Electronic Supplementary Material (ESI) for Soft Matter

Supporting information

Super-hydrophobic Surface with Switchable Adhesion Responsive to Both Temperature and pH

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XPS Test:

X-ray photoelectron spectroscopy data were obtained with a K-Alpha electron spectrometer from Thermofish Scientific Company using AlKα (1486.6 eV) radiation. The base pressure was about 1×10^{-8} mbar. The binding energies were referenced to the C1s line at 284.8 eV from adventitious carbon.

Table S1. XPS analysis results of the samples

Ratio of FAS/ATMS (mol/mol)	Atom Rato (atom%)				
	F	N	Si	C	O
0:1	0	11.77	3.2	71.64	13.39
4:1	25.45	6.51	9.44	45.47	13.12
8:1	28.31	5.07	11.39	41.86	13.36
12:1	28.64	4.35	9.99	43.57	13.45
16:1	29.66	4.33	9.89	42.77	13.35
18:1	32.31	4.31	11.52	38.72	13.14
20:1	31.55	4.08	12.42	38.29	13.65

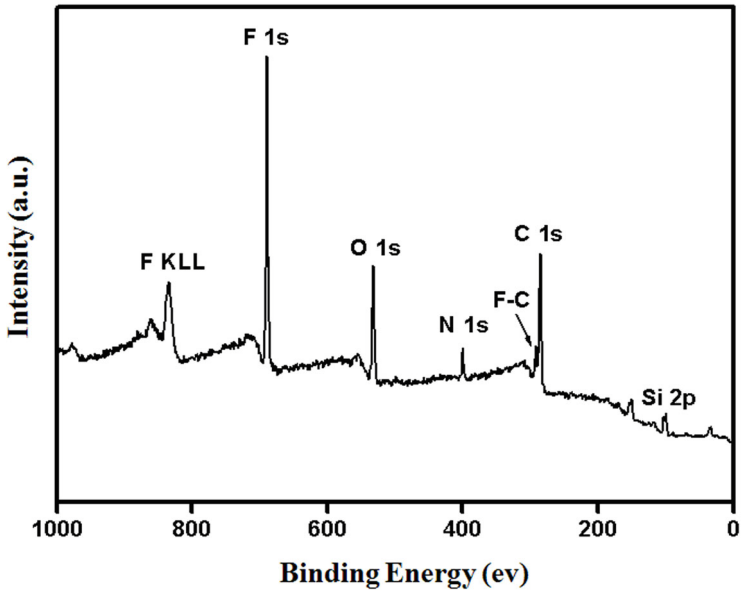

Figure S1. XPS survey of the surface (prepared with the ratio of FAS/ATMS =18)

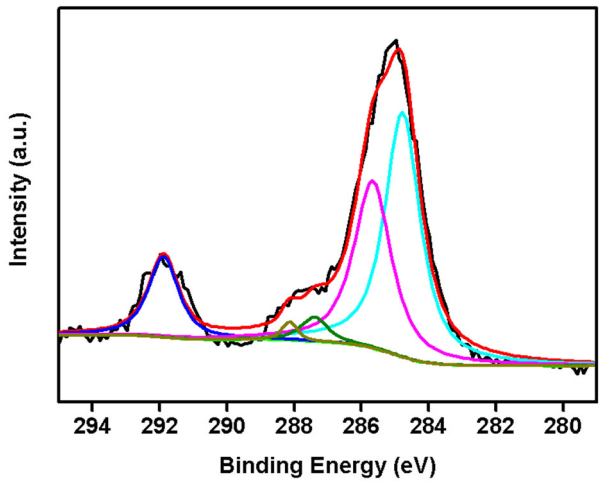

Figure S2. High resolution of C1s on the surface (prepared with the ratio of FAS/ATMS =18)

Figure S2 shows the peaks of $–CF_2–$ (291.9 eV), –COOH (288.17 eV), $–CONH_2$ (287.44 eV), –CH– (285.67 eV) and $–CH_2–$, $–CH_3$ (284.9 eV) from left to right, respectively. From which, typical chemical shift of PAAc (the binding energy of –COOH is about 288.2 eV) and PNIPAAm (the binding energy of $–CONH_2$ is about 287.3 eV) can be observed, and such shift may be due to the formation of the copolymer for the different chemical environment.

IR Test:

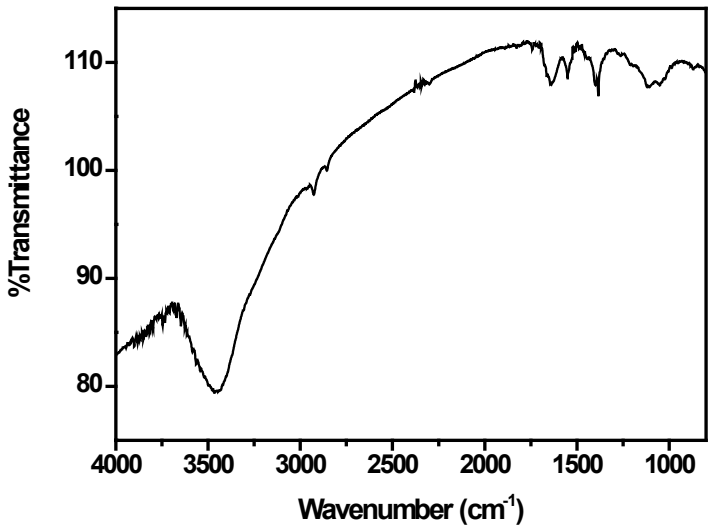

Figure S3 shows the IR spectra of the as-prepared sample (prepared with the ratio of FAS/ATMS =18)

The IR spectrum was obtained on the PerkinEimer Spectrrum 100 FT-IR Spectrometer. The peaks at 1020 cm^{-1}-1120 cm^{-1} can be assigned to the Si-O bond, and the peaks at 1385 cm^{-1} and 1403 cm^{-1} are assigned to $–CH(CH_3)_2$. Importantly, two bands appear at 1645.8 cm^{-1} and 1550 cm^{-1} can be assigned to amide Ⅰ(-CONH-, C=O stretching), and amideⅡ(N -H bending and C-N stretching), indicating the presence of NIPAAM. The peak at 1710 cm^{-1} is assigned to the carboxyl (-COOH) in the acrylic acid, which is in accordance with the XPS results, further confirming the copolymer has been formed on the surface.

Figure S4. The contact angle of a water droplet (4μL) on the native silicon micro/nanostructured substrate, the droplet can spread and at last with a contact angle of about 0°, indicating the substrate is super-hydrophilic.

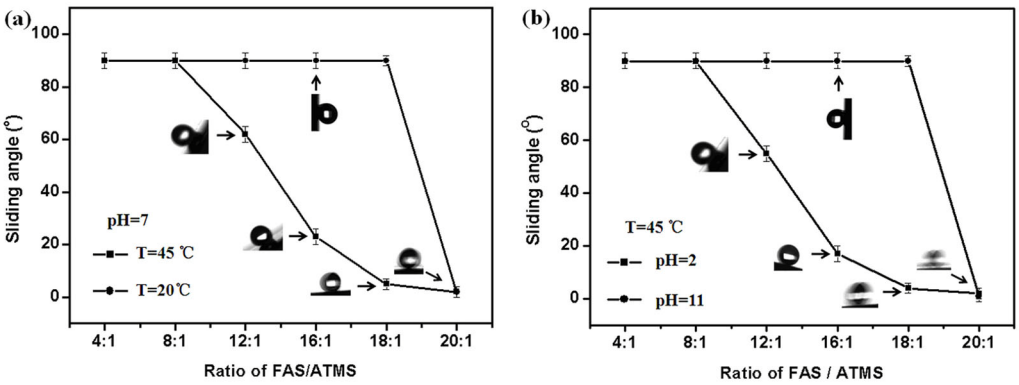

Figure S5. Dependence of the sliding angle on the ratio of FAS/ATMS under different conditions: (a) the pH was fixed while the temperature was at 45℃ and 20℃, respectively; (b) the temperature was constant while changing the pH. The inserts show the behavior of a water droplet sliding on the surface under the concrete condition.

Figure S5 show the relationship between the sliding angle with the ratio of FAS/ATMS responsive to both temperature and pH. It can be observed that the change of sliding angle is increased as the ratios of FAS/ATMS is increased, and reaches its maximum when the ratio of FAS/ATMS = 18. In order to obtain the most

responsivity for adhesion, the surface prepared with the ratio of FAS/ATMS = 18 was chosen for the detailed research about the dual-responsive adhesion.

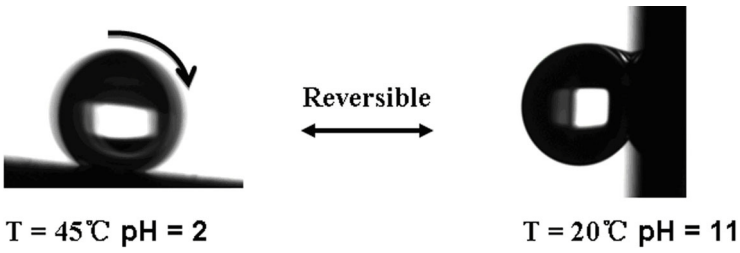

Figure S6. Reversible transition between the low adhesive rolling state and the high adhesive pinning state can be achieved by changing the temperature and pH simultaneously.

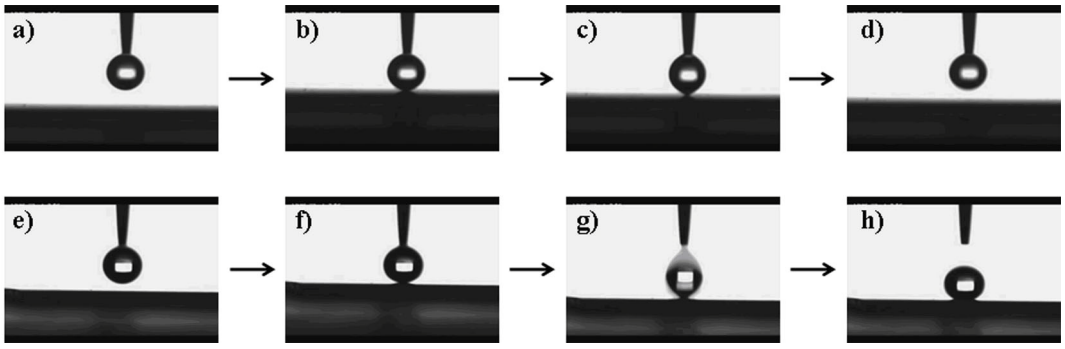

Figure S7. Video record about the surface before and after contact the droplet (pH = 7, 4μL) appended on a syringe at 45℃ (a-d) and 20℃ (e-h), respectively. The water droplet cannot be adhered by the surface at 45℃, indicating the surface is low adhesive. When the temperature is decreased to 20℃, the surface becomes high adhesive and the water droplet can be adhered and break away the syringe, shows remarkable temperature responsivity on the surface.

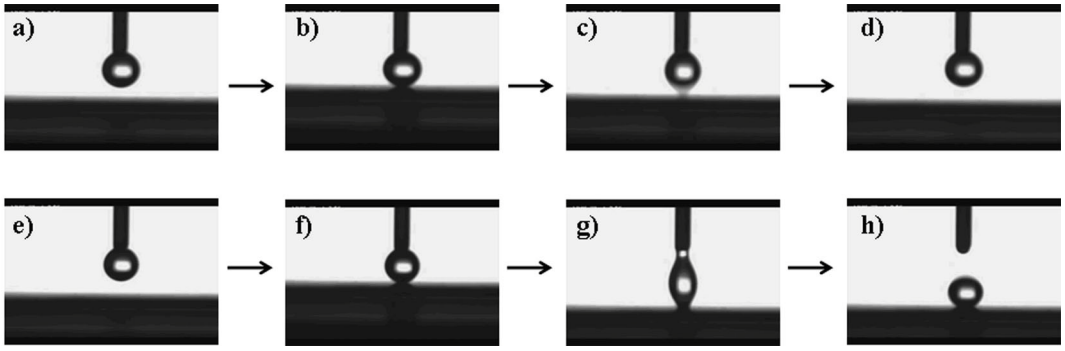

Figure S8. Video record about the surface before and after contact the droplet appended on a syringe at 45℃ with pH = 2 (a-d), and pH = 11 (e-h), respectively. The acid droplet cannot be adhered while a basic droplet can be adhered and break away the syringe, indicating the surface with remarkable pH responsivity.

It can be seen from Figure S7 and S8 that the as-prepared super-hydrophobic surface can respond to both temperature and pH, shows remarkable dual-responsive adhesive property.

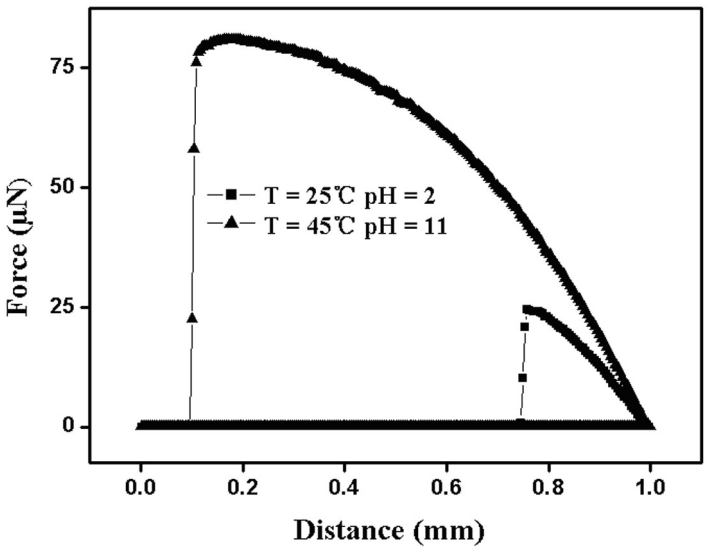

Figure S9. Force-distance curves recorded before and after a water droplet (4 μL) contact the surface (prepared with the ratio of FAS/ATMS = 18) at T = 45℃, pH = 11 and T = 25℃, pH = 2, respectively, indicating the surface can be low adhesive at low temperature and high adhesive at high temperature with different pH.