Electronic Supplementary Material

Compact nanopillar array with enhanced anti-accumulation of multiphase matter on transparent superhydrophobic glass

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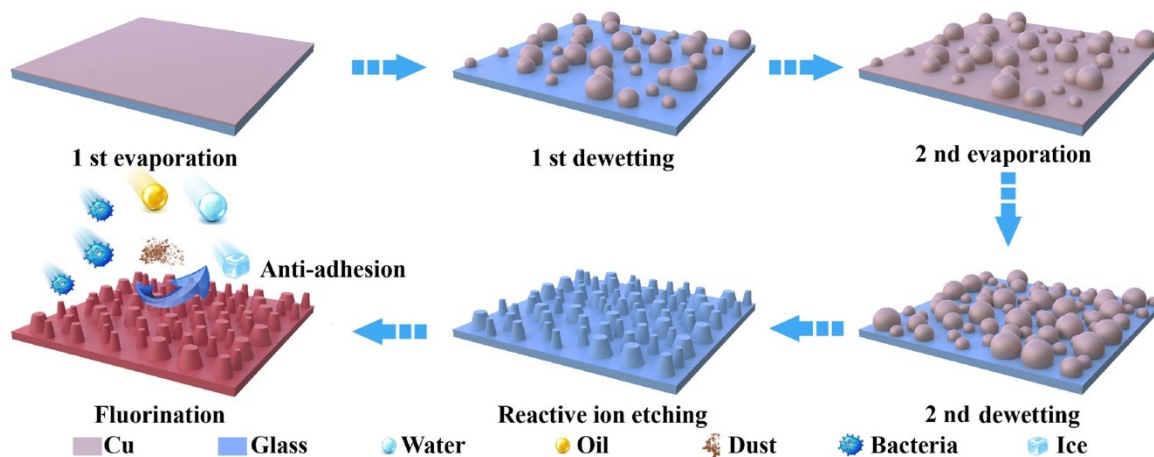
Fig. S1 Schematics of the transparent, antisoiling superhydrophobic glass surface.
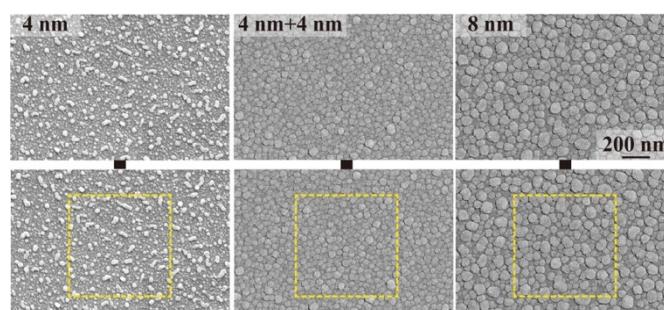

Fig. S2 SEM images of the Cu nanoparticles after a single dewetting of initial film thickness with 4 nm and 8 nm and

repeated dewetting of Cu film with 4 nm in both and additional thickness, denoted by 4nm, 8 nm for a single

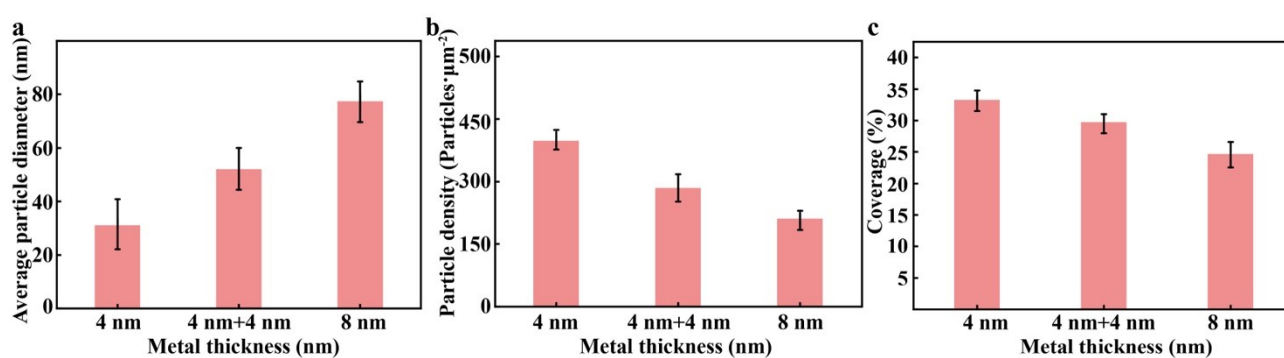dewetting process and 4 nm +4 nm for the repeated dewetting process.

Fig. S3 The main parameters of the dewetted Cu nanoparticles extracted from SEM image analysis with Image J

software.

Table. S1 The main characteristic parameters of the fabricated nanostructures extracted from SEM image analysis

with Image J software.

Samples	Nanopillars distance (l, nm)	Nanopillars density (pillars · μm^{-2})	Nanopillars height (h, nm)
Compact	73 ± 16	140	192 ± 19
Normal 1	132 ± 36	69	153 ± 14
Normal 2	152 ± 38	60	188 ± 26

Table. S2　　The lattice constant, the radius and the calculated P_I of conventional nanopillars.

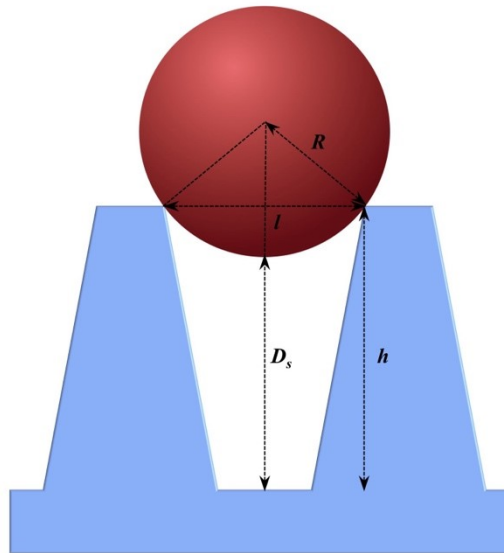| Samples	Lattice constant (nm)	Radius (nm)	P_I (kPa) for water	P_I (kPa) for n-Hexadecane
Normal 1	42 ± 19	260 ± 125	237	39
Normal 2	50 ± 24	273 ± 150	261	43

Fig. S4　　Illustration for the calculation of D_s.

Note 1 The calculation of D_s

The closest distance between the particle and the rough surface (D_s) can be expressed as:

$$D_s = h - (R - \sqrt{R^2 - 0.25l^2})　　　\text{* MERGEFORMAT (S1)}$$

Where l represents adjacent distance between the tops of two nanopillars, h corresponds to the height of nanopillars.

Table. S3　　The adjacent distance between the apexes of two nanopillars (l) and the height (h) of conventional

nanopillars.

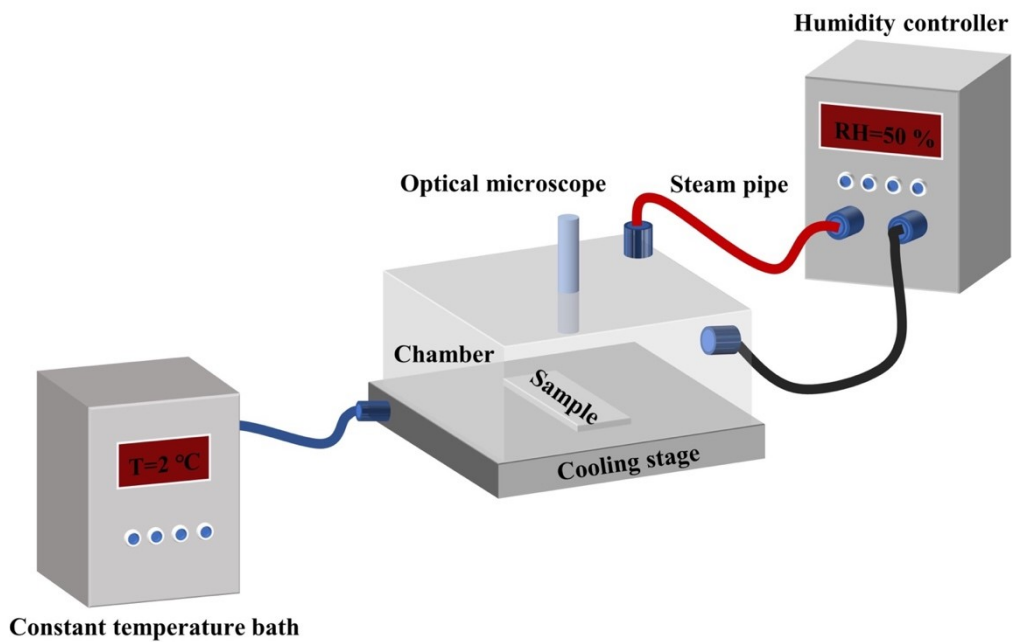| Samples	h (nm)	l (nm)	D_s (nm)
Normal 1	153 ± 14	132 ± 14	39
Normal 2	188 ± 24	152 ± 38	43

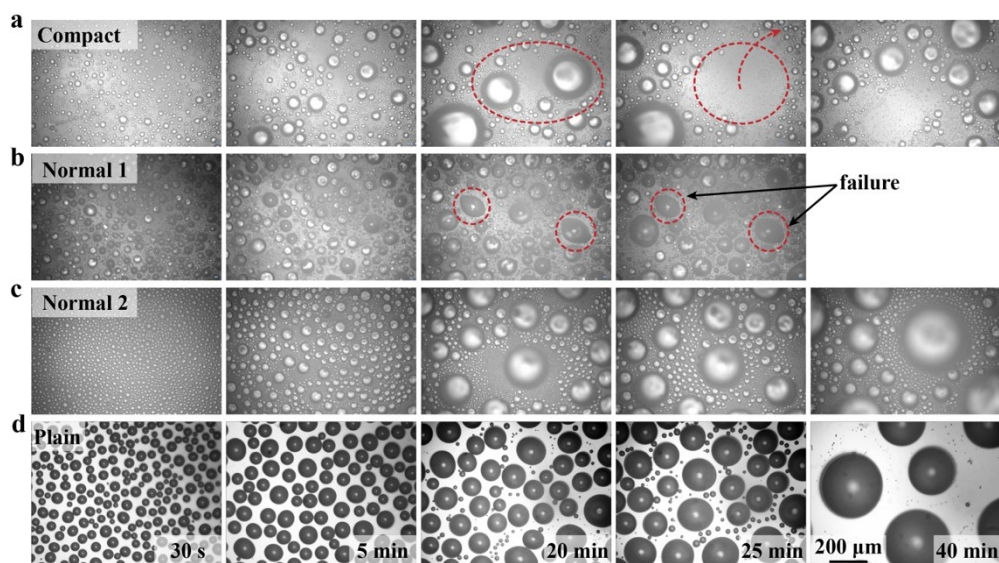**Fig. S5**　Illustration for the temperature and humidity control system

Fig. S6　Condensation performance of the fabricated surfaces.

Fig. S7　Schematic depicting the condensation process and the effect of air pressure on the surfaces of Compact

Nanopillar surfaces. The figure displays two air pressure values: P_u and P_p, which represent the pressure of the
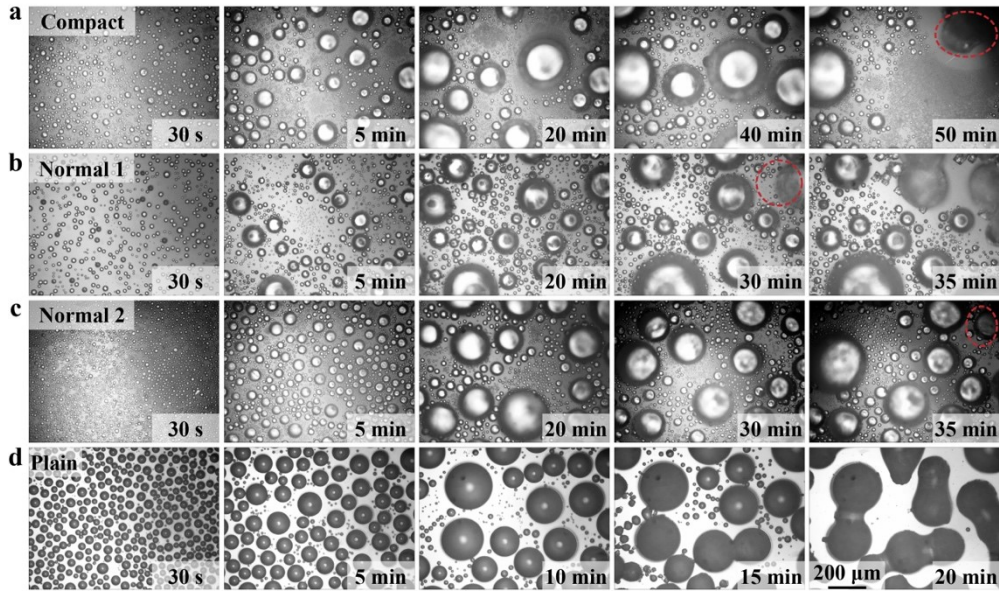
upside air and pocket air, respectively.

Fig. S8 Frosting behaviors on the fabricated surfaces.
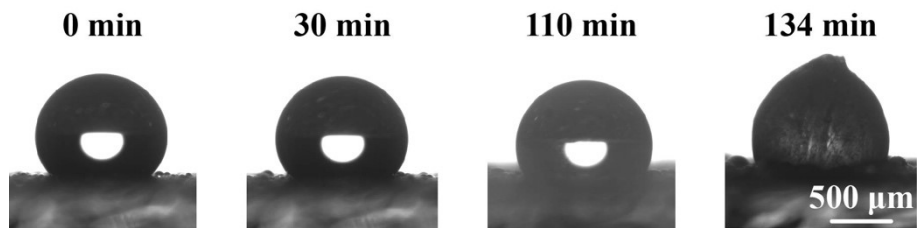

Fig. S9 Dynamic optical micrographs describing the temporal evolution of icing on Compact surfaces. The

experimental conditions include a water volume of 5 μL and a substrate temperature of -20 °C.
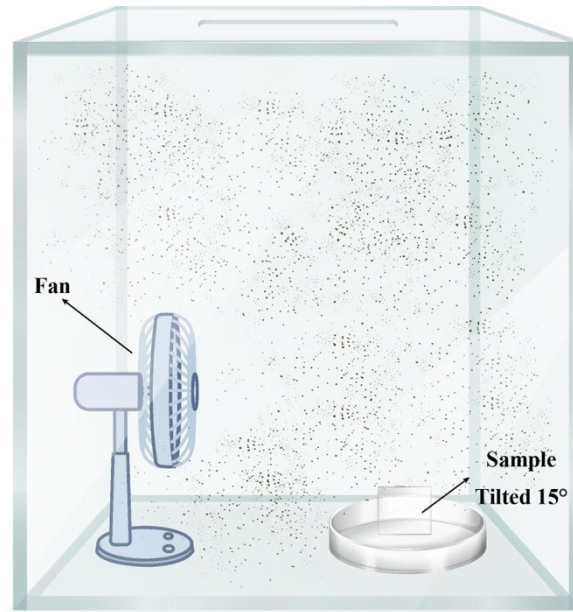
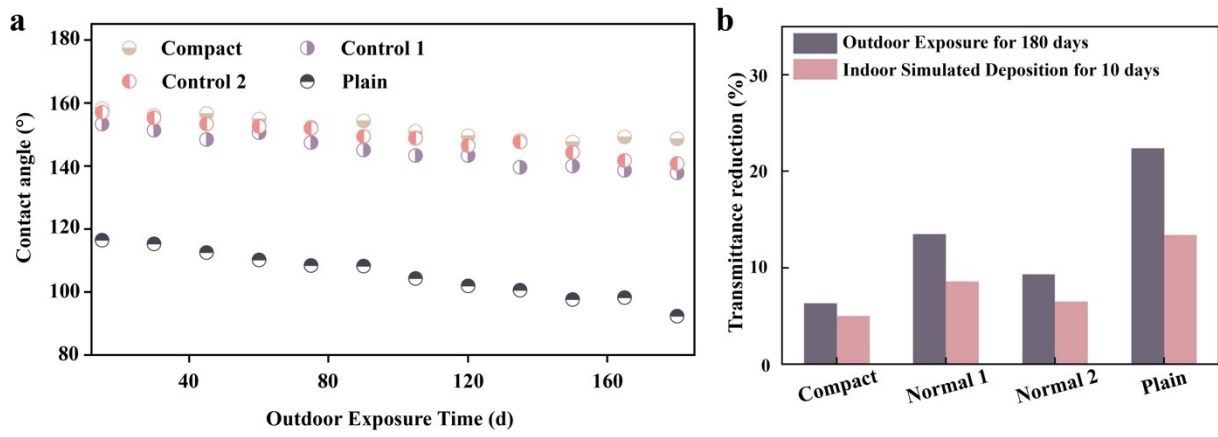**Fig. S10** The diagram illustration of the indoor simulated dustproof test.

Fig. S11 Anti-dust properties of the fabricated surfaces.
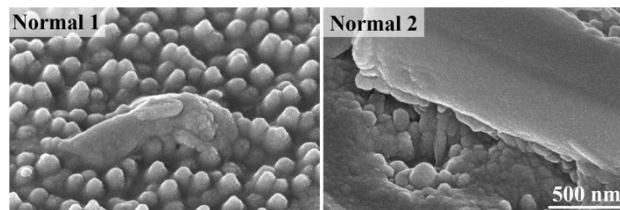

Fig. S12 The SEM images of the dust on the fabricated surfaces after 180 d outdoor exposure test
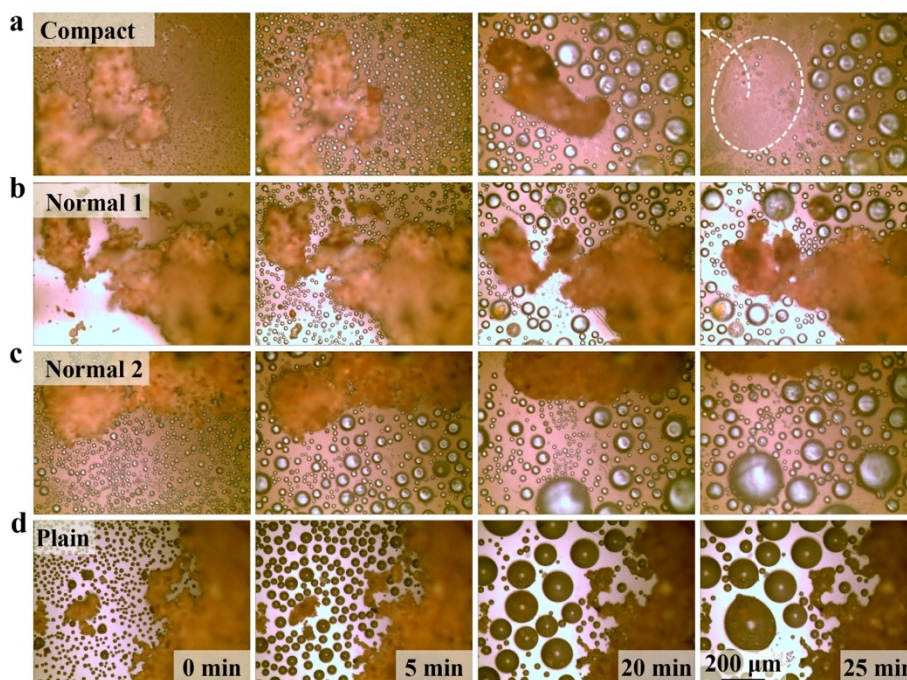
Fig. S13 Anti-Dust Properties of the fabricated surfaces during condensation

Note 2 The detailed experimental procedure for anti-bacteria property.

1 Preparation of liquid medium

The Luria-Bertani (LB) liquid medium was prepared as follows: 100 mL of distilled water was measured in a graduated cylinder and poured into a 250 mL reagent bottle. Using an analytical balance, 1 g of tryptone, 0.5 g of yeast powder, and 1 g of sodium chloride were individually weighed and added to the reagent bottle. The mixture was thoroughly mixed and sterilized at 121 ℃ for 15 min in a high-temperature and high-pressure sterilizer before use.

LB solid medium was prepared as follows: 100 mL of distilled water was measured in a graduated cylinder and poured into a 250 mL reagent bottle. Using an analytical balance, 1 g of tryptone, 0.5 g of yeast powder, 1 g of sodium chloride, and 1.5 g of agar powder were individually weighed and added to the reagent bottle. The mixture was thoroughly mixed and sterilized at 121 ℃ for 15 min in a high-temperature and high-pressure sterilizer. After the medium was cooled to 40-50 ℃, 15 mL of the medium was aseptically transferred to a disposable sterile petri dish using an electric pipette.

2 Bacterial Suspension Preparation

Two 12 mL bacterial culture tubes were acquired, with 3 mL of LB liquid medium added to each. A single colony from an Escherichia coli (E. coli) solid medium was selected and introduced to the liquid medium in one of the tubes, while the other tube functioned as a blank control. The samples were incubated in a shaking incubator at 37°C and 200 rpm for 12 hours. Subsequently, the bacterial suspension underwent centrifugation at 5000 rpm for 5 minutes, the supernatant was removed, and the bacterial cells were resuspended in a sterile Phosphate-Buffered Saline (PBS) solution. Finally, the bacterial suspension was diluted to a concentration of 1×10^7 Colony-Forming Units (CFU)/mL.

3 Pretreatment of surfaces to be tested.

The fabricated nanostructured surfaces were separately positioned within disposable bacterial culture dishes. Subsequently, each sample underwent immersion in 75% ethanol for 30 minutes to ensure sterilization. Upon completion of the sterilization process, the samples were meticulously air-dried and reserved for future utilization.

4 Co-culture and plate coating count test

After sterilization, the samples were positioned in a 6-well plate, ensuring the test surface faced upwards. Next, 3 mL of the prepared bacterial suspension was added to each well to fully submerge the samples. These samples were incubated for 24 h at 37 °C in a static incubator. Following incubation, the samples were gently rinsed with PBS solution to eliminate unattached bacteria. Subsequently, the samples were relocated to a fresh culture plate, and 1 mL of sterile PBS solution was introduced. A 5 min ultrasonication process was conducted to promote detachment of the adhered bacteria. The resulting suspension underwent serial 10-fold dilutions using sterile PBS solution, utilizing dilution factors of 10^1, 10^2, and 10^3 in this research. Aliquots of 100 µL of the diluted bacterial suspension were plated onto LB

agar and incubated at 37°C for 18 hours. CFUs were enumerated and documented photographically. The total CFUs were calculated using the formula: CFUs = (colony count × dilution factor × 10) / (100 μL of diluted suspension × 1 mL).
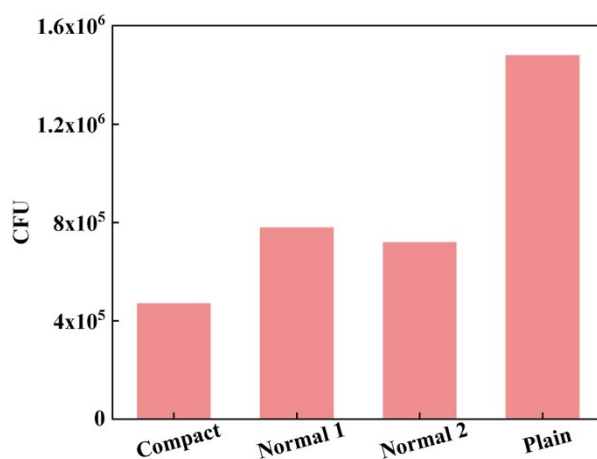

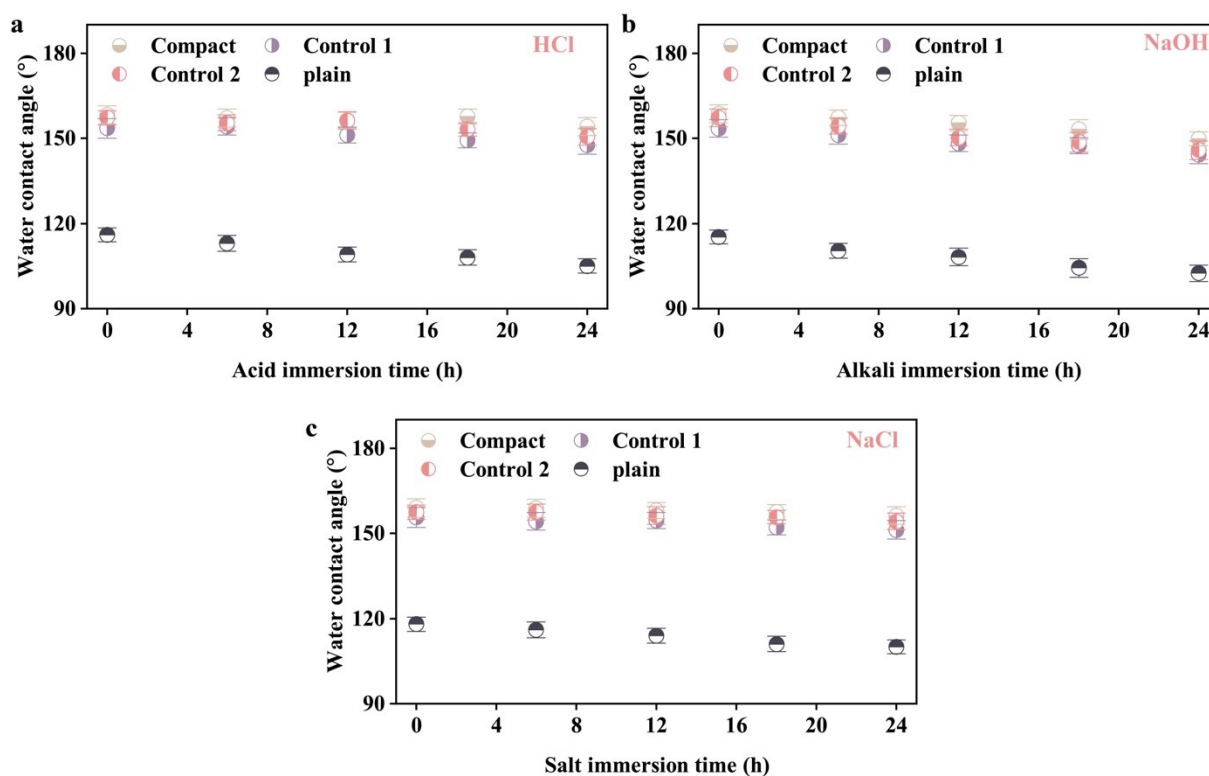**Fig. S14** Statistics of fabricated surfaces bactericidal performance.

Fig. S15 Acid corrosion resistance, alkali corrosion resistance and salt corrosion resistance of fabricated surfaces.