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Electronic Supplementary Information

Oil-Triggered Switchable Wettability on Patterned Alternating Air/Lubricant Infused Superamphiphobic Surfaces

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Calculation of the net free energy barrier

When a droplet with a volume of V_w is over an OTS, the total surface energy in the system is E_0, as shown in Figure S4a.

When a water droplet is put on the superamphiphobic (SAB) areas of the OTS, it will suspend on the micro-nanostructures with the air trapped in the gaps of them, which is characterized as 'Cassie state', as shown in Figure S4b. In this case, the total surface energy in the system is E_{SAB}, as shown in Figure S3b. The shape of the droplet will change compared with the previous case, which leads to the change of the total surface free energy in the entire system. The net energy, ΔE_{SAB}, to describe to describe the change in energy when putting a separate droplet on the SAB area can be calculated by:

$$\Delta E_{SAB} = E_{SAB} - E_0 = \gamma_{wv} S_{cap} + f_1 \gamma_{ws} S_{base} + (1 - f_1)\gamma_{wv} S_{base} - [\gamma_{wv} S_{ori} + f_1 \gamma_{sv} S_{base}] \tag{1}$$

Where γ_{wv}, γ_{ws}, γ_{sv} and f_1 represent the water-vapor interfacial energy(~72mN/m), the water-solid interfacial energy, the solid-vapor interfacial energy and the fraction of water in contact with the solid, respectively. S_{ori}, S_{cap} and S_{base} represent the original surface area of water droplet, the surface area of spherical crown when the water droplet located at the surface and the surface area of spherical crown base, respectively. S_{ori}, S_{cap}, and S_{base} can be calculated based on the droplet volume(V_w) and the apparent water contact angle θ_*.

$$S_{ori} = 4\pi(\frac{3V_w}{4\pi})^{\frac{2}{3}} \tag{2}$$

$$S_{cap} = 2\pi R^2(1 - cos\theta_*) \tag{3}$$

$$S_{base} = \pi R^2(1 - cos^2\theta_*) \tag{4}$$

In these equations, R is the radius of the spherical crown when the water droplet located at the surface, which can be calculated by:

$$R = (\frac{3V_w}{\pi}\frac{1}{2 - 3cos\theta_* + cos^3\theta_*})^{\frac{1}{3}} \tag{5}$$

Therefore, for a water droplet, if f_1 is constant, the ΔE_{SAB} is a function of the apparent water contact angle θ_*, as shown in Figure 2. In our experiments, f_1 is ~0.2. The minimum ΔE_{SAB} is achieved when θ_* is ~ 155°, as shown in Figure 3 g, corresponding to the equilibrium state.

When a water droplet is put on the SLIS area of the OTS, it will float on the stable Lubricating film which is locked in micro-nanostructures. In this case, the total surface energy in the system is E_{SAB}, as shown in Figure S4 c. The shape of the droplet will change compared with the previous case, which leads to the change of the total surface free energy in the entire system. Therefore, the net free energy, ΔE_{SLIS}, to describe the change in energy when putting a separate droplet on the SLIS area can be calculated by:

$$\Delta E_{SLIS} = E_{SLIS} - E_0 = \gamma_{wv}S_{cap} + \gamma_{wo}S_{base} - [\gamma_{wv}S_{ori} + \gamma_{ov}S_{base}] \tag{6}$$

where γ_{wo} and γ_{ov} represent the water-oil and oil-water interface energy, respectively. The water-oil and oil-water interface energy of different oils are listed in table S1. Since S_{ori}, S_{cap} and S_{base} can be calculated based on the droplet volume(V_w) and the apparent water contact angle θ_*, the ΔE_{SLIS} is a function of the apparent water contact angle θ_*, as shown in Figure 2. The minimum ΔE_{SAB} is achieved when θ_* is ~ 110°, as shown in Figure 3 g, corresponding to equilibrium in this case.

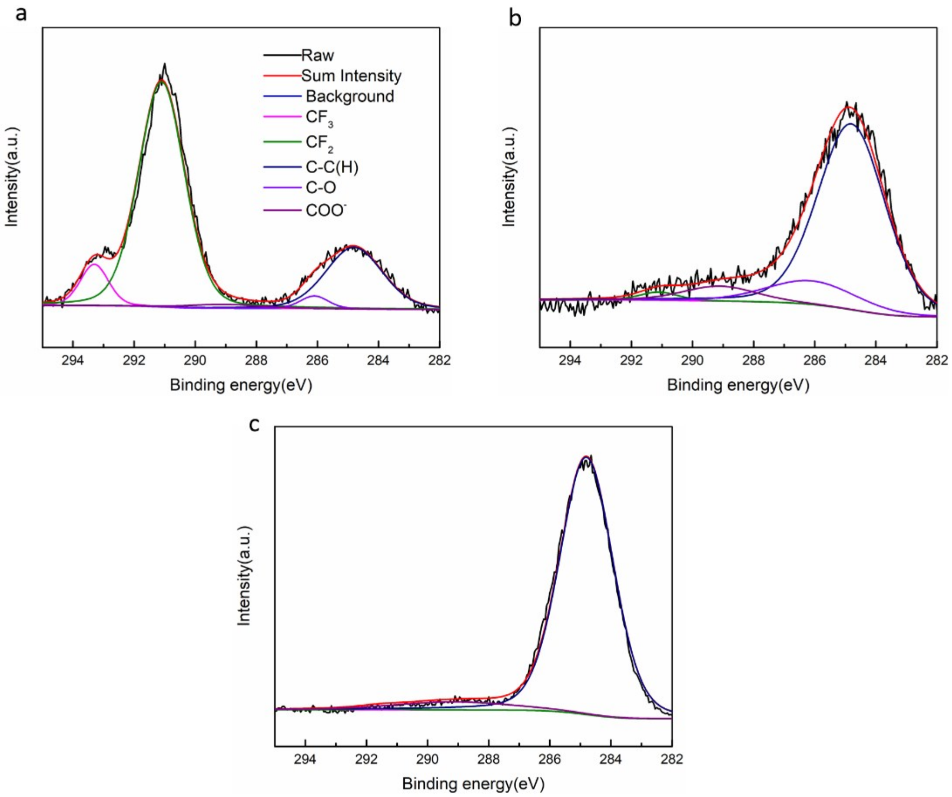

Figure S1. Deconvolution of the XPS C 1s peaks of samples at different fabricating steps (SAM areas). (a) The sample after step 2. (b) The sample after step 3 (laser selectively ablated areas). (c) The sample after step 4 (SHB-SOL areas).

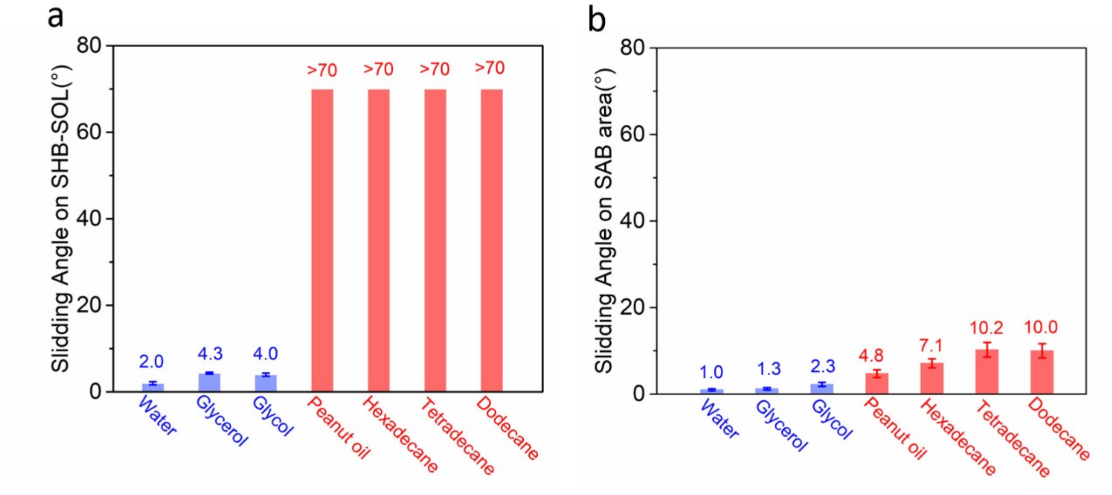

Figure S2. The liquid sliding angles on SHB-SOL (a) and SAB areas (b), respectively. Since the peanut oil, hexadecane, tetradecane and dodecane will spread on the SHB-SOL areas, they cannot side off the surfaces even with a tilt angle larger than 70°.

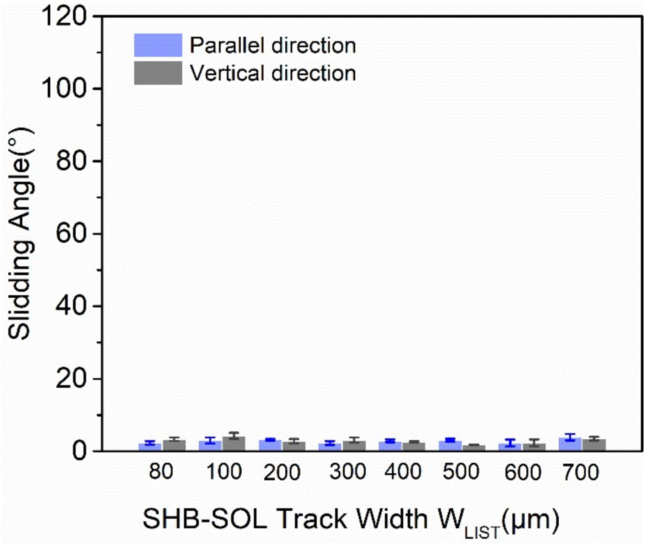

Figure S3. The sliding angles of water droplet(5μL) on SHB-SOL tracks with different widths along the direction parallel or perpendicular to the tracks.

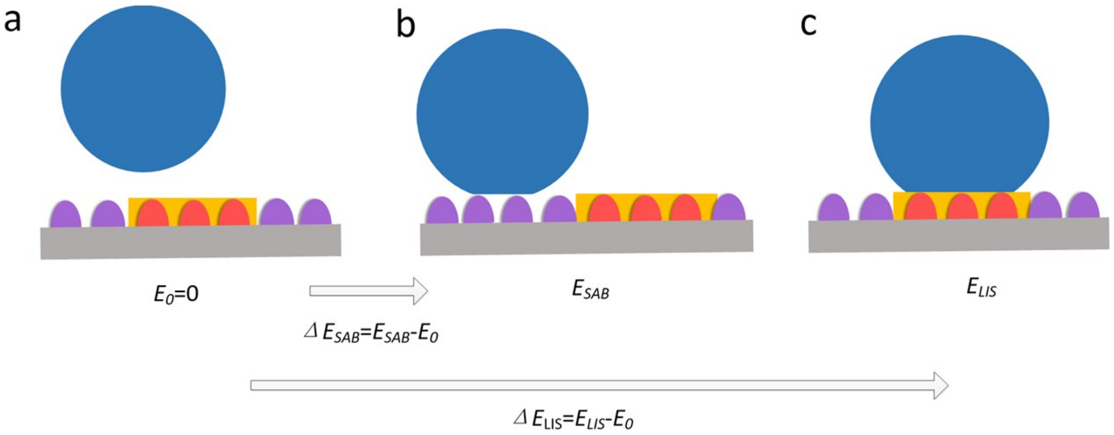

Figure S4. (a) The testing droplet and the OTS are separated. (b) The testing droplet is located at the SAB areas. (c) The testing droplet is located at the SLIS areas.

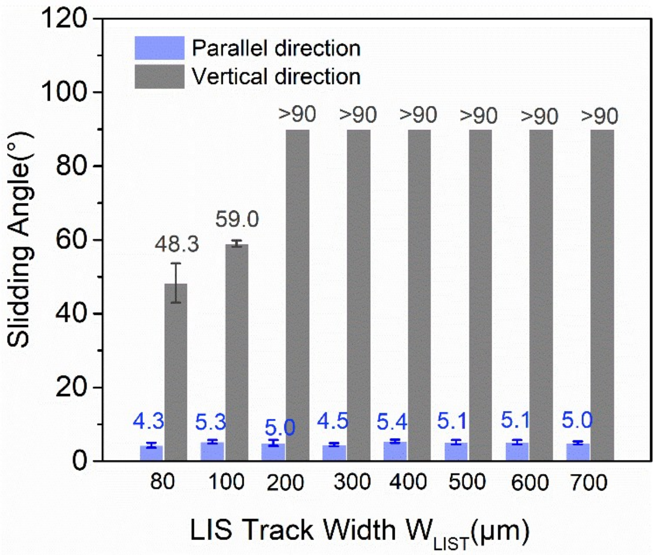

Figure S5. The sliding angle of water droplet(5μL) on SLIS track with different widths along the direction parallel or perpendicular to the track.

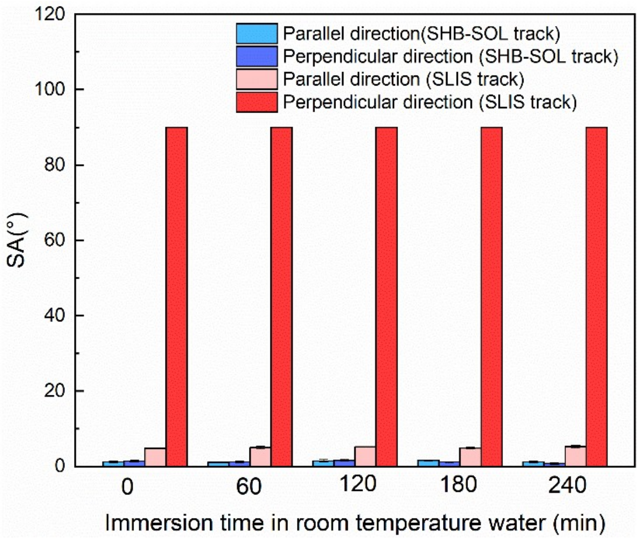

Figure S6. The wetting properties after immersion in water in room temperature for different time. After immersion, the sliding angles of OTSs in both oil-less state (SHB-SOL track) and oil-infused state (SLIS track) did not change, which indicates a good stability in water.

Table S1. The interface energies of different liquids.

Liquid	Liquid-vapor interface energy (mN/m)	Liquid-water Interface energy (mN/m)
C8	21.6	50.6
C10	23.8	50.6
C12	25.4	50.7
C14	26.6	50.8
C16	27.5	50.9

The liquid-water interface energies of different liquid are calculated by the equation: $\gamma_{AB} = \gamma_A + \gamma_B - 2(\gamma_A^d \gamma_A^d)^{0.5}$, where γ_A^d and γ_B^d are the dispersion force contributions of the liquid surface energies [1,2]. The dispersion force contribution of the water surface energy is 21.8 mN/m. The dispersion force contributions of saturated aliphatic hydrocarbon surface energies are approximately equal to their surface energies.

[1] Fowkes, F. M., *Ind. Eng. Chem.* 56, 40-42, 1964.

[2] Israelachvili, J. N. *Intermolecular and Surface Forces,* Academic Press, 2011.