Supporting Information:

How Ice Bridges the Gap

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1 Separate phase maps

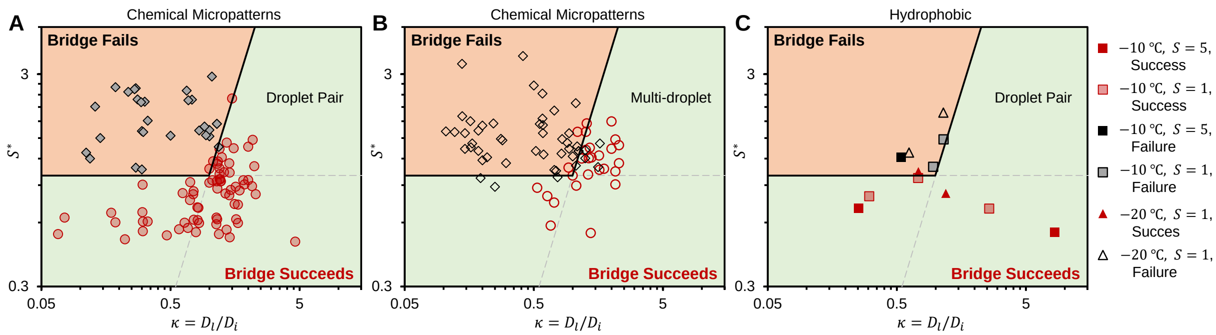

Figure S1: Experimental values of S^* plotted against their corresponding κ values. (A) Isolated pair interactions and (B) Multi-droplet ice bridging events, as done on the chemically micropatterned surface at $-10\,°\mathrm{C}$. Diamonds represent data points where the inter-droplet ice bridge(s) failed, whereas circles are where the liquid droplet is successfully frozen by an ice bridge. These two plots show that the connection criteria is effectively unchanged when comparing isolated and multi-droplet experiments. The solid lines correspond to $S^*_{Cr} = 1$ and $S^*_{Cr} = \kappa^2$. (C) Phase map for isolated pair interactions on a smooth hydrophobic surface ($\theta \approx 100°$), at -10 and $-20\,°\mathrm{C}$. The experiments were done for two different supersaturations, $S = 1$ and 5. Supersaturation is defined as $S = c_\infty / c_l$, where c_∞ is the concentration of water vapor in the atmosphere and c_l is the saturation vapor pressure with respect to liquid water. All three plots together reveal that the connection criteria remain the same, regardless of the surface temperature, supersaturation, or whether the surface is uniformly hydrophobic or chemically micropatterned. The only caveat is that the bridge has to be directed and unbranched, that is $L < \lambda$, where λ is the destabilization wavelength of the ice fronts.

2 Multi-droplet ice bridging

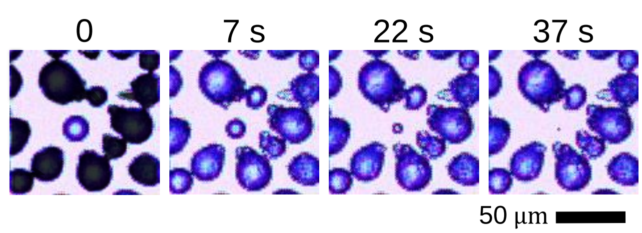

Figure S2: A single liquid droplet being harvested by multiple frozen droplets, false-colored black in the first frame. The substrate temperature was $T_w = -10\,°\mathrm{C}$, the air temperature was $T_\infty = 24\,°\mathrm{C}$, and the relative humidity was 26%.

3 Fabrication of superhydrophobic surfaces

Wafers of copper alloy were degreased in acetone and immersed in ethanol for 10 min each. After rinsing them with deionized water, they were immersed in 10 mM $AgNO_3$ for 10 min. Thus, micro and nano-particles were galvanically deposited onto the copper, thereby creating the requisite roughness needed for superhydrophobicity. Finally the wafers were immersed in 2 mM of 1-hexadecanethiol in ethanol for 15 min, coating them with a hydrophobic monolayer.

4 Percolation dynamics

4.1 Percolation on a chemically micropatterned surface: Denser packings

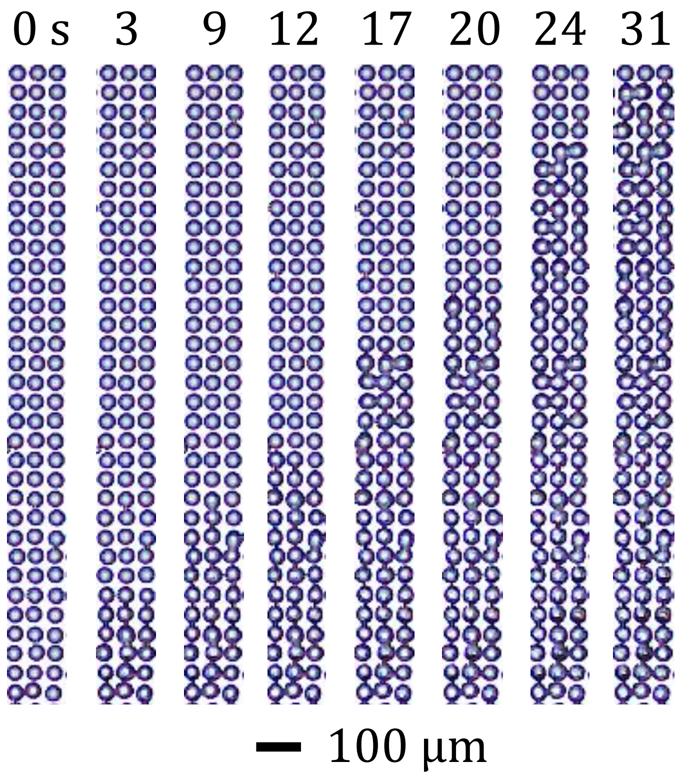

Figure S3: Figure 5C from main text without false-coloring.

4.2 Percolation on a smooth hydrophobic surface

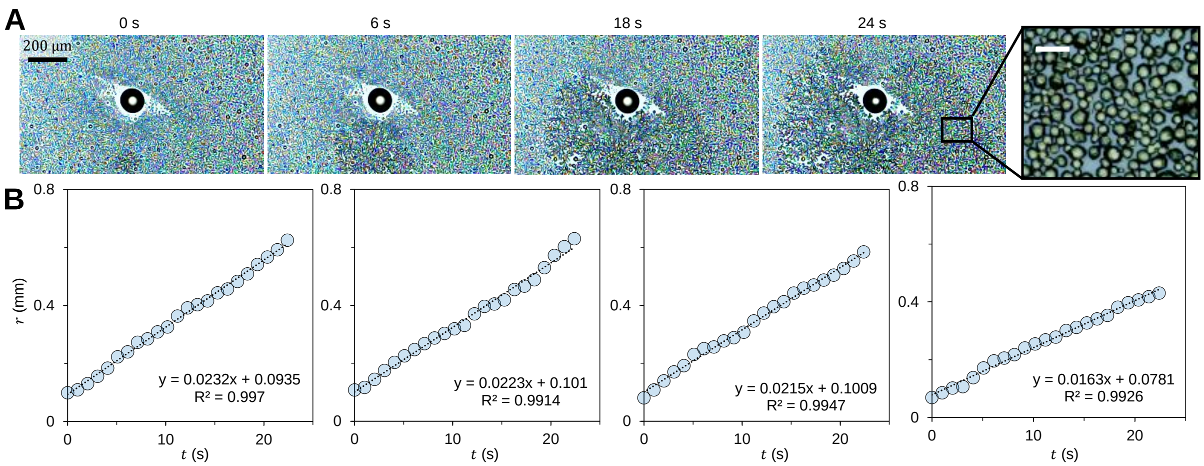

Figure S4: (A) Figure 6A from the main text without false-coloring or cropping. (B) Four random points were chosen along the freeze front at the initial frame corresponding to $t = 0$, and were tracked over time to obtain $r - t$ plots. The percolation speed was measured to be a constant $v_p = 20.8 \pm 3\,\mu$m/s over a time span of 22.4 s. The white scale bar in (A) denotes 50 μm.

5 Video Captions

Video S1

A typical interdroplet freeze front. Condensation frosting on a chemically micropatterned surface at $T_w = -10\,^\circ\mathrm{C}$, $T_\infty = 24\,^\circ\mathrm{C}$ and humidity $H = 26\,\%$. Video corresponds to Fig. 1.

Video S2

Ice bridging with tip-splitting deformities. Ice bridging for $L_b \gg \lambda$. Three liquid droplets, whose diameter and inter-droplet separation are both of order $100\,\mu\mathrm{m}$, are placed on a substrate chilled to $T_w = -10\,^\circ\mathrm{C}$ with $T_\infty = 16.3\,^\circ\mathrm{C}$ and $H = 15.6\,\%$. The first droplet freezes and grows ice bridges toward its two liquid neighbors. Note that the two bridges are not uniform and show tip-splitting deformities. Video corresponds to Fig. 2C.

Video S3

1D percolation front. A chain reaction of successive freezing of six droplets in an array due to the propagation of an inter-droplet freeze front. The surface was the chemically micropatterned substrate set to $T_w = -10\,^\circ\mathrm{C}$, with $T_\infty = 24\,^\circ\mathrm{C}$ and a relative humidity of 26%. Video corresponds to Fig. 5A.

Video S4

Formation of a dry zone. A droplet was frozen at $T_w = -10\,^\circ\mathrm{C}$, $T_\infty = 23.5\,^\circ\mathrm{C}$, and humidity $H = 32\,\%$. The nearest microcondensate all evaporated, leading to a global failure of ice bridge connections. Thus an evaporation front was created that propagated thereafter. Video corresponds to Fig. 5C.