Supplementary Information (SI) for Journal of Materials Chemistry A.

Supporting Information

Bionic integrated system (BIS) with efficient water transport and fog water collection behavior

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1.The study prepares aluminum surfaces with various microchannel structures using laser etching, inspired by the natural micro and nano structures of sarracenia and wheat awns. The microchannels are categorized into main, secondary normal, and secondary stepped types based on the laser etching parameters.

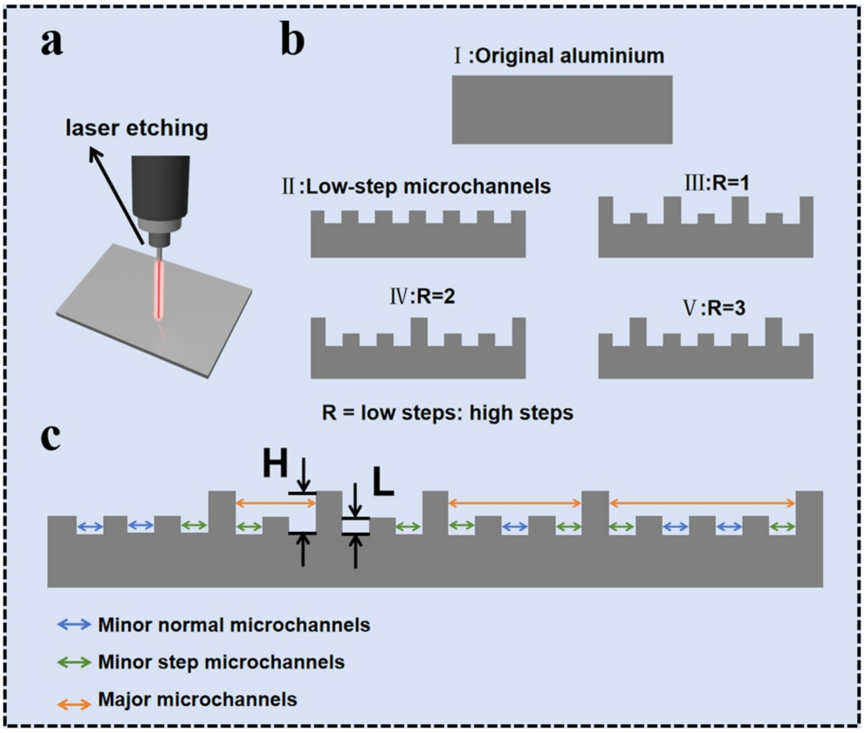

Figure. S1. (a) Schematic diagram of laser etching process. (b) Cross-section diagram of different microchannel grooves. (c) Cross-section of the layered ladder structure on the surface of different microchannels.

2.The surface of the original aluminum sheet is smooth and uniform, and the water contact angle is 87° . After laser etching on the surface of the hierarchical structure, the surface of the etched aluminum sheet presents a state of large particles accumulation, showing super hydrophilicity (**Movie 1**). The width of the microchannel is changed by adjusting the total number of steps NS within 5mm width. The surface structure of the microchannel with different orders is shown in the figure.

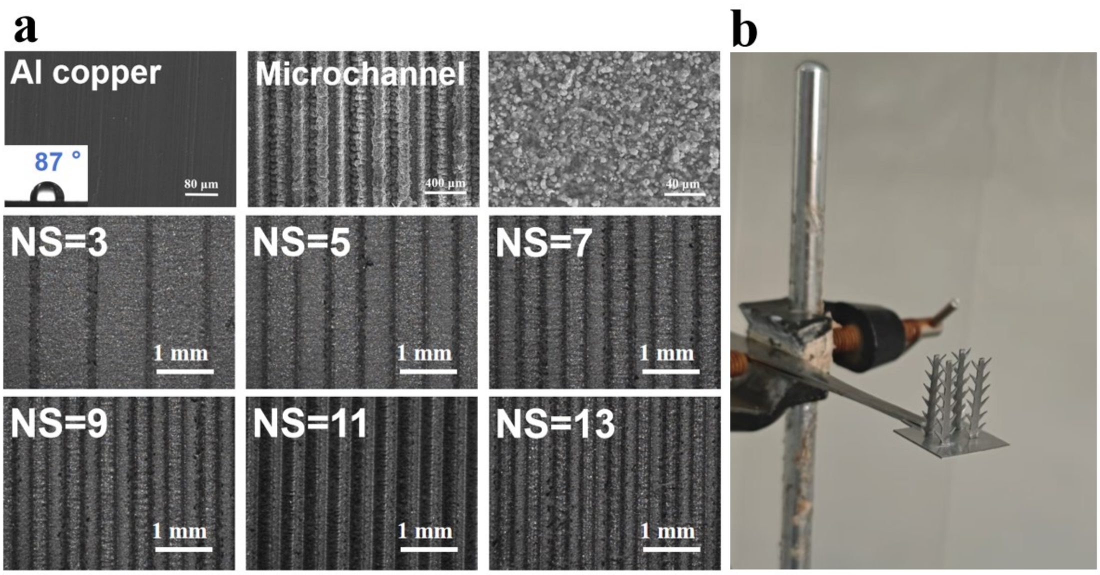

Figure. S2. (a) Schematic diagram of the surface morphology before and after the etched graded microchannels on the surface of aluminum sheet and the surface structure of the microchannels of different orders. (b) The optical image of the SHBS@BIS array fog collector.

3.To accurately characterize the transport distance of the liquid on the surface of the microchannel with different characteristics, a square groove was carefully etched at the bottom of the microchannel. Then, 1 μL Rhodamine B solution was dropped into the groove, and the transmission process of the liquid on the surface of the microchannel was observed, and the transmission distance of the liquid was recorded(**Figure S3**).

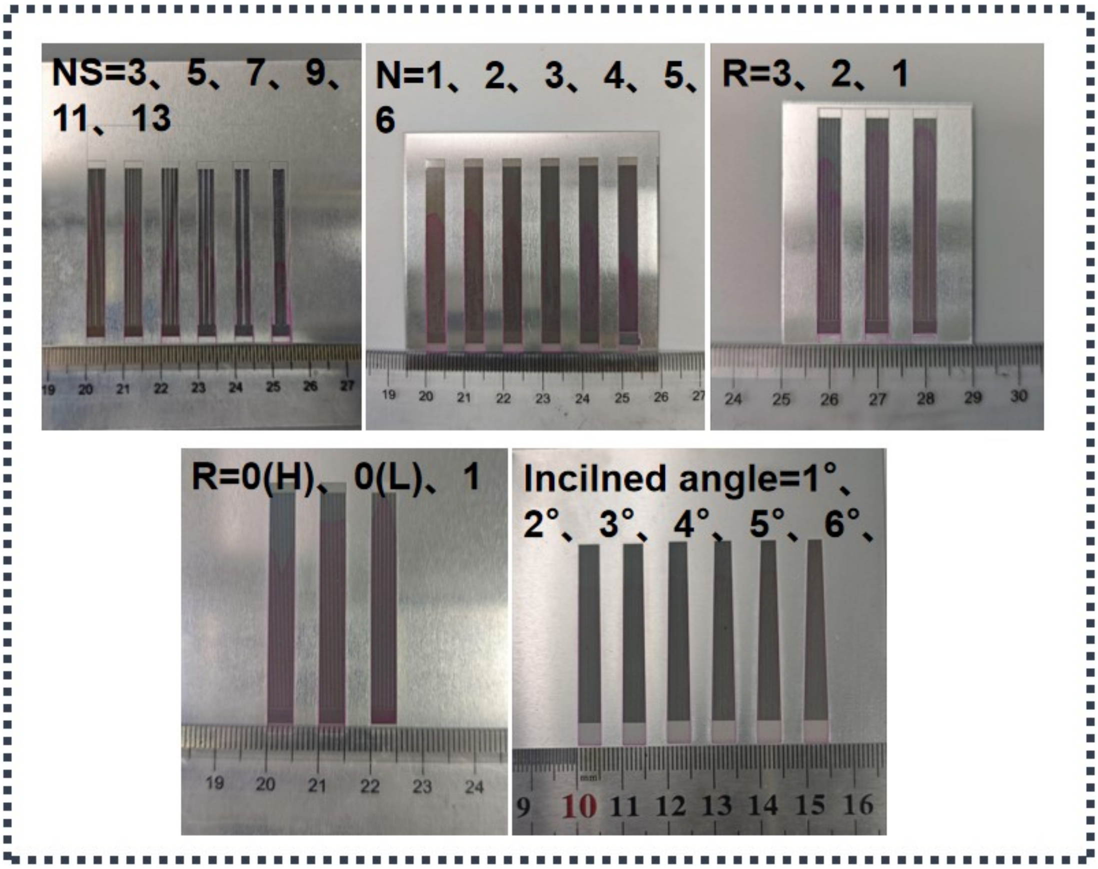

Figure. S3. Microchannel width NS, groove depth H, low: high order quantity ratio R and the influence of inclined angle on liquid transport distance.

4. To ensure the long-term stability of fog collectors in these environments, the durability of the superhydrophobic surface (SHB) is thoroughly tested. This includes the evaluation of its UV resistance, fog erosion resistance, acid and alkali resistance, and wear resistance (**Figure S4**).

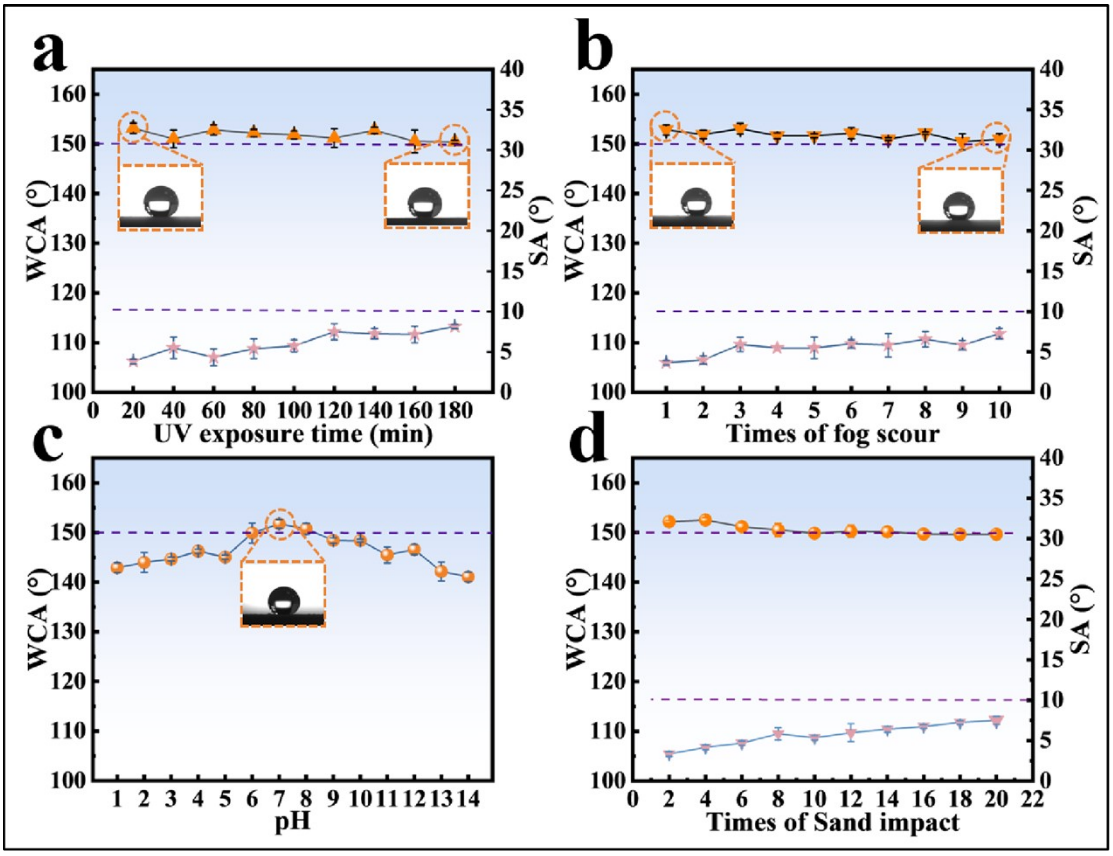

Figure. S4. (a) UV resistance test of superhydrophobic substrate (SHBS) surface. (b) Test of anti-fogging properties of superhydrophobic substrate surface. (c) Test of acid and alkali resistance on the surface of superhydrophobic substrate. (d) Sand shock test of superhydrophobic substrate surface.

5.The antifouling and self-cleaning properties of the material surface also deeply affect the actual use of the sample. Excellent anti-fouling ability, can effectively reduce the adhesion of other liquids to the surface, prevent the surface structure from being destroyed, affecting the performance. In order to explore the anti-pollution properties of the superhydrophobic surface, the superhydrophobic substrate(SHBS) and the original substrate(OS) were soaked in cola, coffee and milk, respectively, and each beverage was soaked for 10 s for a cycle, and photos were taken (the test sequence in the figure is Coffee, Cola and milk). As shown in the figure, all three liquids have some residue on the surface of OS sample, but basically no residue on the surface of SHBS sample. The contact Angle and sliding Angle were measured. After 10 cycles, the contact Angle of SHBS did not change significantly, and still maintained good hydrophobic performance.

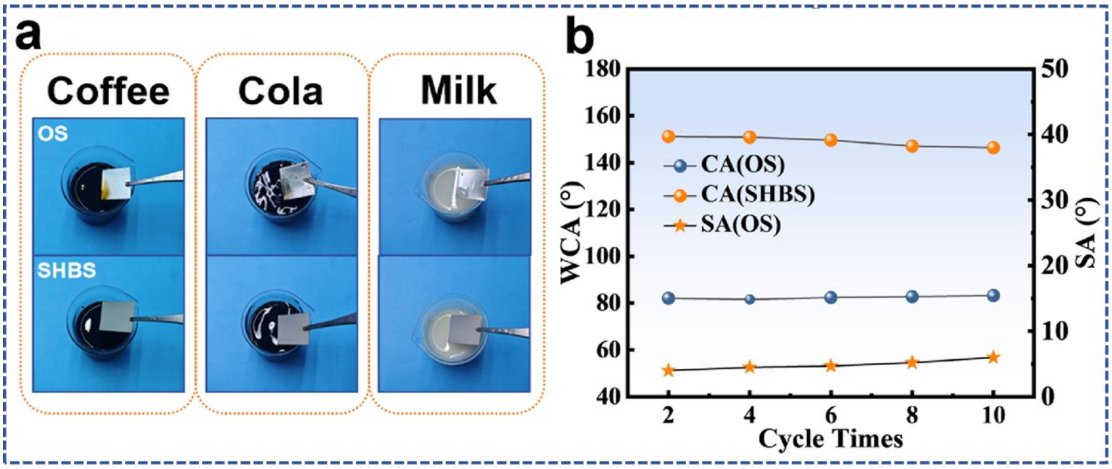

Figure. S5. (a)The antifouling properties of original substrate(OS) and superhydrophobic substrate(SHBS) in Coffee, Cola and milk, respectively.(b) (b) The effect of the anti-fouling self-cleaning performance test on the water contact angle and sliding angle of the surface of the hydrophobic substrate

6. The bionic integrated system (BIS), combined with other devices, forms a windmill fog collector that can generate electricity from solar panels in inland areas with strong ultraviolet light . This electrical energy is then converted into mechanical energy that drives the windmill fog collector to spin.

Coastal areas are often accompanied by strong winds and foggy weather conditions due to the influence of sea breezes. In these areas, the windmill fog collector converts the captured mechanical energy into kinetic energy under the direct drive of the wind, which not only efficiently collects fog water, but also realizes wind power generation.

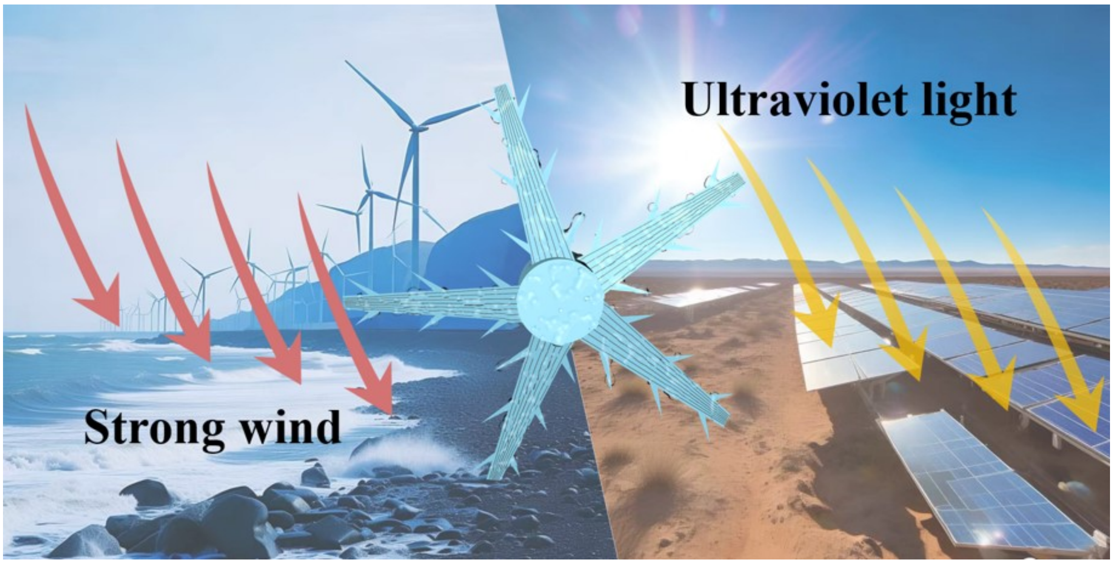

Figure. S6. Application of bionic integrated system (BIS) combined with other devices to form a windmill fog collector.