Evaporation of Sessile Droplets on Slippery Liquid-Infused Porous Surfaces (SLIPS)

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Supporting Information:

1.1 Fabrication of Textured Surfaces

We constructed surfaces consisting of square pillars of SU-8 photoresist with pillar widths ranging from 10 µm to 90 µm arranged in square lattice patterns such that the centre-to-centre separation between pillars ($L$) is 100 µm. For example, a sample with 40 µm wide pillars ($L-I$) would give pillar separation ($I$) of 60 µm (Figure 2b). The two-dimensional Cassie surface area fraction, $\varphi_s = 1-(L-I)^2/L^2$, therefore ranged from 0.01 to 0.81. SU-8 is an epoxy based negative photoresist that can be spin coated or spread over a range of thicknesses to fabricate thick patterns with smooth walls using photolithography. The SU-8 becomes strong, stiff and chemically resistant after processing and has a typical static water contact angle of $\theta \approx 80^\circ$ on a flat and smooth surface with large contact angle hysteresis\(^1\). Textured surfaces were created using 4” diameter polished silicon wafers (Pi-KEM). They were first cleaned with acetone and 2-propanol followed by a 10 minute bake at 100 °C to remove any remaining solvent. The substrate was then treated with an adhesion promoter (hexamethylidisilazane) prior to applying SU-8 2025 (MicroChem) resist. The amount of resist deposited onto each substrate was controlled at 4 ml. The spin coating consists of two stages. Substrates were first accelerated to 500 rpm at 164 rpm/s for 10 s and 1770 rpm at 328 rpm/s and for 30 s to achieve a required thickness of $h_p=50\mu$m. Since $L$ is kept at 100µm the Wenzel roughness, $r_w = 1+4h(L-I)/L^2$, for these samples therefore ranges from 1.2 to 2.8. The coated substrate was then baked on a hotplate for 3 min at 65 °C followed by 6 min at 95 °C. Substrates were then allowed to cool down to room temperature and the inner portion of the substrate was patterned to minimise thickness variation in the surface features due to edge defects. The SU-8 coated substrates underwent UV exposure in a mask aligner (EVG 620) under hard contact mode with an exposure dosage of 160 mJ/cm². Post-exposure baking was
performed on a hotplate for 1 min at 65 °C followed by 6 min at 95 °C before being left to cool to room temperature. Following the post-exposure bake, the substrates were developed in EC solvent and agitated for 5 min in a sonicating bath. The developed substrate was washed with fresh EC solvent for approximately 10 s followed by rinse with 2-propanol before being dried using nitrogen gas. A final 15 min hard bake at 200 °C was added to ensure that the SU-8 photoresist properties did not change during use as a substrate for evaporation experiments.

1.2 Surface Chemistry Modification

A hydrophobic coating was applied to the samples to prevent water from displacing the lubricating liquid and wetting the SU-8 features. Prior to impregnation they were cleaned once more with acetone and 2-propanol followed by a 10 minute bake at 100 °C to completely remove any remaining solvent. An OTS in hexane solution was prepared using 200 ml of hexane and 50µl of OTS. The solution was covered and then sonicated for 20 min. Meanwhile, samples were treated with oxygen plasma (Plasmalab 80Plus, Oxford Instruments) to promote adhesion of the OTS to the surface. The substrates were then placed in the Hexane/OTS mixture for 1 hour. After this time, samples were then extracted from the mixture and immediately placed in a fresh beaker of pure hexane and sonicated for a further 15 min prior to being baked on a hotplate for 15 min at 110°C.

1.3 Impregnation with Lubricating Liquid

To create a uniform impregnation layer on the surfaces, the samples were dip coated in lubricating liquid to create the SLIPS surface and for this silicone oil (Sigma-Aldrich) was used. The textured surfaces were attached to glass slides and completely immersed in the oil. They were then vertically withdrawn from the liquid at a speed of 1 mm s$^{-1}$. This speed was found to be optimal according to the equation $V_{\text{crit}} = 0.12\mu_0\gamma_{LV}(\delta\kappa)^{3/2}$, where $\mu_0$ is the
viscosity of the lubricating liquid and $\delta$ is the height of the surface textures. At this speed, a uniform coating and impregnation is achieved.

1.4 Levelling Krüss Meter for Sliding Angle Measurements

Sliding angle measurements for water droplets on textured surfaces impregnated with silicone oil were carried out using the Krüss DSA30 Contact Angle meter equipped with a tilt stage. Prior to sliding angle measurements, the tilt stage was set to its zero position and entire the Krüss Contact Angle meter was levelled using an Engineer’s workshop level (Level Developments, 14-0.05-150) with an accuracy of 50µm over 1m. The tilt stage on the Krüss machine allows incremental steps of 0.1°, the sliding angle measurements for all of the samples were taken only when the droplet starts to move on a surface. The sliding angle of each sample was obtained from an average of three separate measurements.

REFERENCES
