Electronic Supplementary Information

Influence of Different Chemical Modification to the Icephobic Properties of Superhydrophobic Surfaces under Condensate Environment

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Surface wettability measurement.

Static contact angle (CA) and sliding angle (SA) were measured with a modified optical angle meter (Cam 200, KSV Instrument Ltd., Finland) in a microclimate chamber with a controlled humidity and temperature. The schematic diagram of experimental set-up was demonstrated in Figure S1. The environmental control system consisted of a thermostatic bath, three ultrasensitive T-type thermocouples, a nitrogen/water vapor flux, a hygroscope and a data acquisition system. The surface temperature of the samples was precisely maintained in a range of 30 to -40 °C by the thermostatic bath, and the temperatures of the surface and in atmosphere were well controlled and recorded simultaneously. The relative humidity (RH) inside the chamber was regulated by adjusting the feeding rate of dry nitrogen and water vapor, and measured by a hygroscope with a relative error of about 3%. The measurements were taken after 10 minutes placed in the microclimate chamber for heat exchange and balance.

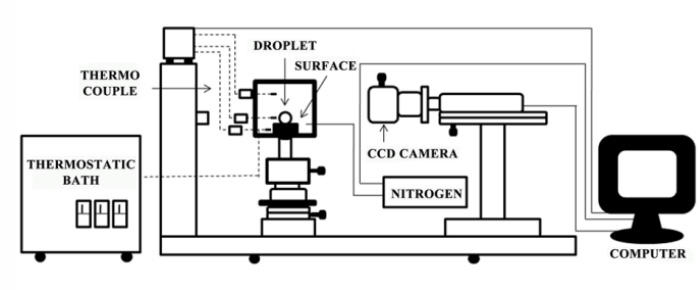

Figure S1. Schematic diagram of water contact angle and sliding angle measurement.

Overcooled water droplet impact experiment.

The impact experiments of supercooled water droplets were conducted using an apparatus illustrated in Figure S2. A flat tip needle (0.1 mm inner diameter) was connected to a dispensing system and a 15 mL water bottle by plastic tubing. The water contacting parts of the whole system including the bottle, needle and tubing was made of polypropylene, and their inner wall was treated with the PTES solution following a same procedure as the Al surface treatment described previously to prevent ice nucleation. 15 mL of ultra-pure water (of density, ρ=1000 kg/m^3, surface tension, σ=0.0728 N/m, and viscosity, μ=0.89×10-3 Ns/m^2) was cooled with a thermostatic bath as the source of overcooled water. During the impact experiment, air was pumped by the dispensing system to release overcooled water droplets (7.25 μL) from the needle. The whole set up was enclosed in a temperature environmental chamber (DIS-GDS, China) with a controlled temperature and RH. After the test samples were kept under target temperature and relative humidity for 10 minutes to get equilibrium, the impact dynamics of a droplet was recorded after using a high speed camera (Phantom v710, USA) operated with a frame speed of 3000 frames per second (fps) and an image resolution of 1024×768 pixels. A cold lighting system (CEL-S500/350, Aulight, China) was used to backlight the impacting droplet on the target surface.

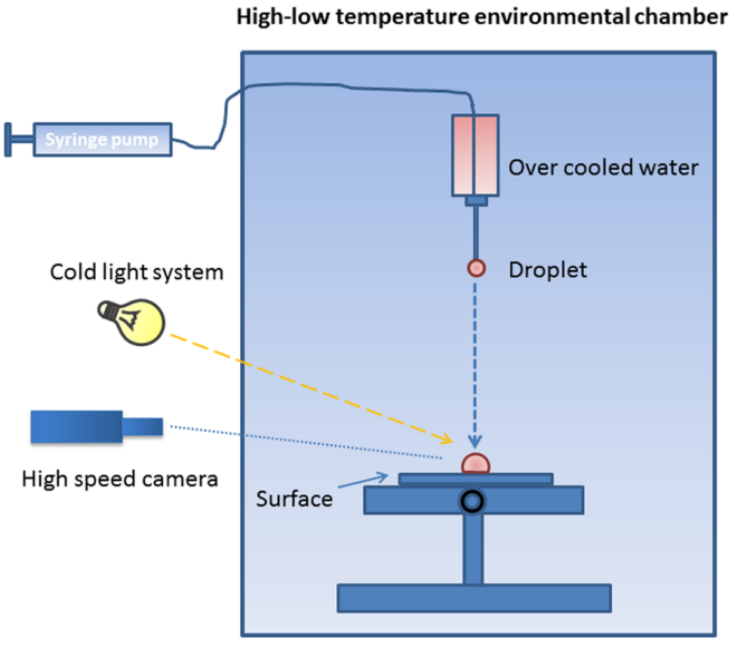

Figure S2. Schematic diagram of the impact experiment of overcooled water droplets.

Ice adhesion tests.

The ice adhesion tensile strength tests were performed using INSTRON 3366 universal testing machine (Instron Corp., USA) in an air-conditioned chamber and the measurement setup was illustrated in Figure S3. In the test, the up and low patterns were made of bare aluminum plate, and the sample was stuck to the low pattern using glue. The up patter and low pattern with the sample was first equilibrated either under an ambient condition (25°C and relative humidity about 50%) or a supersaturated condition (-10 °C and relative humidity about 90%) for 30 minutes. Then the interspace (3 mm thick) between the up patterns and sample was fully filled with supercooled water (about -5°C). The formed sample assembly was then placed in a freezer at −10 °C for 24 h. Finally, the tensile strength of the ice adhesion was tested in the chamber at −10 °C with the tensile speed of 0.5 mm/min.

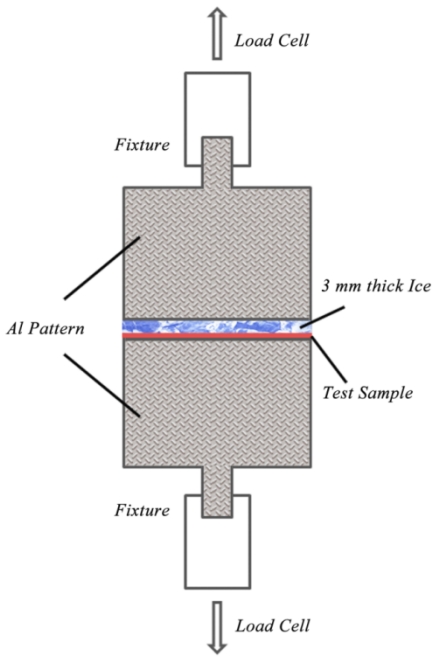

Figure S3. Schematic diagram of the setup in ice adhesion tensile strength tests.

Surface concentration (atom %)					
Sample	C	O	F	Al	Si
S40	41.71	39.92	-	18.36	-
PTES	20.02	34.91	30.56	12.14	2.37
PA	43.21	42.95	-	13.84	-
TTPS	22.18	52.17	-	17.96	7.69

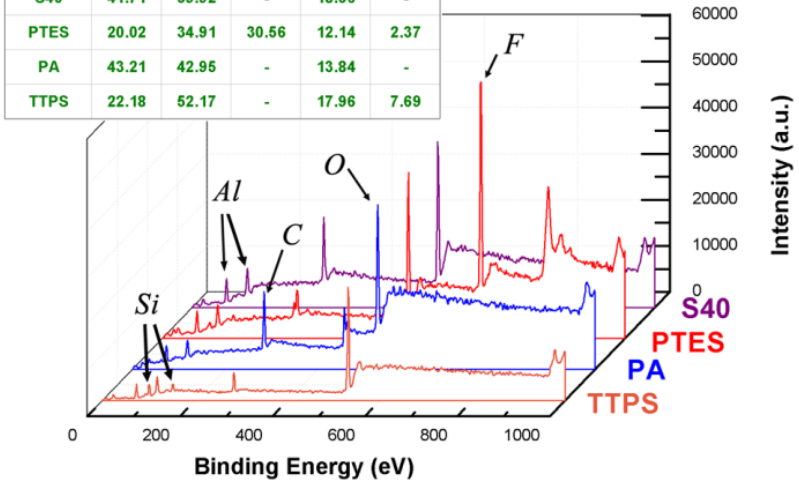

Figure S4. XPS spectra of the etched sample (S40), and the PTES, PA and TTPS modified samples. The inserted table showed the surface elemental abundance of the four samples.

Table S1. Average height (h) and roughness (Ra) from surface profile test of S40, and PTES, PA and TTPS coated roughened surface.

Sample	S40	PTES	PA	TTPS
h (μm)	5.15±0.31	4.92±0.44	5.34±0.29	5.01±0.37
R_a (μm)	1.18±0.20	1.03±0.16	1.15±0.21	0.98±0.15

Table S2. CA on PTES, PA and TTPS coated flat mica sheet and surface free energy calculated by Owens-Wendt-Kaelble method.

Solid Surface	Contact Angle(°)		γ_L^D(mJ/m^2)	γ_L^P(mJ/m^2)	γ_L(mJ/m^2)	γ_S^D(mJ/m^2)	γ_S^P(mJ/m^2)	γ_S(mJ/m^2)
PTES	Water	105.03	21.8	51.0	72.8	10.8	2.6	13.4
	Diiodomethane	90.13	48.5	2.3	50.8			
PA	Water	102.81	21.8	51.0	72.8	25.3	0.5	25.7
	Diiodomethane	65.24	48.5	2.3	50.8			
TTPS	Water	98.28	21.8	51.0	72.8	27.2	0.9	28.1
	Diiodomethane	60.88	48.5	2.3	50.8			