Supporting Information

How Slippery are SLIPS? Measuring effective slip on lubricated surfaces with colloidal probe AFM

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Additional statistical details regarding hydrodynamic force experiments

A total of 6 experiments were conducted. In each experiment approach rates of 1, 5 and 10 μm/s were used to collect values of compliance, and 40 and 80 μm/s for measuring effective slip length. 3 - 4 positions were tested at each approach velocity per surface tested. In each experiment two surfaces were placed in the same liquid cell. The combinations varied between clean Si wafer and OTS-Si wafer, and clean Si wafer and infused OTS-Si wafer. For fitting effective slip lengths, the following measurements were collected for each surface.

Clean Si wafer: across 5 different experiments, 11 force curves at 40 μm/s and 11 at 80 μm/s.

Clean OTS-Si: across 3 different experiments, 11 force curves at 40 μm/s and 11 at 80 μm/s.

Infused OTS-Si: across 3 different experiments, 9 force curves at 40 μm/s and 9 force curves at 80 μm/s.

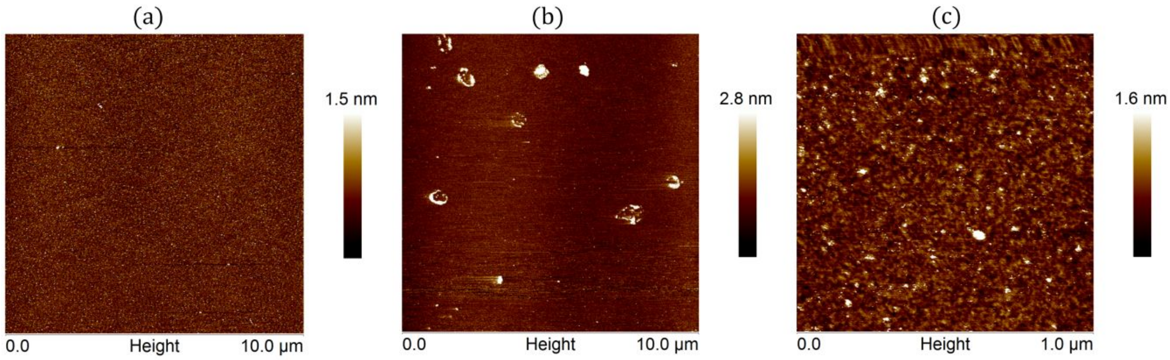

Figure S1. Tapping mode AFM micrographs of (a) clean silicon wafer, with RMS roughness 0.25 nm, and (b) – (c) OTS coated silicon wafer with RMS roughness 0.35 nm.

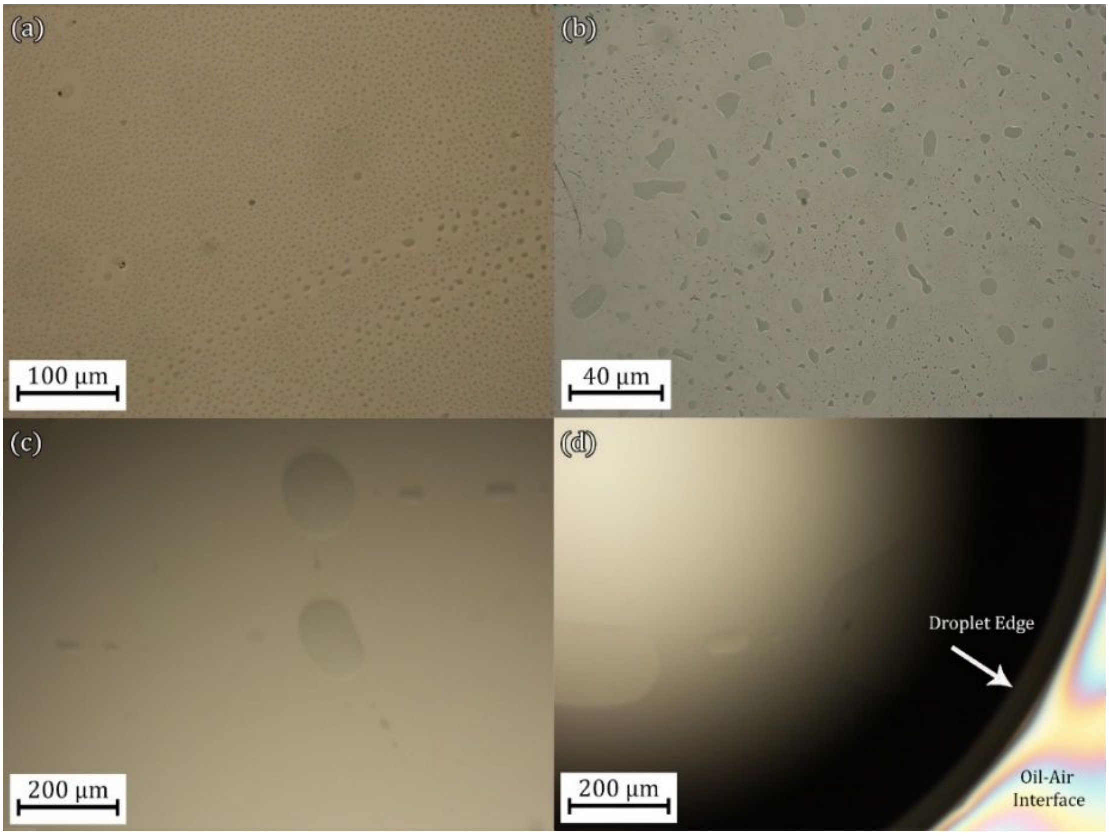

Figure S2. Optical micrographs OTS-Si infused with different thickness of silicon oil and then submerged in water. Silicone oil film thickness prior to immersion is water was: (a) 20 nm, (b) 150 nm, (c) 300 nm, (d) 300 nm beneath a water droplet, near droplet edge.

Table S1. Hamaker constants for a silicone oil layer on different substrates in different media. Also reported corresponding silicone oil contact angle and spreading coefficient for each system. Contact angle measurements have an error of ± 1°.

Surface	*A* (10^-21 J)	Silicone oil contact angle (°)	*S* (mN/m)
OTS in Air	-7.38107	< 5	-0.07649
SiO2 in Air	-6.01	< 5	-0.07649
Silicon in Air	-196.193	-	-
OTS in Water	-1.44383	8	-0.4282
SiO2 in Water	-0.54533	133	-74.0079
Silicon in Water	-35.4103	-	-
OTS in Sucrose 60%	0.456215	8	-0.36981
SiO2 in Sucrose 60%	0.918804	133	-63.9159
Silicon in Sucrose 60%	15.53654	-	-

*Refractive and dielectric constants for silicone oil (10 cSt) and sucrose 60% w/w are taken from reference.[1] Parameters for water, SiO_2 and Si are taken from[2] and OTS is taken from.[3] Values of A calculated using $\nu_e \approx 4\times10^{15}$ s^{-1} as the plasma frequency of free electron gas, and temperature of 20 °C.

The non-retarded Hamaker constant A, was calculated via Lifshitz theory:[2]

$$A = \frac{3}{4}k_B T\left(\frac{\varepsilon_1 - \varepsilon_3}{\varepsilon_1 + \varepsilon_3}\right)\left(\frac{\varepsilon_2 - \varepsilon_3}{\varepsilon_2 + \varepsilon_3}\right) + \frac{3\pi\hbar\nu_e}{4\sqrt{2}} \times \frac{(n_1^2 - n_3^2)(n_2^2 - n_3^2)}{\sqrt{(n_1^2 + n_3^2)(n_2^2 + n_3^2)}\left[\sqrt{(n_1^2 + n_3^2)} + \sqrt{(n_2^2 + n_3^2)}\,\right]}$$

Where $\nu_e \approx 4\times10^{15}$ s^{-1} is the plasma frequency of free electron gas, k_B is the Boltzmann constant, T is the absolute temperature, ħ is the reduced Plank constant, and ε_{123} and n_{123} are the dielectric constants and refractive indices of the oil lubricant, surface and liquid medium respectively.

Table S2. Water contact angle (CA), advancing (Adv) and receding (Rec) contact angle, and sliding angle (SA) values in air on clean silicon wafers (Si) and OTS-coated silicon wafers (OTS-Si), infused with different silicone oil thickness, as determined by ellipsometry. All errors are ± 1 º unless stated otherwise.

Sample	Static CA (°)	Adv (°)	Rec (°)	SA (°)
Si	33	Pinning	Pinning	> 90
Si excess oil	Wetting ridge	Pinning	Pinning	> 90
OTS-Si	109	112	104	15 ± 2
OTS-Si excess oil	Wetting ridge	-	-	< 1
OTS-Si 360 nm oil	106	107	104	2
OTS-Si 30 nm oil	106	107	104	3
OTS-Si 22 nm oil	107	109	104	7
OTS-Si 0 nm oil*	108	112	106	12 ± 2

*For this last step, the silicone oil thickness was decreased to zero by spraying the surface with a water stream.

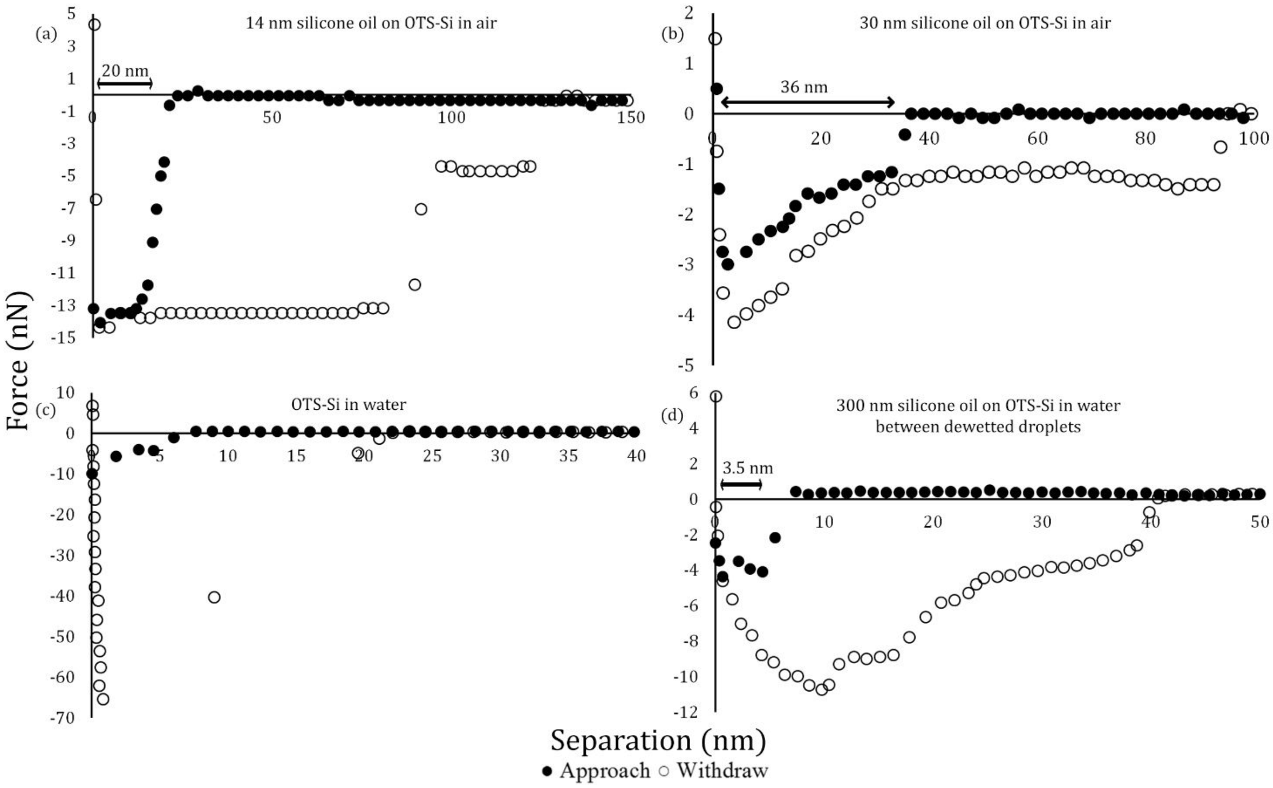

Figure S3. AFM approach and withdraw force curves on OTS-Si in air (a) infused with 14 nm (k = 4.4 N/m), and (b) 30 nm of silicone oil (k = 2.9 N/m). AFM approach and withdraw force curves in water on OTS-Si (c) non-infused (k = 3.6 N/m), and (d) infused with an initial 300 nm silicone oil film (k = 2.1 N/m), which then dewetted into droplets; the measurement is taken between dewetted oil droplets. Silicone oil thicknesses were characterised by ellipsometry in air prior to AFM force measurements. Estimated film thicknesses via AFM are represented by the distance between the jump in on approach and the contact with the substrate. Cantilevers used for force experiments had spring constants ranging from k = 2 – 4.5 N/m

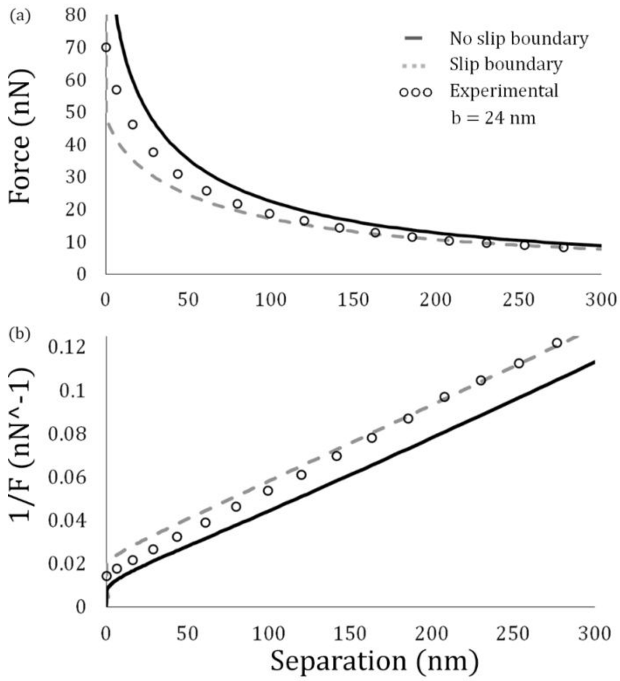

Figure S4. Hydrodynamic approach force curve using colloid probe AFM in sucrose solution at an approach rate of 40 µm/s on OTS-Si. Data shown at close separation distances to highlight where experimental data typically diverges from fitted slip length. Plotted as (a) hydrodynamic force (nN) against separation distance (nm), and (b) inverse hydrodynamic force (nN^{-1}) against separation distance (nm) for a linear relationship. Colloid probe used had radius 9.36 µm, and spring constant k = 0.75 N/m.

REFERENCES

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