Electronic Supplementary Material (ESI) for Soft Matter

Supporting Information

Hierarchically structured porous aluminum surfaces for high-efficient removal of condensed water

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Measurement of receding contact angle (θ_{rec}) of condensed droplets on hierarchically structured porous aluminum surfaces: The θ_{rec} of condensed microdroplets on the surfaces were measured using a CA System (DSA100, Kruss Co., Germany) with the objective lens of ×50. The aluminum sheets with structured porous surfaces were put on a cold plate. When the samples' temperature is lower than the dew point of water vapor, condensation occurred. The surface temperature (3 °C and the relative humidity of 30%) was kept until the diameter of condensed microdroplets was about 200 μm. Then, the sample was slowly warmed to the room temperature to evaporate condensed microdroplets. The evaporation of condensed microdroplets as well as the receding motion of the microdroplets was recorded by a microscopic imaging system with a speed of 7.17 frames per second (fps). During the evaporation of a condensed microdroplet, the stick-slip motion of the footprint was observed. Because of the quasi-equilibrium during the evaporation of condensed microdroplets, the contact angle (CA) of a condensed microdroplet when its footprint slipped backwards was taken of as the θ_{rec}.

***In situ* observations of the condensation, coalescence and self-removal on the structured aluminum surfaces:** The condensation on aluminum sheets was observed using a high speed imaging system (high-speed video camera, Phantom, V7.3) connected to an optical microscope (Olymbus co. BX51). A humidity controller (Beijing YaDu Technical Company for Cleaning Air, Ltd.) was used to control the relative humidity (RH). The surface temperature of the cold plate was tested precisely by 4 T-type thermocouples, recorded by a temperature data acquisition system (Beijing Zhongxin Sci-Tech. Co., Ltd.) and averaged as the surface temperature. The process of condensation was recorded in 15 min with the speed of 20 fps. The surface temperature of the super-hydrophobic surfaces and the RH were maintained at 3 °C, 30 %, respectively.

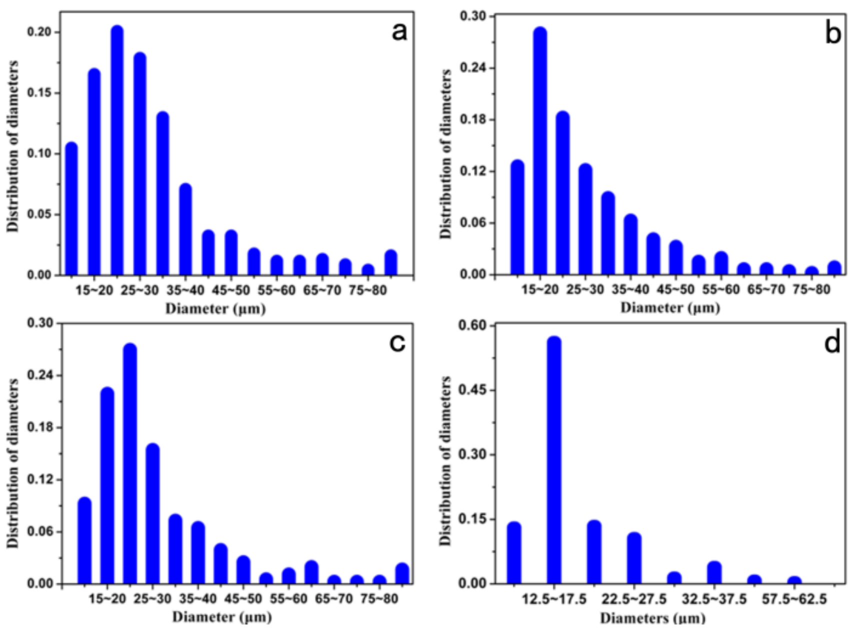

Figure S1: Distribution of diameters of coalescing microdroplets on hierarchically structured aluminum surfaces with W_{ad} of a) 7.9 mJ/m^2, b) 28.5 mJ/m^2, c) 48.5 mJ/m^2 and d) 70.9 mJ/m^2.

The diameters of microdroplets coalesced to induce self-removal of microdroplets were measured and shown in Figure S1. The diameter of coalescing microdroplets to induce self-removal on these surfaces is mainly in the range of 10~30 μm (Figure S1 a, b, c and d). Furthermore, with the increase of the W_{ad} to condensed micrdroplets on all surfaces, the distribution of diameters becomes narrower indicating that the self-removal of coalesced microdroplets is more difficult. It should be pointed out that the magnification in these experiments was 200 times in order to observe more coalescing and self-removal events. And thus coalescing micordroplets with diameters smaller than 10 μm were not captured. Counting condensed microdroplets larger than 10 μm is reasonable, because neglectable number of condensed microdroplets with diameter smaller than 10 μm were observed to be self-removed after the coalescence. And this agrees with the results reports previously,[1, 2] in which a critical size of 10 μm for the coalescence induced self-removal was presented.

[1] F. C. Wang, F. Q. Yang and Y. P. Zhao, *Applied Physics Letters* **2011**, *98,* 174502.

[2] J. Boreyko and C.-H. Chen, *Physical Review Letters*, **2009**, *103,* 053112.