at small post spacing, equilibrium Wenzel for large post spacing, and an intermediate state at medium post spacing. Next, we measured droplet roll-off angle and surprisingly found that it was minimized on surfaces in the intermediate range that were expected to induce Wenzel-like wetting rather than on surfaces that exhibit equilibrium Cassie wetting. We argue that the droplets in the intermediate range are metastable Cassie droplets whose internal Laplace pressure is insufficient to overcome the energy barrier required to homogeneously wet the posts. These metastable Cassie droplets showed superior roll-off behavior because the effective length of the contact line that is pinned to the surface is reduced. We have developed models that can predict this roll-off behavior and the transition between the metastable Cassie and Wenzel regimes. This fundamental understanding can be used to optimize texture design for properties such as water repellency.

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