Supporting Information

In Situ Electric-Driven Reversible Switching of Water-Droplet Adhesion on a Superhydrophobic Surface

Liping Heng, Tianqi Guo, Bin Wang, Lizhen Fan and Lei Jiang

Chart S1. Synthesis of P1



Materials and Instrumentation

Dimethylformamide (DMF, Labscan) was stirred with calcium hydride overnight, distilled under reduced pressure, and kept under dry nitrogen. CuCl(PPh₃)₃ and other chemicals were purchased from Aldrich and used as received without further purification.

¹H and ¹³C NMR spectra were measured on a Bruker ARX 400 NMR spectrometer using CDCl₃ as deuterated solvent and tetramethylsilane (TMS) as internal reference. MALDI-TOF spectra were recorded on a GCT Premier CAB048 mass spectrometer operating in a chemical ionization mode (CI) with methane as carrier gas.

Compound **M1** and **M2** were prepared according to the literature methods, respectively.^{1, 2} The characterization data are given as below. *1,2-Bis(4-ethynylphenyl)-1,2-diphenylethene (M1)*: 75% total yield as a light yellow solid. ¹H NMR (400 MHz, CDCl₃), δ (TMS, ppm): 7.24 (m, 4H), 7.14 (m, 6H), 7.10 (m, 8H), 3.05 and 3.04 (2H, HC≡). ¹³C NMR (100 MHz, CDCl₃), δ (TMS, ppm): 144.86, 143.55, 141.73, 132.32, 132.18, 131.94, 131.87, 128.63, 128.47, 127.60, 127.52, 120.94, 84.41 (≡C−Ar), 78.12 (≡C−H). HRMS (MALDT-TOF): *m/z* 380.3151 (M⁺, calcd 380.1565).

1,4-bis(6-azidohexyloxy)benzene (M2): 89.3% yield as a white solid. ¹H NMR (400 MHz, CDCl₃), δ (TMS, ppm): 6.81 (s, 4H), 3.90 (t, 4H), 3.42 (t, 4H), 1.87 (m, 4H), 1.77 (m, 4H), 1.51 (m, 8H). ¹³C NMR (100MHz, CDCl₃), δ (TMS, ppm): 153.8, 116.0, 69.0, 52.0, 29.9, 29.4, 27.1, 26.3. HRMS (MALDI-TOF): m/z 360.2270 (M+, calcd: 360.2274).

Polymer (P1): Into a 50 mL two-necked round-bottom flask were added 800 mg (2.1 mmol) of **M1**, 760 mg (2.1 mmol) of **M2**, and 36 mg (0.04 mmol) of CuCl(PPh₃)₃. The flask was evacuated under vacuum and pumped in dry nitrogen for three times. Then 30 mL of dry DMF was injected and the mixture was stirred at 60 °C for 24 h. The mixture was diluted by adding 30 mL THF and the solution was then added dropwise into 500 mL methanol through a cotton filter under stirring. The precipitate was allowed to stand overnight and collected by filtration. After repeating the precipitation three times, the polymer was washed with methanol and dried under vacuum at room temperature to a constant weight. A light gray solid was obtained in 81% yield. ¹H NMR (400 MHz, CDCl₃), δ (TMS, ppm): 7.66, 7.55, 7.07, 6.76, 4.35, 3.85, 1.92, 1.72, 1.48, 1.38. ¹³C NMR (100 MHz, CDCl₃), δ (ppm): 153.02, 143.53, 143.38, 140.72, 131.81, 131.33, 128.68, 127.79, 127.67, 126.56, 125.06, 124.92, 115.30, 68.14, 50.20, 30.20, 29.04, 26.14, 25.47. M_w : 23400, PDI: 1.6.

Reference:

[1] Hu, R.; Lam, J. W. Y.; Liu, J.; Sung, H. H. Y.; Willians, I. D.; Yue, Z. N.; Wong, K. S.;
Yuen, M. M. F.; Tang, B. Z. *Polym. Chem.* 2012, *3*, 1481.

[2] Qin, A.; Lam, J. W. Y.; Jim, C. K. W.; Zhang, L.; Yan, J.; Häussler, H.; Liu, J., Dong, Y.;
 Liang, D.; Chen, E.; Jia, G.; Tang, B. Z. *Macromolecules* 2008, *41*, 3808.



Figure S1. Schematic illustration of fluorination treatment: an FAS hydrophobic layer deposited on the as-prepared polymer surface by plasma treatment and high-temperature (80°C) CVD.



Figure S2. SEM images of the honeycomb structure film treated with 500 s oxygen plasma at 200 W and modified with FAS. Top-view a) and side-view b)



Figure S3 AFM images of a) the as-prepared honeycomb structure film and b) smooth film. c), e) and g) the honeycomb structure films treated with 200 s, 350 s and 500 s of oxygen plasma at 200 W and modified by FAS. d), f) and h) the smooth films treated with 200 s, 350 s and 500 s of oxygen plasma at 200 W and modified by FAS. The roughness of the surface increases with increasing treatment time.



Figure S4 The effect of the solution conductivity on the adhesions of the film by using the pure water, 0.01M and 1M KCl water solution



Figure S5. SEM and AFM images of a)-b) the honeycomb structure P3HT films treated with 500 s oxygen plasma at 200 W and modified by FAS, c)-d) the honeycomb structure PI films treated with 500 s oxygen plasma at 200 W and modified by FAS.



Figure S6 a) PI film adhesive force as a function of the applied voltage, b) P3HT film adhesive force as a function of the applied voltage.





Figure S7 P3HT films used for droplet transfer.

Table S1	Roughness	of the	porous	film	and	smooth	film	treated	with	different	time	oxygen
plasma. T	he roughnes	s of the	surface	s incr	rease	d with in	creas	ing trea	tment	time.		

Treatment time (s)	Rq of the porous film (nm)	Rq of the smooth film (nm)
0	235.5±53.0	2.0±0.1
200	286.4±43.2	11.5±0.3
350	340.3±64.6	17.3±1.5
500	446.7±47.6	26.9±1.3

Table S2. Atomic percentages of carbon (C), oxygen (O) and fluorine (F) on the as-prepared porous film surfaces which were treated by different process

Atomic type	Before plasma (%)	After 500 s plasma (%)	After FAS (%)
С	84.58	78.11	32.66
0	6.04	17.08	17.10
F	0	0	44.22

Туре		CAs (°)	Adhesion force (µN)	CA hysteresis (°)
Before	voltage	164.6±5.7	1.7±1.7	3.1±0.4
application				
After	voltage	162.2±3.0°	12.3±3.5	9.7 ± 0.7
application				

Table S3. CA and CA hysteresis before and after 12 V voltage application

Table S4 Relationship of the film thickness, threshold voltage and maximum adhesion before jump

No	Thickness(µm)	Threshold voltage (V)	Adhesion(µN)
1	2.1±0.5	18±4	18.4±6.5
2	4.6±0.6	54±6	42.6±7.6
3	8.2±1.3	72±10	55.2±10.2

Туре	Dielectric constants	Rq of the porous film (nm)
P1	3.5	446.7±47.6
PI	3.0	385.8±56.6
P3HT	6.8	433.2±49.3

Table S5. Dielectric constants of P1, PI and P3HT, roughness of the porous film treated with 500s oxygen plasma.