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Preferential Condensation of Water Droplets Using Hybrid Hydrophobic-Hydrophilic Surfaces KRIPA VARANASI, MIT, TAO DENG, GE Global Research, ADAM PAXSON, RAJEEV DHIMAN, MIT — Heterogeneous vapor-to-liquid nucleation of water is an everyday phenomenon and plays an important role in the formation of rain drops, dew, heat transfer, water recovery, etc. Classical nucleation theory predicts that an energy barrier that depends strongly on the intrinsic wettability of the surface has to be overcome for the formation of initial liquid nuclei. Since the intrinsic wettability of regular surfaces is spatially uniform, heterogeneous nucleation of water droplets seems to occur in a random fashion without any particular spatial preference. This effect accounts for the recent observations on the loss of superhydrophobic properties of lotus leaves and associated synthetic surfaces under condensation. By taking advantage of the strong dependence of the nucleation energy barrier on wettability, we show for the first time that heterogeneous nucleation can be spatially controlled by the manipulation of the local intrinsic wettability of a surface. Using an environmental scanning electron microscope, we show that water droplets preferentially nucleate on the hydrophilic regions of the hybrid hydrophobic-hydrophilic surfaces we fabricated. Such ability to control water nucleation could address the condensation-related limitations of superhydrophobic surfaces and has implications for efficiency enhancements in energy, water, and electronics cooling systems.

Kripa Varanasi
MIT

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