

## Supplementary Information

### Scaling resistance by fluoro-treatments: The importance of wetting states

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#### Supplementary Information includes:

S1: Preparation of PDMS elastomer

S2: Calculation of surface energy

S3: Results of measurements and calculation process for slip length

S4: Surface roughness of the membranes.

S5: Physical significance of parameter in the wetting state factor calculation formula

S6: The actual flux as a function of the concentration factor.

Fig. S1 Preparation schematic diagram of PDMS elastomer.

Fig. S2 (A) Schematic drawing of a cone-and-plate rheometer. (B) Schematic of non-slip and slip boundary conditions.

Fig. S3 Torque of MP-PVDF, FAS-MP-PVDF, CF4-MP-PVDF membranes corresponding to shear rates varying from 30 1/s to 100 1/s.

Fig. S4 The effects of CF4 Plasma or fluorosilane treatment on surface morphology.

Fig. S5 Physical significance of parameters involved in calculating the wetting state factor.

Table S1 Contact angles of three membranes

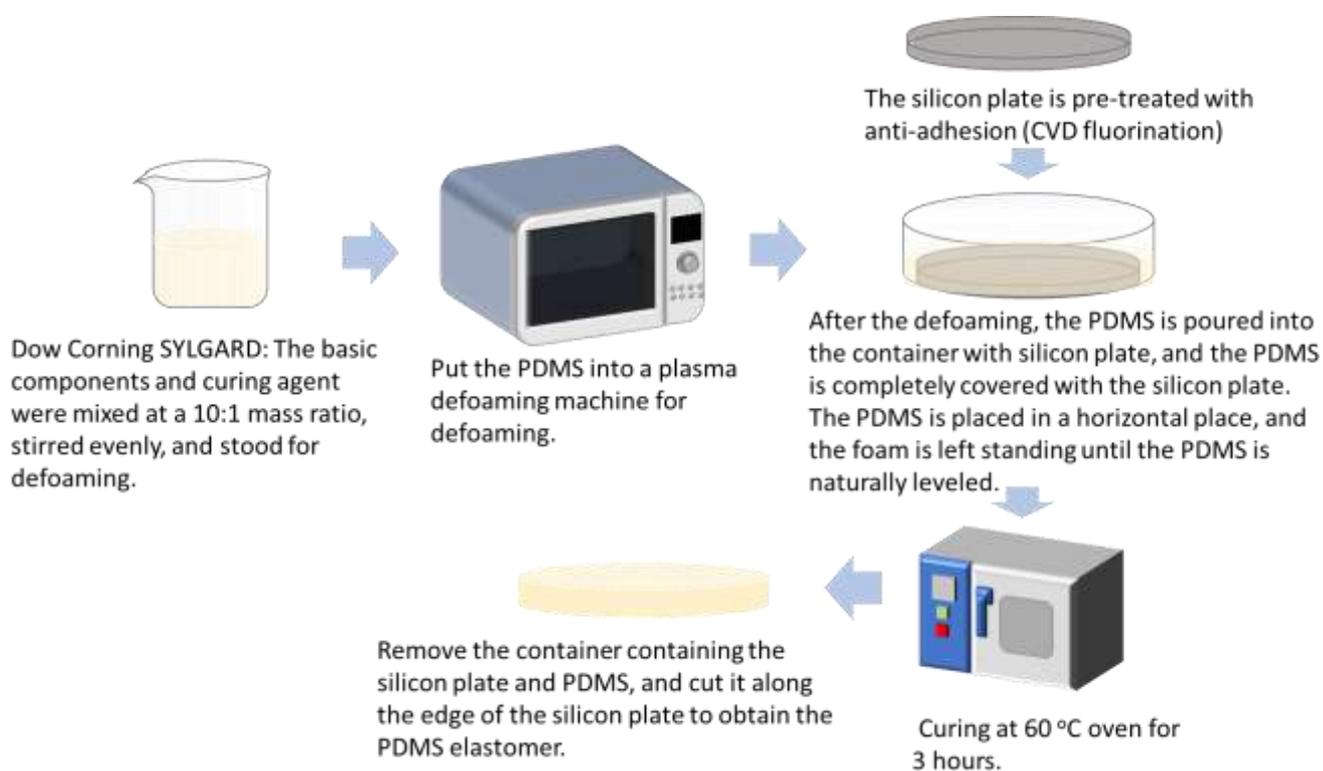
Table S2 Surface free energy parameters of test liquids

Table S3 Surface energies of three membranes determined by the LW/AB method

## Supplementary Information includes:

### S1: Preparation of PDMS elastomer

Briefly, a specific amount of PDMS mixture, with the weight composition of PDMS and the curing agent being 10:1, was spread onto the silicon wafer. Afterwards, the mixture was placed in an oven at 60 °C for 3 h to allow simultaneous curing and moulding. The as-obtained PDMS elastomer was peeled off and used as a substrate for the casting process.



**Fig. S1** Preparation schematic diagram of PDMS elastomer.

## S2: Calculation of surface energy

Surface energies of pristine and 17-FAS, CF<sub>4</sub> modified membrane substrates were estimated using the LW/AB method (Eq.1) based on independent contact angles with three different liquids [1]. The contact angles were measured by a contact angle goniometer (Maist Drop Meter A-100P) via the sessile drop method, as shown in section 2.4 in the main texts.

$$(\gamma_L^{LW} + 2\sqrt{\gamma_L^+ \gamma_L^-})(1 + \cos\theta) = 2(\sqrt{\gamma_S^{LW} \gamma_L^{LW}} + \sqrt{\gamma_S^+ \gamma_L^-} + \sqrt{\gamma_S^- \gamma_L^+}) \quad (1)$$

**Table S1** Contact angles of three membranes

	MP-PVDF	FAS-MP-PVDF	CF4-MP-OVDF
Water/ <sup>o</sup>	155.3±1.7	164.1±3.9	166.2±1.5
Diiodomethane	63.5±4.0	156.3±7.8	155.0±4.1
glycerol	144.4±5.0	156.0±3.8	151.7±5.5

**Table S2** Surface free energy parameters of test liquids  $\gamma/(mJ.m^{-2})$

	$\gamma_L$	$\gamma_L^{LW}$	$\gamma_L^+$	$\gamma_L^-$
water	72.8	21.8	25.5	25.5
Diiodomethane	50.8	50.8	0	0
glycerol	64.0	34.0	3.92	57.4

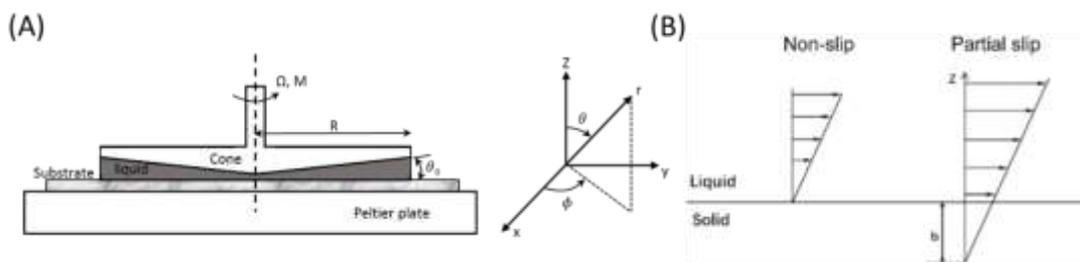
The surface energy parameters of the solid can be obtained by measuring the contact angle between the solid surface and the three liquids with known  $\gamma_L^{LW}$ 、 $\gamma_L^+$ 、 $\gamma_L^-$  values.

**Table S3** Surface energies of three membranes determined by the LW/AB method

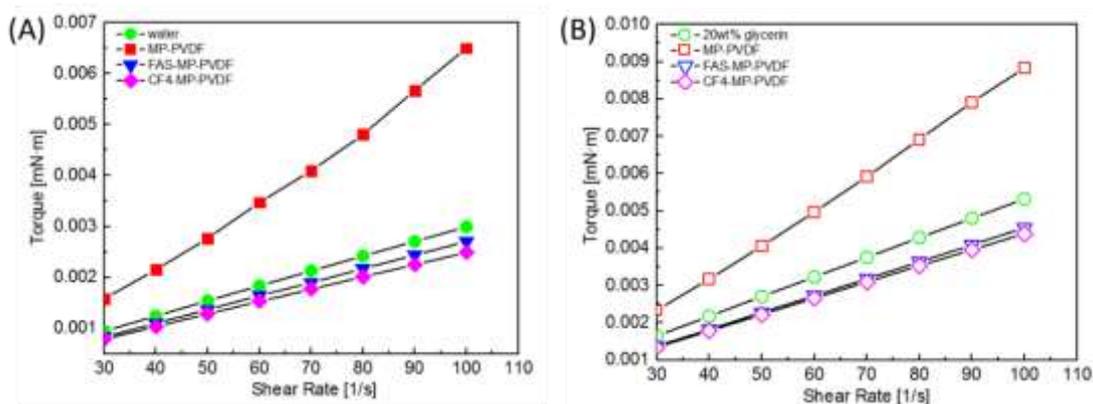
	MP-PVDF	FAS-MP-PVDF	CF4-MP-PVDF
Surface energy/mJ.m <sup>-2</sup>	33.72±3.10	0.16±0.15	0.46±0.25

### S3: Results of measurements and calculation process for slip length

The slip length of the membrane was determined by torque measurement using a rheometer (AR-2000ex). A thermostatic controlled Peltier plate (base plate) was maintained at a constant temperature of  $25 \pm 0.2$  °C. The membrane samples were carefully fixed to the base plate via tape, a stainless-steel cone plate with a diameter of 50 mm and cone angle of  $1^\circ$  was used to measure liquid viscosity on membranes, whose shear rate range was set at 30-100 ( $s^{-1}$ ). The equipment was pre-calibrated using deionised water: deionised water and 20 wt.% glycerin solutions were chosen as the test liquids.



**Fig.S2** (A) Schematic drawing of a cone-and-plate rheometer. (B) Schematic of non-slip and slip boundary conditions.



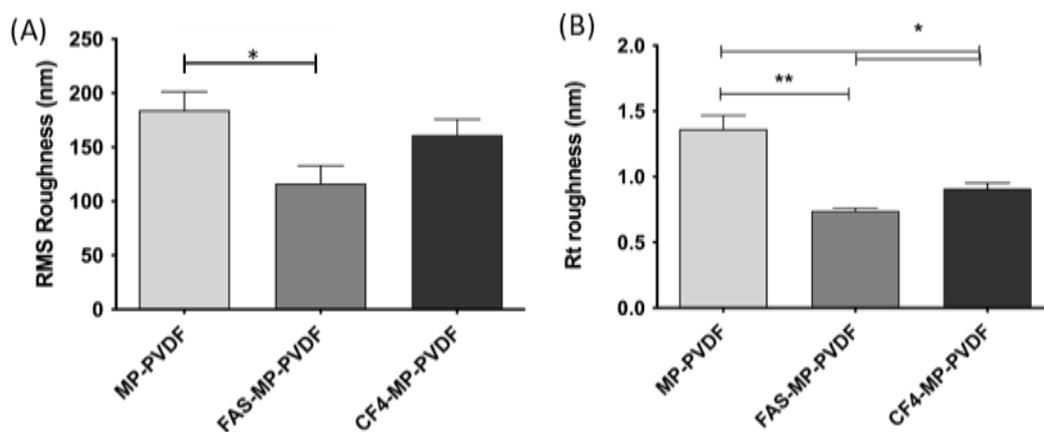
**Fig. S3** Torque of MP-PVDF, FAS-MP-PVDF, CF4-MP-PVDF membranes corresponding to shear rates varying from 30 1/s to 100 1/s. (A) corresponds to deionised water as the test liquid, and (B) corresponds to 20 wt.% glycerin.

Slip length of three membranes was determined with eq.2 [2]:

$$M = \int_0^R 2\pi r^2 \tau_{\theta\phi} dr = \frac{2\pi \mu \Omega R^3}{3 \theta_0} \left( 1 - \frac{3\delta}{2R\theta_0} + \frac{3\delta^2}{R^2\theta_0^2} \right) \quad (2)$$

Where M is the torque,  $\mu$  is the viscosity of the test liquid,  $\Omega$  is the angular velocity, R is the radius of the cone plate,  $\theta_0$  is the cone Angle,  $\tau_{\theta\phi}$  is the shear stress in the direction of  $\phi$ , and  $\delta$  is the slip length. The calculated slip lengths are shown in Fig.7 of the main text.

S4: Surface roughness of the membranes.



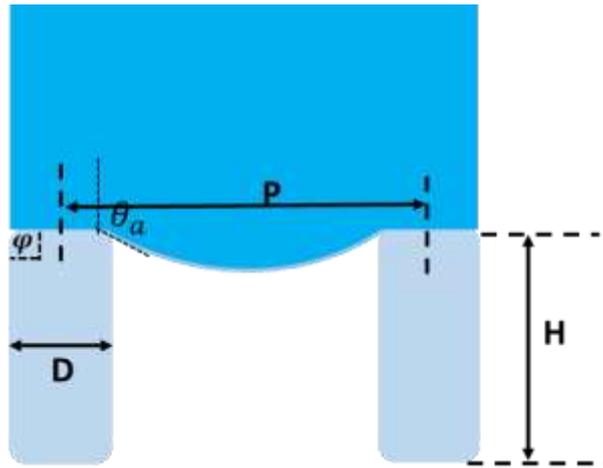
**Fig. S4** The effects of CF<sub>4</sub> Plasma or fluorosilane treatment on surface morphology. (A) The root means square roughness (RMS) and (B) The Peak-to-valley roughness (Rt) of MP-PVDF, FAS-MP-PVDF, CF<sub>4</sub>-MP-PVDF. Roughness values were obtained from a scan size of 3  $\mu\text{m}$  x 3  $\mu\text{m}$  on the top surface of micropillars. \* indicates  $p < 0.05$  and thus there is a significant difference.

### S5: Physical significance of parameter in the wetting state factor calculation formula

The wetting state of the surface with pillar structure was identified using the wetting state factor  $\zeta$  [3], defined as:

$$\zeta = \frac{(\sqrt{2}S_f - 1)}{2a_r} \tan(\theta_a - \varphi) \quad (3)$$

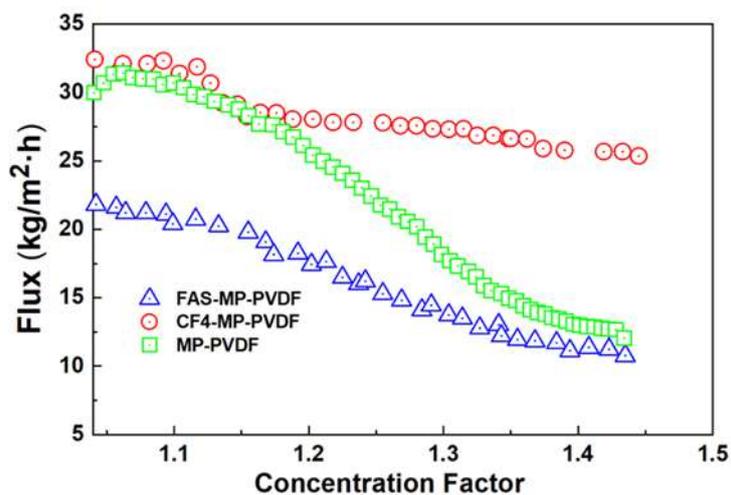
Where  $S_f$  indicates the spacing factor (ratio of pitch to diameter),  $a_r$  is aspect ratio given by height and diameter of pillar on the membrane,  $\theta_a$  is advancing angle and  $\varphi$  is the interior angle as a geometrical factor ( $\varphi=90^\circ$  for cylindrical pillars).



**Fig. S5** Physical significance of parameters involved in the calculation of the wetting state factor.

spacing factor  $S_f = P/D$ , aspect ratio  $a_r = H/D$ ,  $P=10 \mu\text{m}$ ,  $D=5 \mu\text{m}$ ,  $H=10 \mu\text{m}$ .

S6: The curve of actual flux for three membranes



**Fig. S6** The actual flux as a function of concentration factor. The initial flux of MP-PVDF, FAS-MP-PVDF and CF4-MP-PVDF was 31.2 kg/m<sup>2</sup>·h, 21.6 kg/m<sup>2</sup>·h, 32.1 kg/m<sup>2</sup>·h, respectively.

#### References:

1. Shalel-Levanon, S. and A. Marmur, Validity and accuracy in evaluating surface tension of solids by additive approaches. *Journal of Colloid and Interface Science*, 2003. **268**(1): p. 272-272.
2. Choi, C.-H. and C.-J. Kim, Large Slip of Aqueous Liquid Flow over a Nanoengineered Superhydrophobic Surface. *Physical Review Letters*, 2006. **96**(6).
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