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Effect of Vapor Flow on Jumping Droplets during Condensation on Superhydrophobic Surfaces DANIEL J. PRESTON, NENAD MILJKOVIC, Massachusetts Institute of Technology, RYAN ENRIGHT, Bell Labs Ireland, ALEXANDER LIMIA, EVELYN N. WANG, Massachusetts Institute of Technology — Upon coalescence of droplets on a superhydrophobic surface, the net reduction in droplet surface area results in a release of surface energy that can cause the coalesced droplet to "jump" away from the surface. Jumping condensing surfaces have been shown to enhance condensation heat transfer by up to 30% compared to state-of-the-art dropwise condensing surfaces. While the heat transfer enhancement of jumping condensation is well documented, droplet behavior after departure from the surface has not been considered. Vapor flows to the condensing surface due to mass conservation. This flow can increase drag on departing droplets, resulting in complete droplet reversal and return to the surface. Upon return, these larger droplets impede heat transfer until they jump again or finally shed due to gravity. By characterizing individual droplet trajectories during condensation on hydrophobic nanostructured copper oxide surfaces for a variety of heat fluxes $(q^{2} = 0.1 - 1)$ 2 W/cm2), we showed that vapor flow entrainment dominates droplet motion for droplets smaller than R ≈ 30 um at high heat fluxes (q" >2 W/cm2). Furthermore, we developed an analytical model of droplet motion based on first principles and the Reynolds drag equation which agreed well with the experimental data. We considered condensation on both flat and tubular geometries with our model, and we suggest avenues to further enhance heat transfer which minimize droplet return due to entrainment.

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