Supplementary Information

Bubble-Induced Rupture of Droplets on Hydrophobic and Lubricant Impregnated Surfaces

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SI: Sample Fabrication

Part 1: Mixing and curing of PDMS substrate.

PDMS monomer and curing agent taken in 10:1 ratio is mixed thoroughly using a glass rod. The mixture is placed in a desiccator and degassed using a vacuum pump for 20-30 minutes. After degassing, the mixture is gently poured on the textured silicon substrate (dimension ~ 1 cm x 1 cm) used as a template. The substrate comprising square array of pillars (size ~ 10 µm, height ~ 10 µm and spacing ~ 10 µm) is placed firmly in a petri dish, PDMS mixture is poured into the petri dish to a desired height. For plain PDMS sample, a smooth and flat petri dish was used as the mold. The mixture is degassed in a desiccator using a vacuum pump again for 10 minutes. Curing of this mixture is done at 90 °C for 4 hours. The cured PDMS is subsequently peeled off carefully.

Part 2: Lubricant Impregnated Surfaces.

Cured structured PDMS surfaces are used to make lubricant-impregnated surfaces. Silicone oil with viscosity 10 cSt, 100 cSt, and 1000 cSt are used as lubricating oil. The textured PDMS substrates are immersed in the oil for at least 24 hrs. This is necessary to saturate the PDMS substrate with the lubricating oil to form oil-infused PDMS [1]. The sample is subsequently...
removed from the oil bath. The excess oil from the surface is first removed by gravity draining,
then by using big water droplets hovering and sliding off the surface until the excess oil film is
removed.

*S2: Advancing and receding contact angles on different substrates*

Contact angles of an advancing and receding water droplet on different LIS, plain and
structured substrates were measured using a contact angle meter (Dataphysics OCA 25). The
average advancing and receding contact angles for a water droplet on different substrates are
tabulated below.

Table S1. Advancing and receding contact angle (in degrees) of droplet of different surfaces.

<table>
<thead>
<tr>
<th></th>
<th>Plain</th>
<th>Structured</th>
<th>LIS-10</th>
<th>LIS-100</th>
<th>LIS-1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advancing CA</td>
<td>113 ± 2</td>
<td>134 ± 2</td>
<td>101 ± 2</td>
<td>97 ± 2</td>
<td>95 ± 2</td>
</tr>
<tr>
<td>Receding CA</td>
<td>94 ± 2</td>
<td>103 ± 2</td>
<td>97 ± 1</td>
<td>94 ± 2</td>
<td>93 ± 2</td>
</tr>
<tr>
<td>Contact angle hysteresis</td>
<td>19 ± 2</td>
<td>31 ± 4</td>
<td>4 ± 2</td>
<td>3 ± 2</td>
<td>2 ± 1</td>
</tr>
<tr>
<td>Static CA</td>
<td>110 ± 3</td>
<td>125 ± 2</td>
<td>100 ± 7</td>
<td>95 ± 2</td>
<td>95 ± 4</td>
</tr>
</tbody>
</table>
Fig S1. Transient change of base diameter and droplet height as the air is injected into the droplet placed on different surfaces. The time is normalized with respect to total time for which bubble grows without rupture. The dashed lines represent the base diameter and the dotted lines represent droplet height. The error bars represent the standard deviation across 3 experiments. The last point on the graphs for each surface represents the rupture point of the droplet.

**S4: Influence of the rate of injection of air on droplet dynamics**

All the data reported in the manuscript are for a constant air inlet rate of 0.2 ml/min. On plain and textured PDMS, rupture of the air-induced bubble always occurs at the apex of the droplet, irrespective of the rate at which air is injected. In the case of LIS, the rupture always occurs near the base of the droplet when the air flow rate is low (0.2 ml/min). However, at higher injection rate, the possibility of liquid layer at the apex of the droplet thinning faster than the time scale of the bubble reaching the contact line increases. Therefore, with increase in the rate of air injection, the probability of rupture from the apex of the drop increases on LIS (see table S2). It should be noted that at higher injection rate, controlled experiments on LIS is challenging because of high mobility of the droplet on LIS. Detailed comparison about the final
volume, rupture point and total time of expansion at different air injection speeds is given below. Initial volume of the droplet was 15 ± 3 µl for all the cases.

Figure S2. (a) The final volume of the droplet before rupture occurs on the test substrates for 3 different air injection rates. At higher air injection rates, the bubble ruptures at smaller volume of air injected (b) the time duration for which the bubble continues to grow before rupturing. The error bars represent the standard deviation across 3 experiments.

Figure S3. The variation of size of the nucleated hole on LIS-100 and LIS-1000 with respect to time (normalized with respect to total time for which bubble grows without rupture). The error bars represent the standard deviation across 3 experiments.
Table S2. The probability of film rupture to occur at the apex (top) of the droplet or the base (bottom) corresponding to different air inlet rate. Set of 5 experiments were examined for each case.

<table>
<thead>
<tr>
<th>Air inlet rate</th>
<th>Plain</th>
<th>Structured</th>
<th>LIS-10</th>
<th>LIS-100</th>
<th>LIS-1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.2 ml/min</td>
<td>Top: 100% Bottom: 0%</td>
<td>Top: 100% Bottom: 0%</td>
<td>Top: 0% Bottom: 100%</td>
<td>Top: 0% Bottom: 100%</td>
<td>Top: 0% Bottom: 100%</td>
</tr>
<tr>
<td>2 ml/min</td>
<td>Top: 100% Bottom: 0%</td>
<td>Top: 100% Bottom: 0%</td>
<td>Top: 60% Bottom: 40%</td>
<td>Top: 40% Bottom: 60%</td>
<td>Top: 20% Bottom: 80%</td>
</tr>
<tr>
<td>10 ml/min</td>
<td>Top: 100% Bottom: 0%</td>
<td>Top: 100% Bottom: 0%</td>
<td>Top: 80% Bottom: 20%</td>
<td>Top: 60% Bottom: 40%</td>
<td>Top: 40% Bottom: 60%</td>
</tr>
</tbody>
</table>

Supplementary videos:

Movie S1: Bubble injection into a water droplet on plain PDMS substrate.

Movie S2: Bubble injection into a water droplet on textured PDMS substrate.

Movie S3: Bubble injection into a water droplet on LIS-10.

Movie S4: Bubble injection into a water droplet on LIS-100.

Movie S5: Bubble injection into a water droplet on LIS-1000.

References