Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting Information

Superamphiphobic Coatings with Polymer-wrapped Particles: Enhancing Water Harvesting

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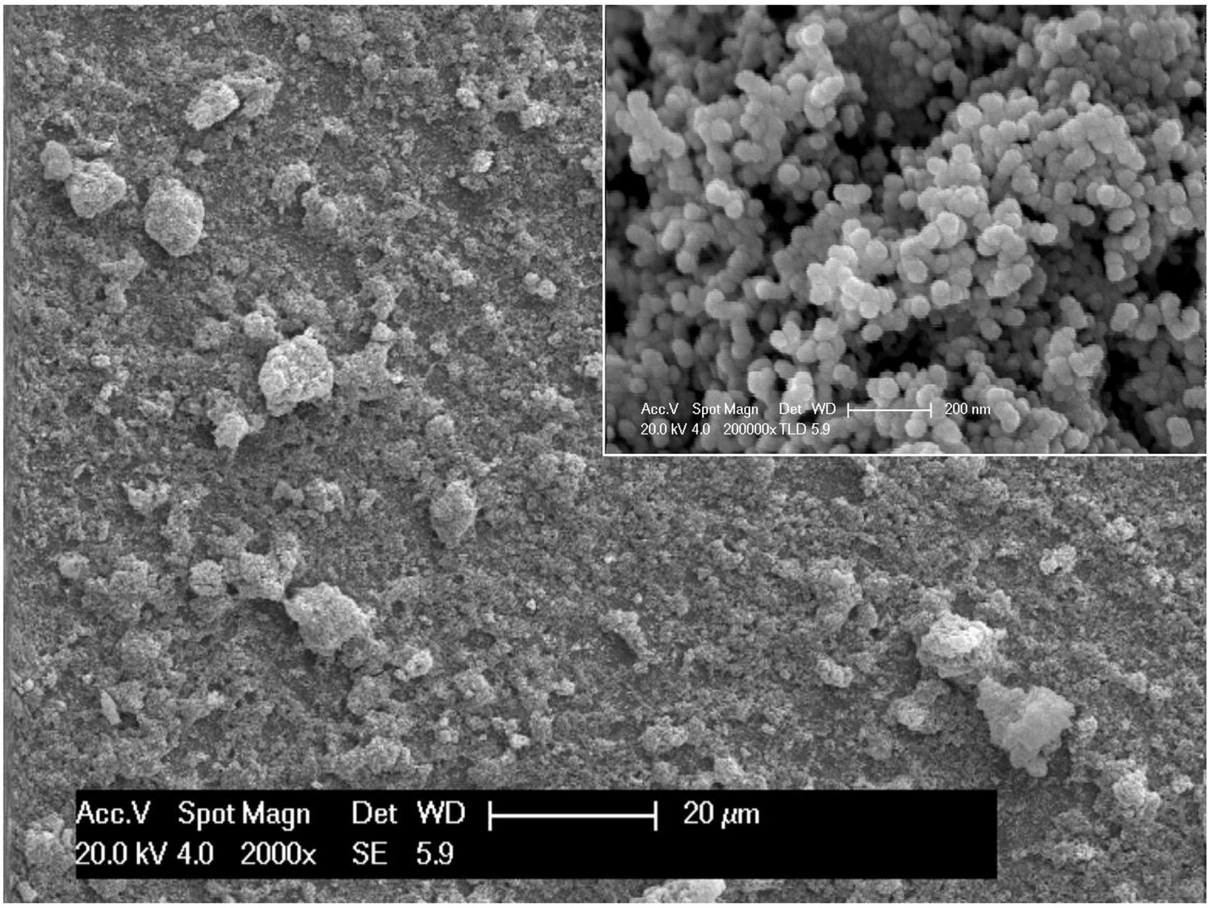


Fig. S1. SEM images of chained nano-SiO_2 superamphiphobic coating surface.

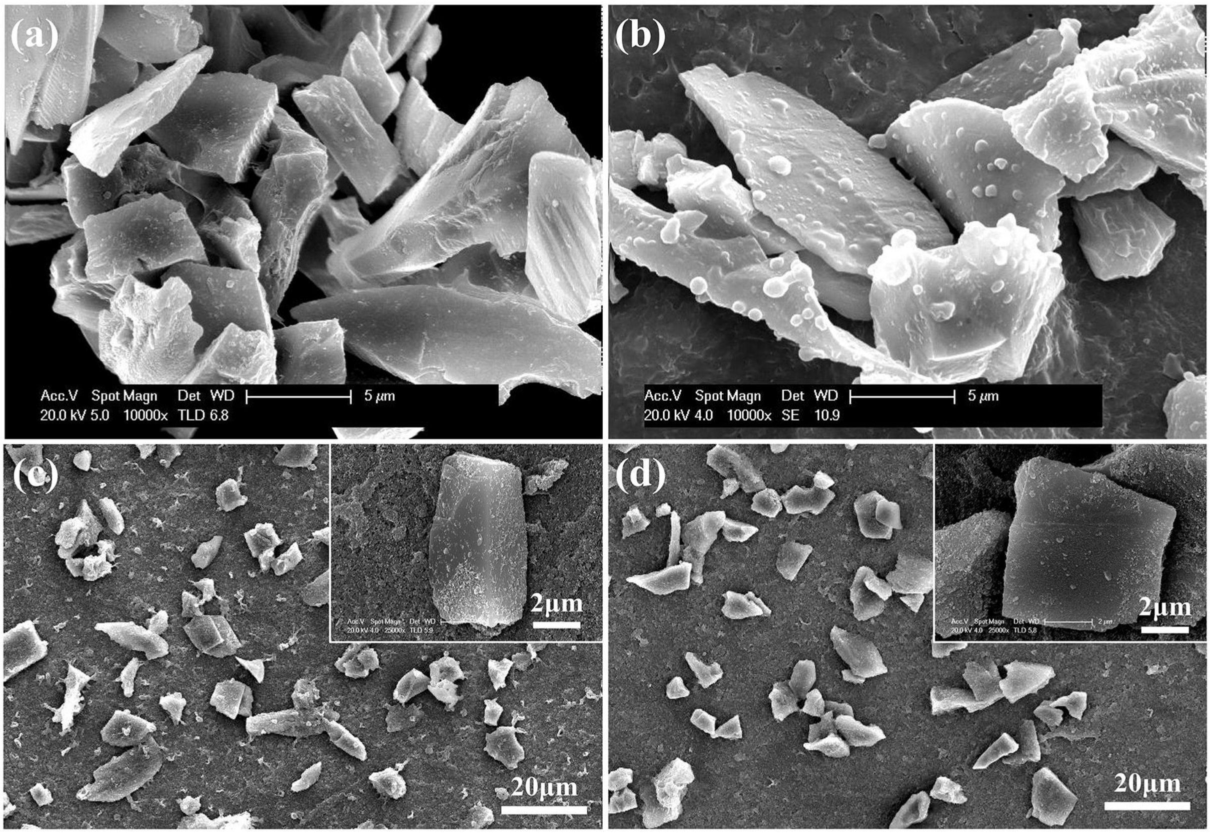
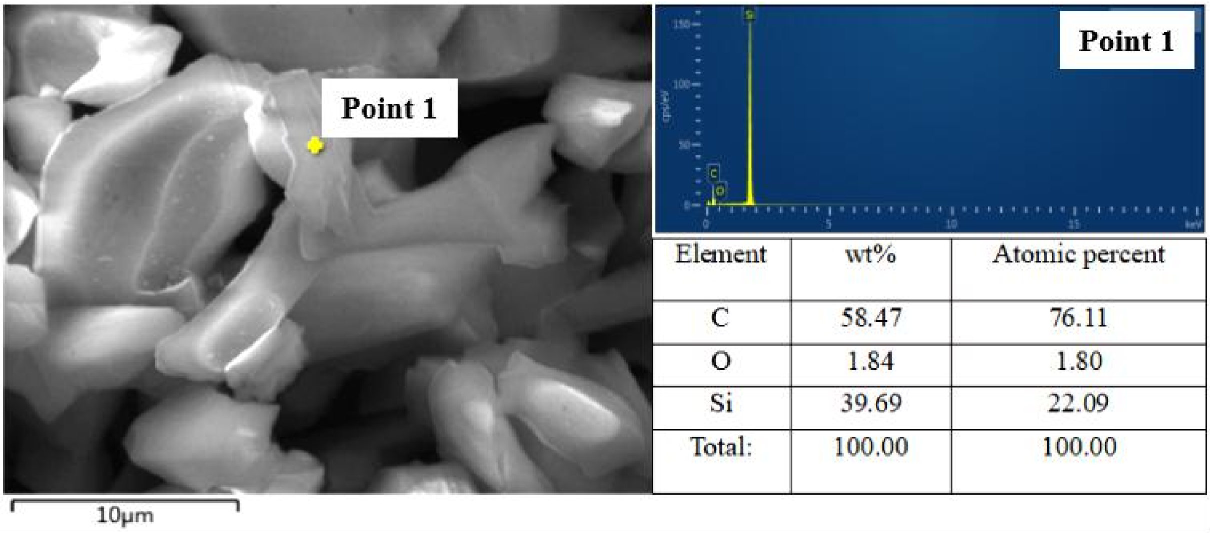
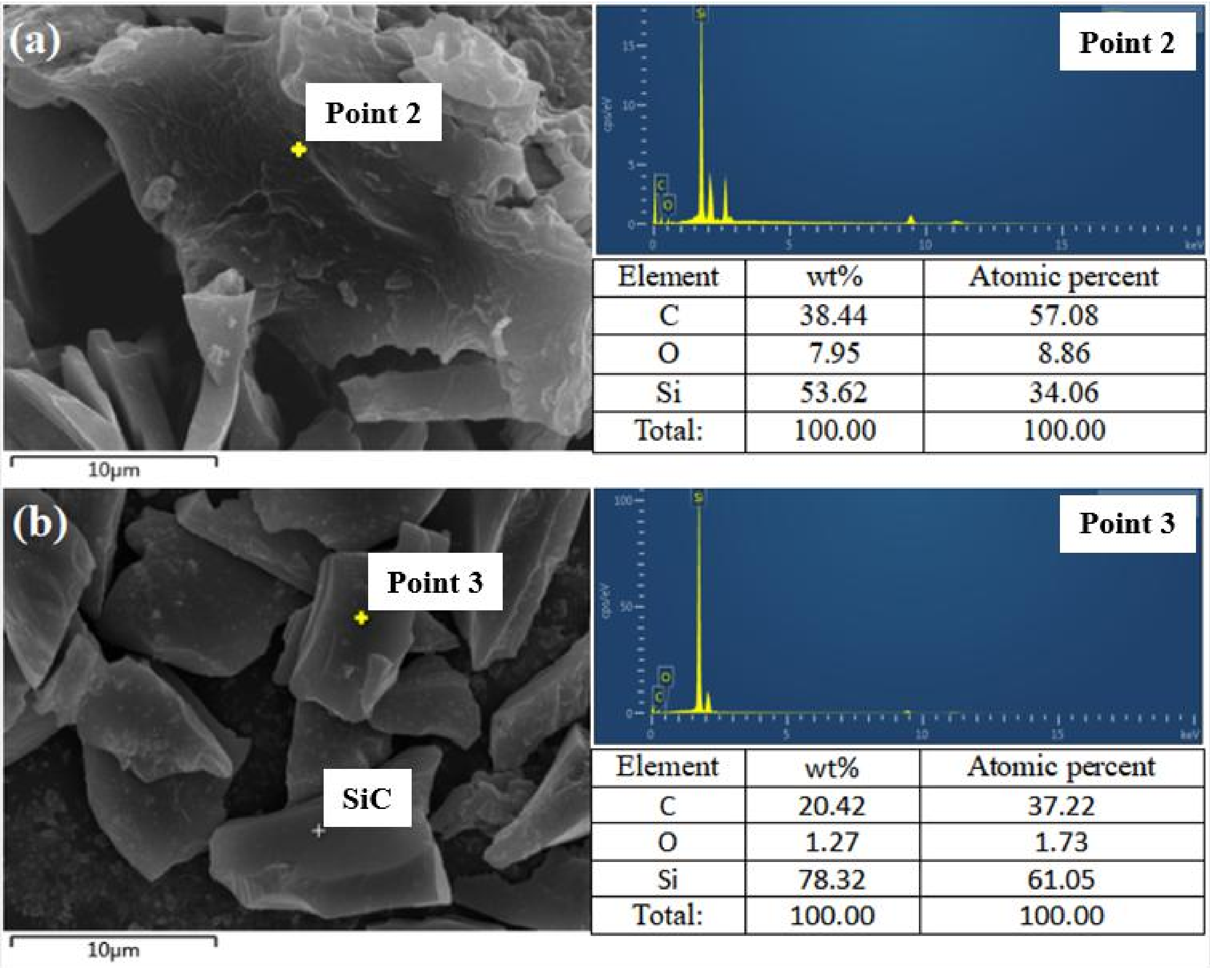


Fig. S2. (a) SEM images of SiC@PVA. (b) SEM images of SiC@KH550. (c) Hybrid superamphiphobic coating surface of SVS, the inserted picture is the magnified vision of SiC@PVA. (d) Hybrid superamphiphobic coating surface of SHS, the inserted picture is the magnified vision of SiC@KH550.



Element	wt%	Atomic percent
C	58.47	76.11
O	1.84	1.80
Si	39.69	22.09
Total:	100.00	100.00

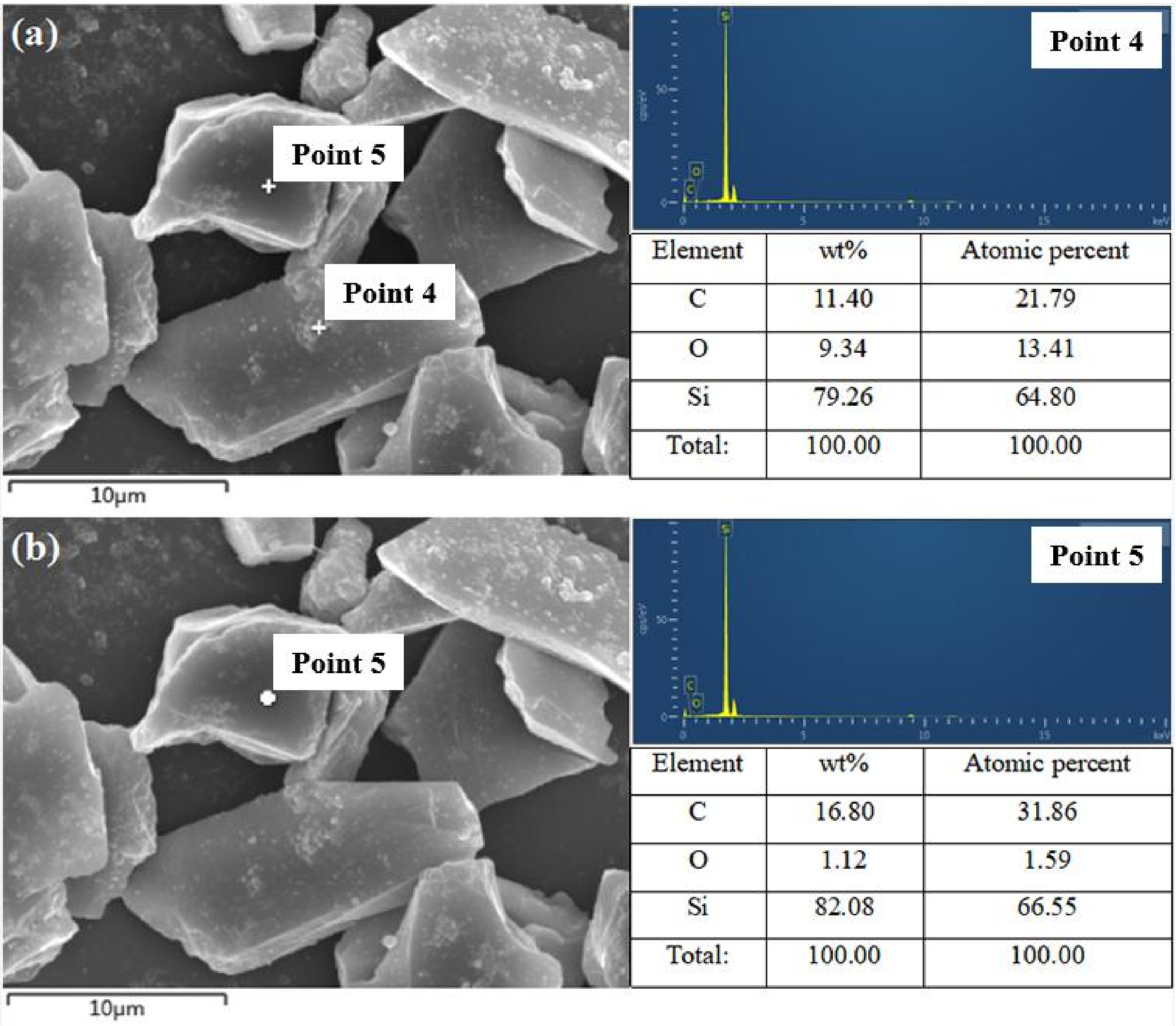
Fig. S3. Element composition of SiC particles.



Element	wt%	Atomic percent
C	38.44	57.08
O	7.95	8.86
Si	53.62	34.06
Total:	100.00	100.00

Element	wt%	Atomic percent
C	20.42	37.22
O	1.27	1.73
Si	78.32	61.05
Total:	100.00	100.00

Fig. S4. Element composition of SiC@PAA. (a) Shows that PAA is coated on SiC particles, and (b) shows that some SiC particles or some regions of SiC surface with little PAA.



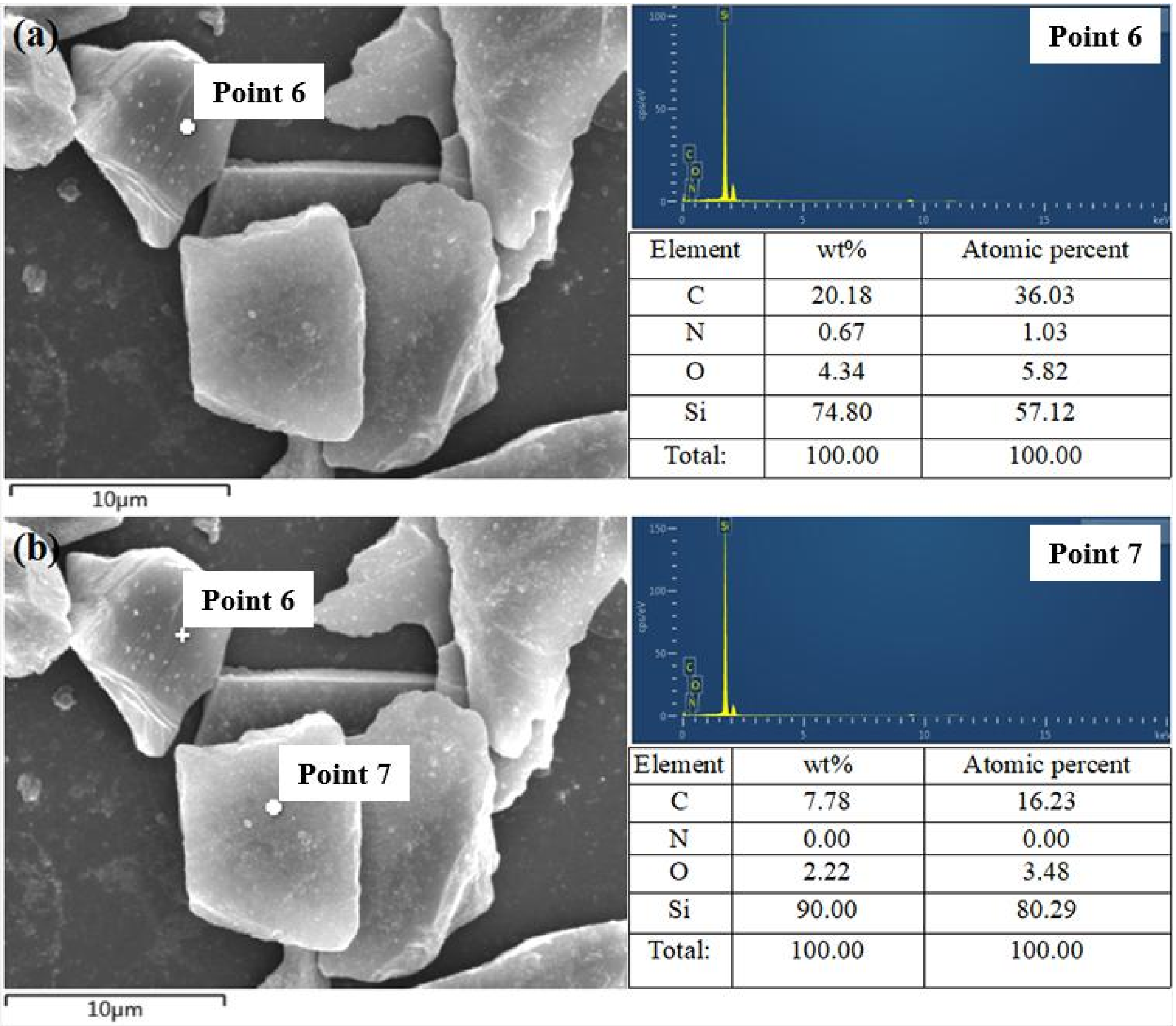
Point 4

Element	wt%	Atomic percent
C	11.40	21.79
O	9.34	13.41
Si	79.26	64.80
Total:	100.00	100.00

Point 5

Element	wt%	Atomic percent
C	16.80	31.86
O	1.12	1.59
Si	82.08	66.55
Total:	100.00	100.00

Fig. S5. Element composition of SiC@PVA. (a) shows that PVA is coated on SiC particles, and (b) shows that some SiC particles or some regions of SiC surface with little PVA.



Element	wt%	Atomic percent
C	20.18	36.03
N	0.67	1.03
O	4.34	5.82
Si	74.80	57.12
Total:	100.00	100.00

Element	wt%	Atomic percent
C	7.78	16.23
N	0.00	0.00
O	2.22	3.48
Si	90.00	80.29
Total:	100.00	100.00

Fig. S6. Element composition of SiC@KH550. (a) shows that KH550 is coated on SiC particles, and (b) shows that some SiC particles or some regions of SiC surface with no KH550.

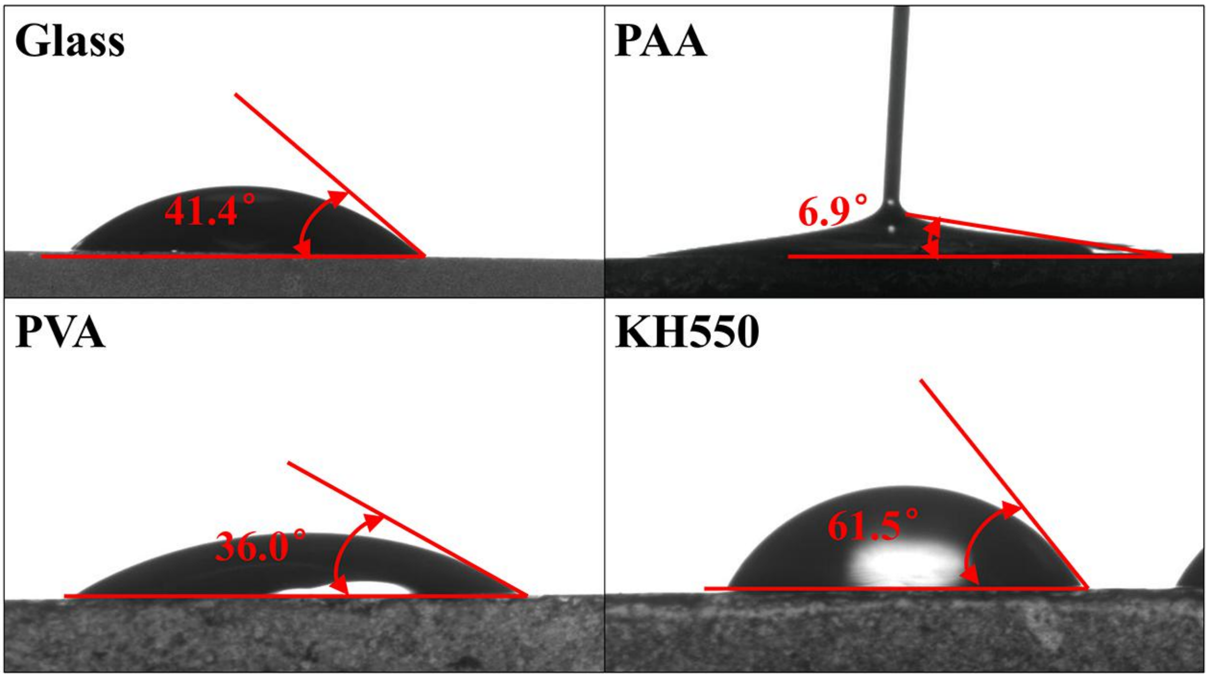


Fig. S7. Water contact angles of different surfaces. We selected four smooth glass, one does not coat any thing, and the other three glasses were coated by PAA, PVA and KH550, respectively.

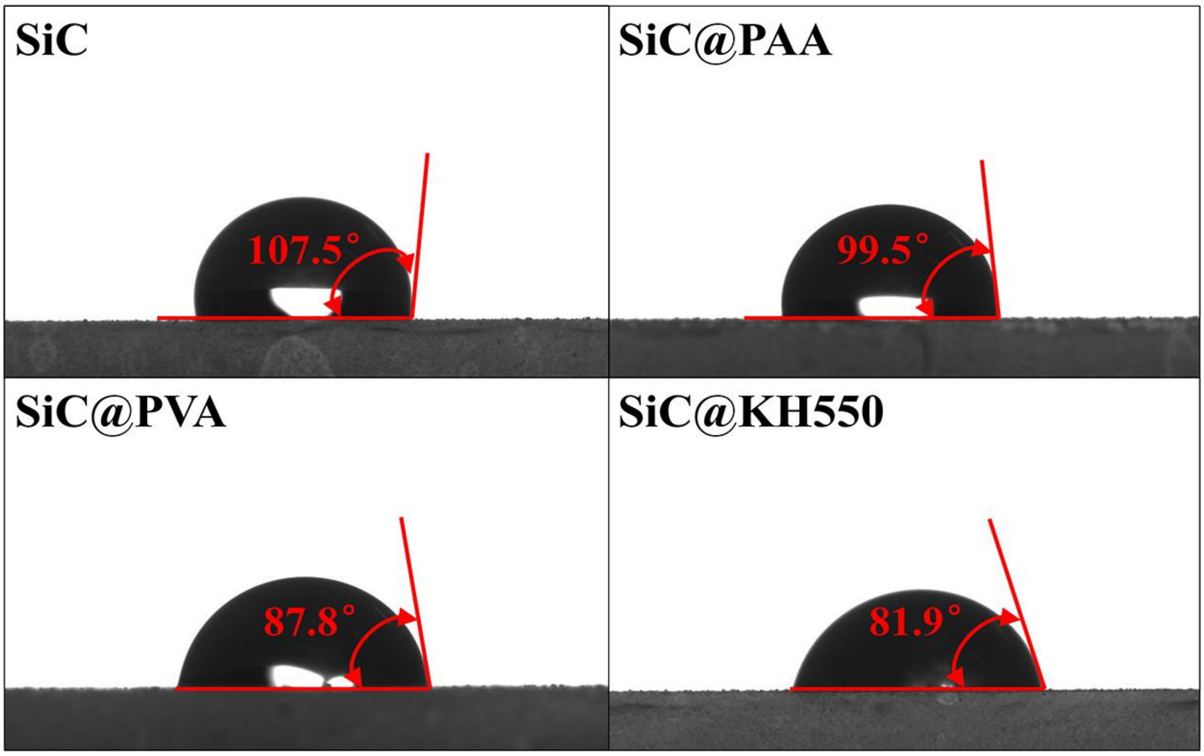


Fig. S8. Water contact angles of SiC, SiC@PAA, SiC@PVA and SiC@KH550.

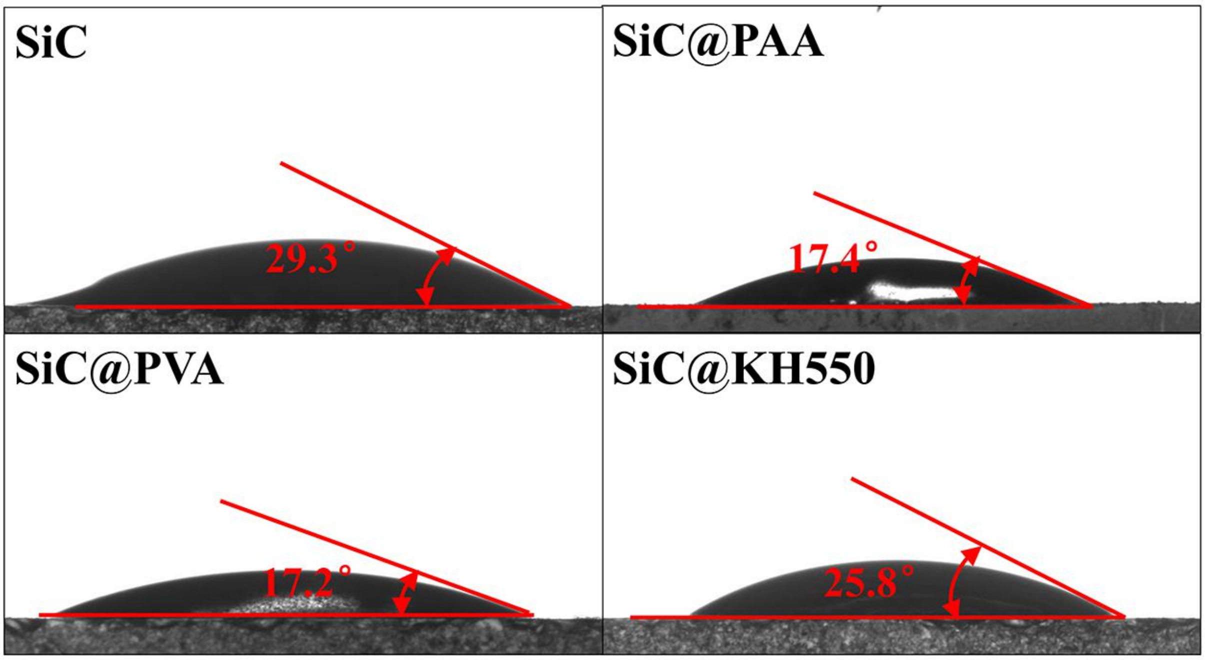


Fig. S9. Oil contact angles of SiC, SiC@PAA, SiC@PVA and SiC@KH550.

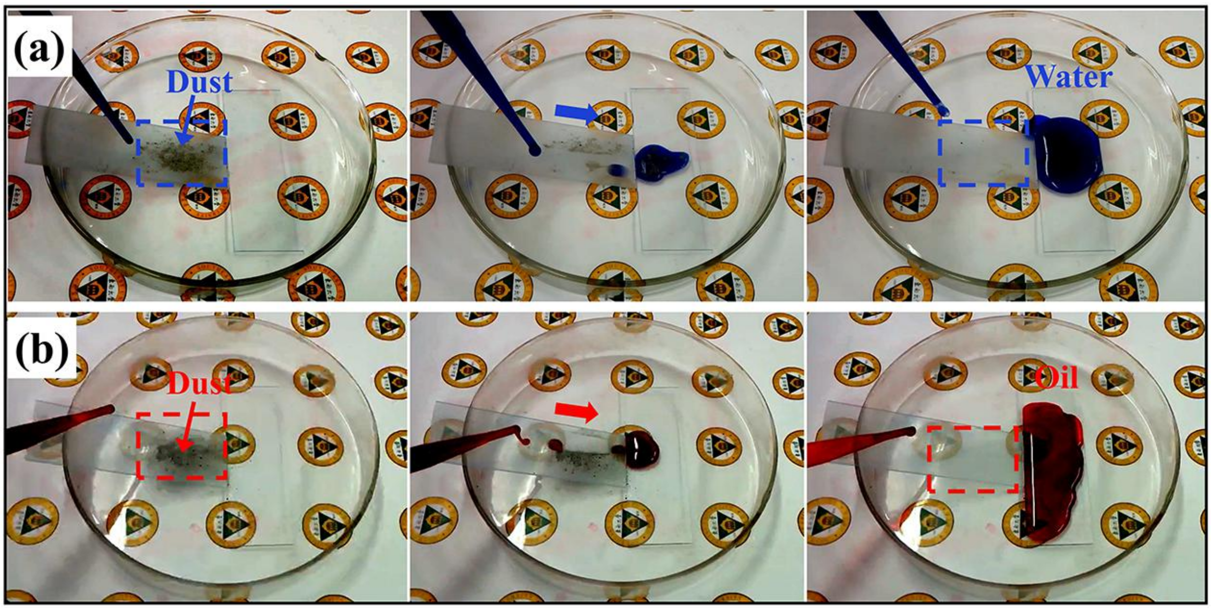


Fig. S10. Self-cleaning performances of SAS.

(a) Self-cleaning performances of SAS for water. (b) Self-cleaning performances of SAS for oil. Plenty of fly ash cover on the surfaces of the glasses, and the dust can be quickly carried away by the rolling water and oil. Therefore, the surface shows excellent self-cleaning effect and anti-oil pollution effect.

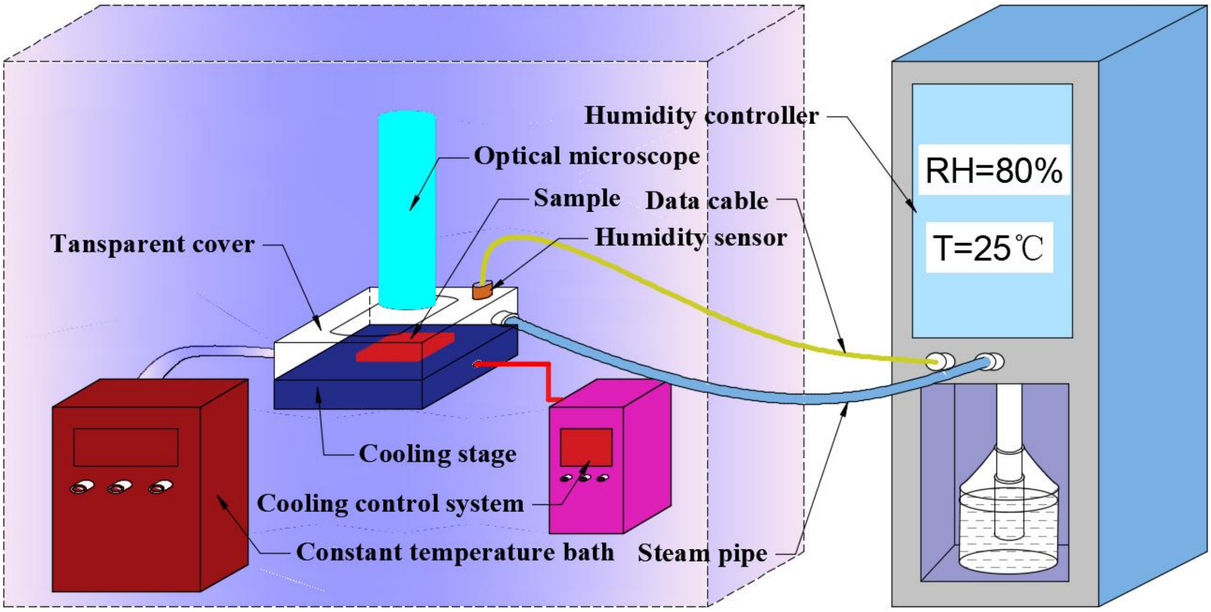


Fig. S11. Illustration of the condensation test system.

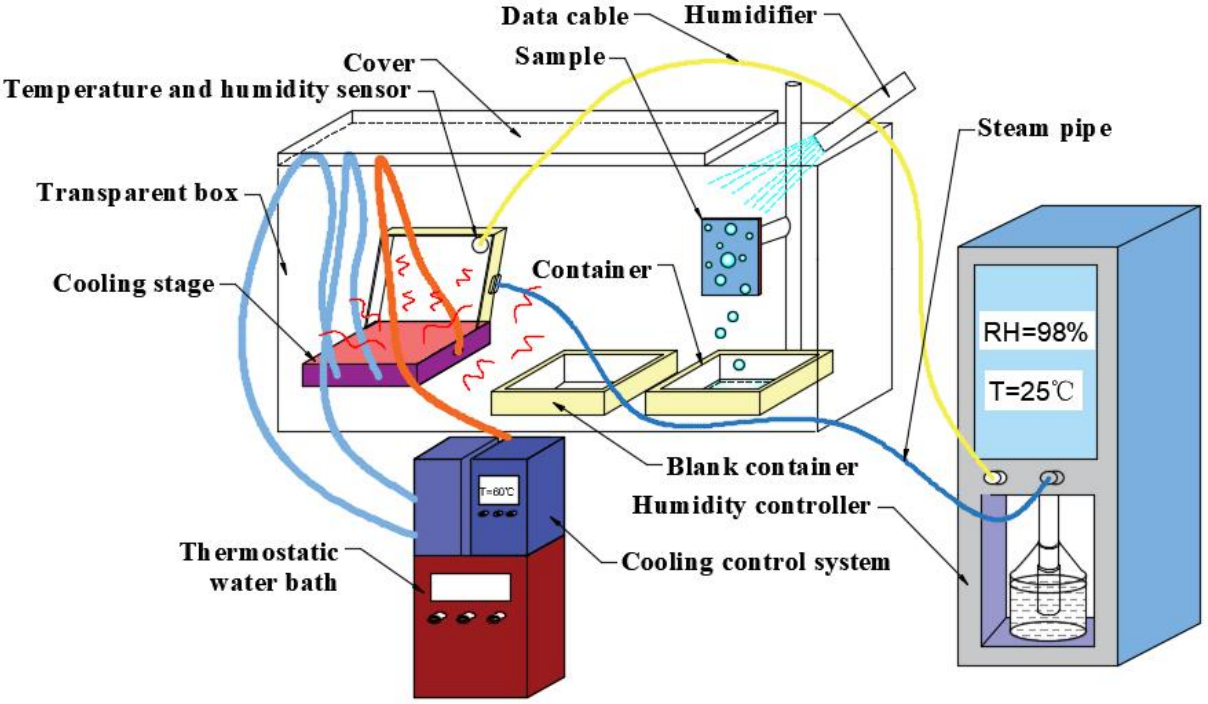


Fig. S12. Water collection system of high-humidity atmosphere.

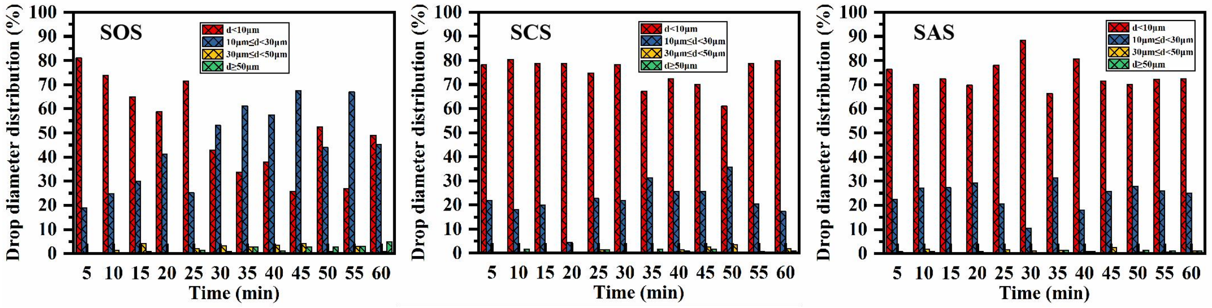


Fig. S13. Drop diameter distribution of SOS, SCS and SAS.

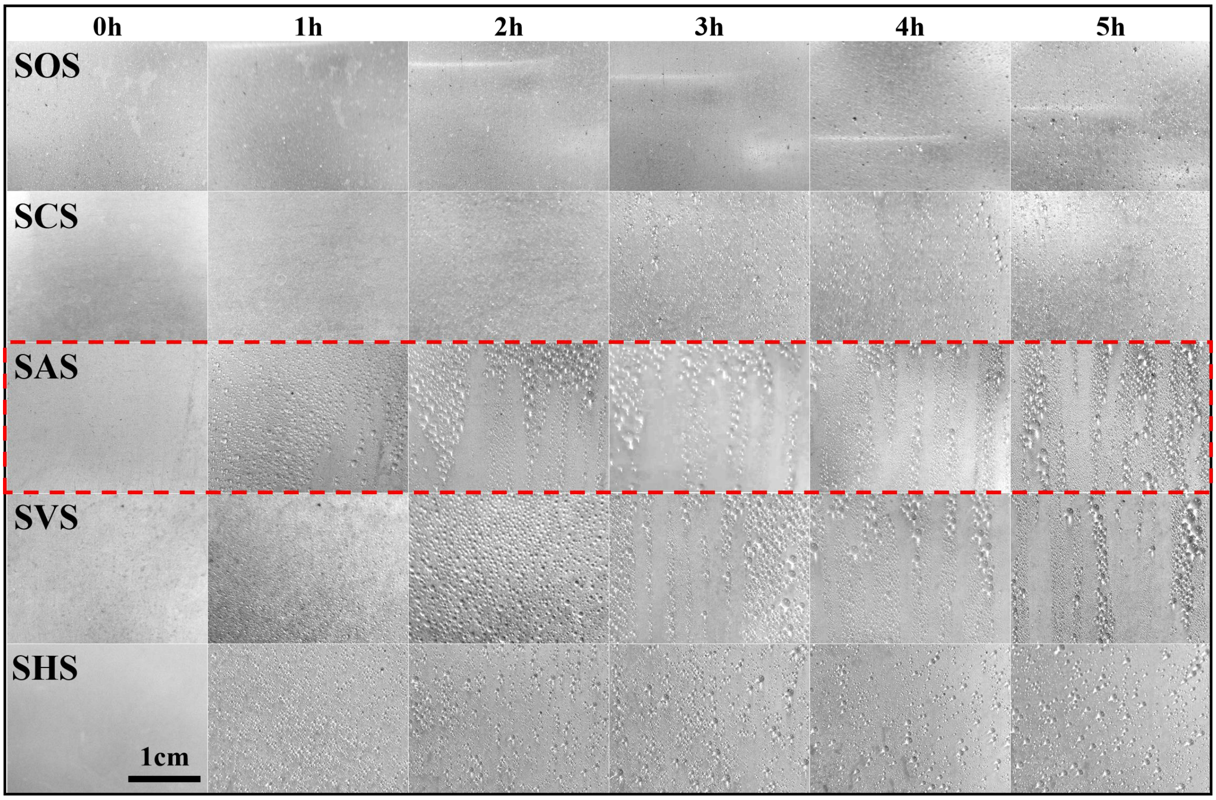


Fig. S14. Pictures of water collection surface at different time points. These pictures show that when the fog hits the water collection surfaces, the number of water droplets formed on the surface of sample SAS was the most, and followed by that on the surface of sample SVS, and the number of water droplets formed on the surface of sample SOS was the lowest. Therefore, the addition of SiC particles can promote the formation of water droplets in fog, and when the SiC particles are wrapped by hydrophilic polymer, the water collection surface is more capable of harvesting fog to form water droplets.

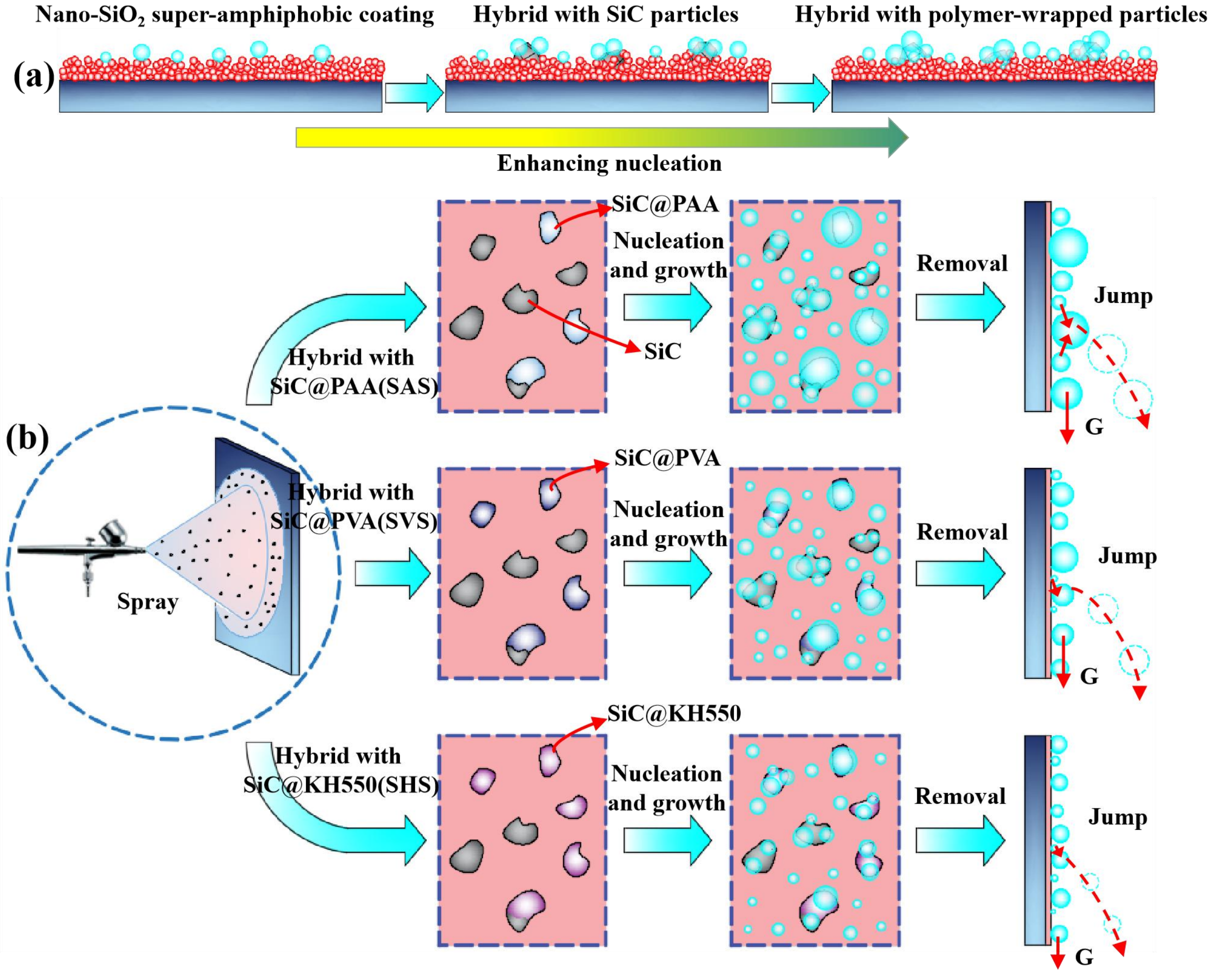


Fig. S15. Illustration of the principle for enhancing nucleation and drop removal for SAS, SVS and SHS. (a) Shows that the chained nano-SiO$_2$ superamphiphobic hybrid with SiC and SiC@polymer particles is beneficial to enhance the droplets nucleation, and the wrapped particles have the better nucleation effect. (b) Explains that the nucleation effect of SAS is better than SVS and SHS due to the mole number of the hydrophilic group -OH.

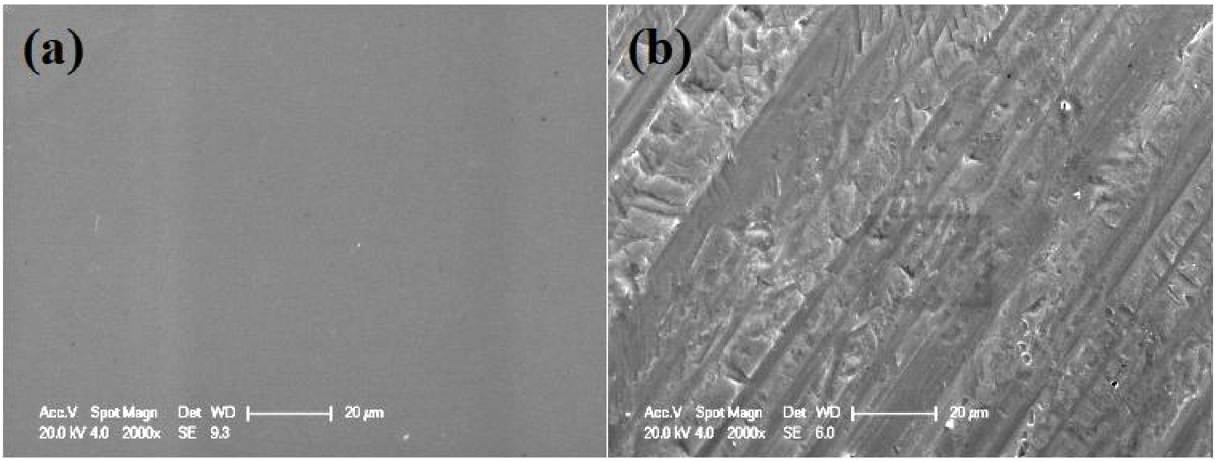


Fig. S16. SEM surface morphology of glass and aluminum sheet. (a) The smooth surface of glass. (b) The roughened surface of aluminum sheet, and its roughness is about 240 μm.

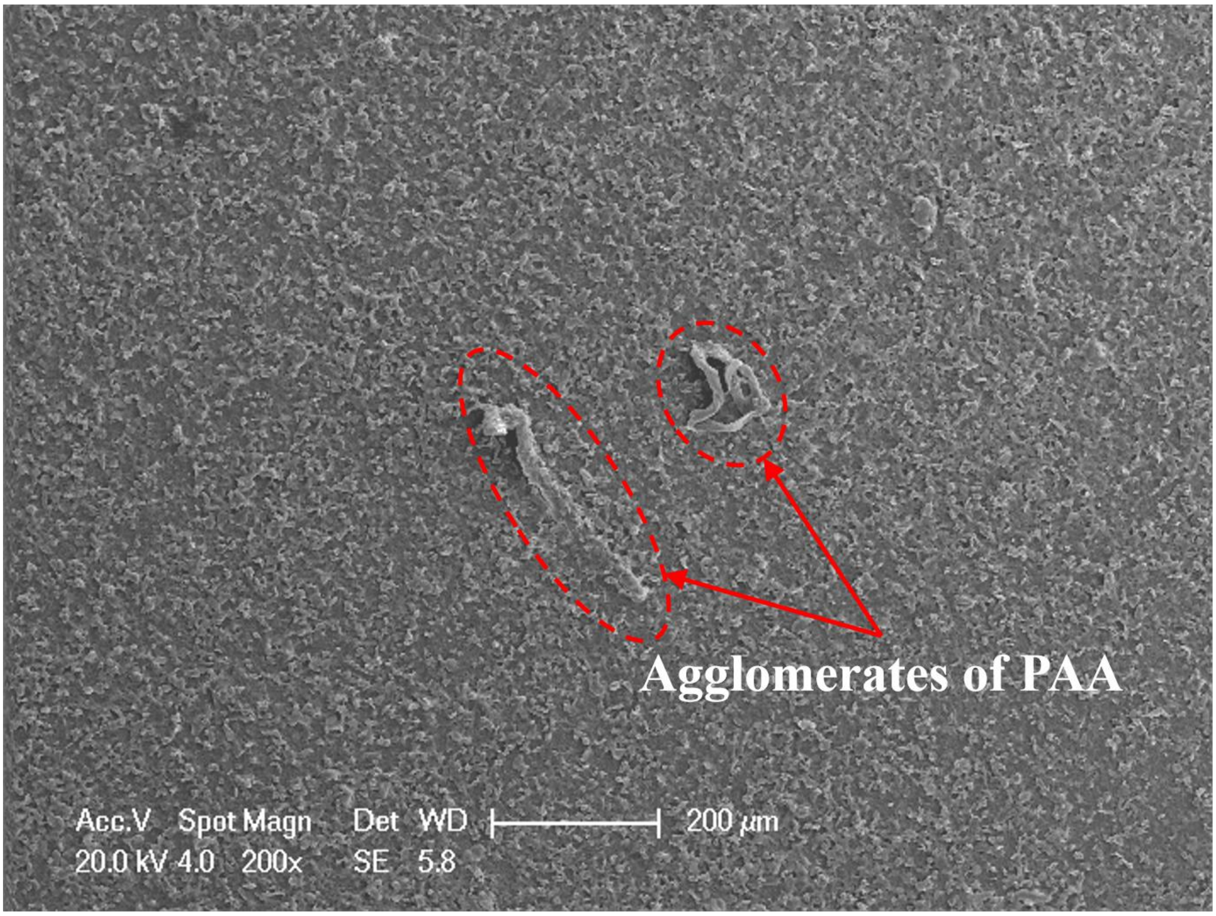
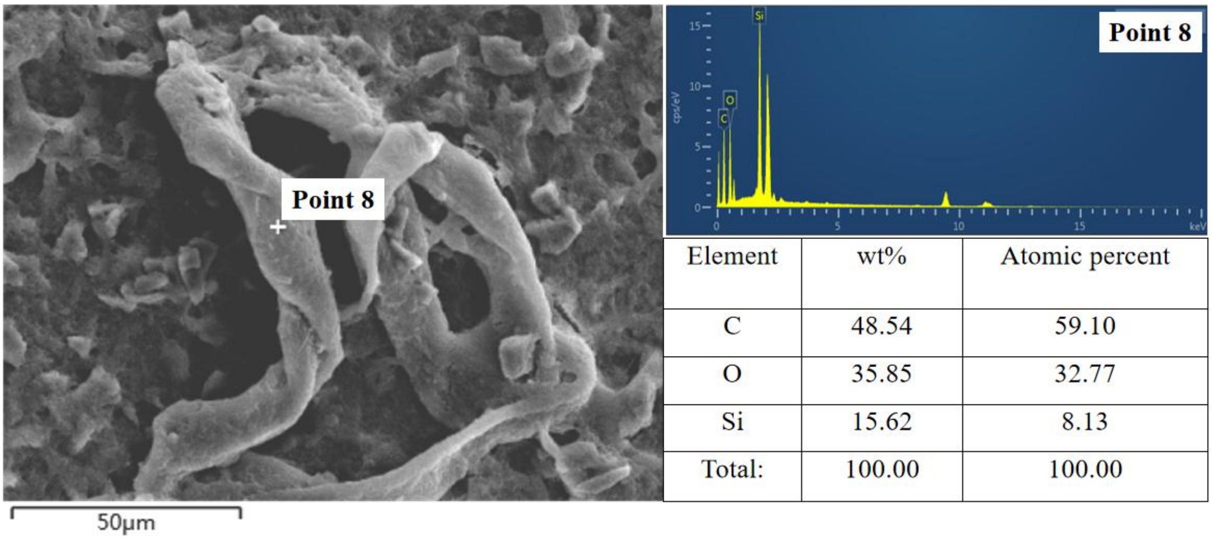


Fig. S17. Agglomerates of PAA.



Element	wt%	Atomic percent
C	48.54	59.10
O	35.85	32.77
Si	15.62	8.13
Total:	100.00	100.00

Fig. S18. Agglomerates of PAA and its element composition.

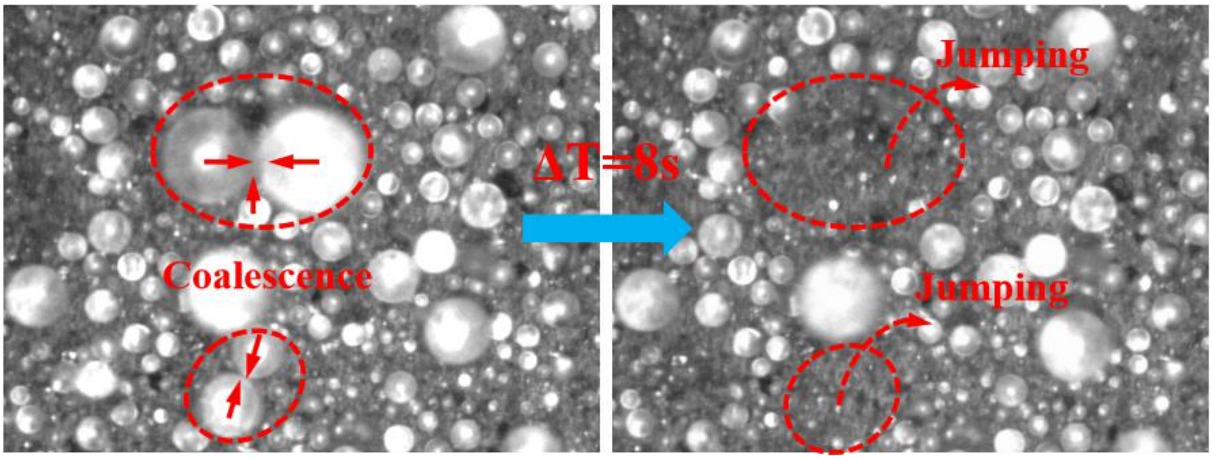


Fig. S19. Top view of droplets coalescence and jumping on SAS.

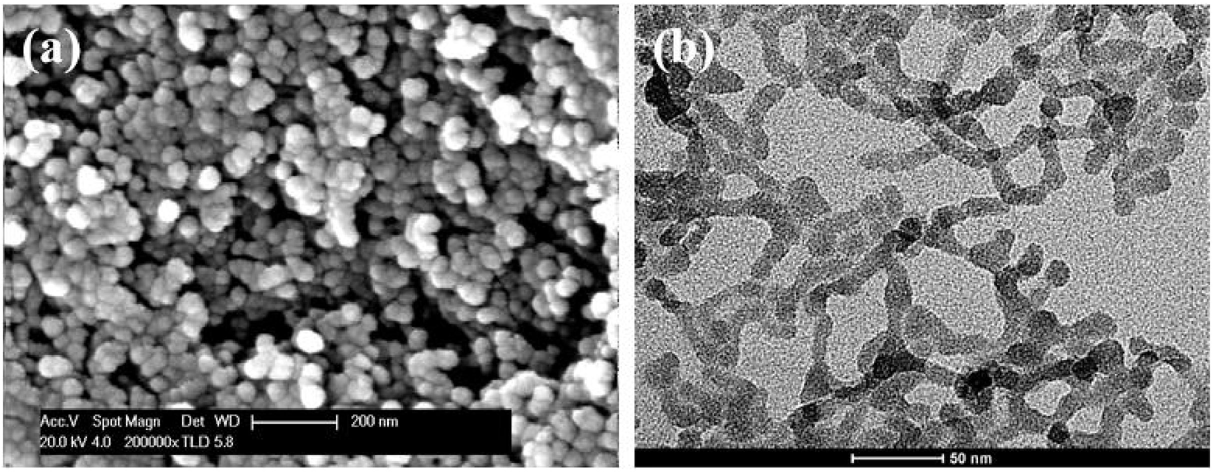
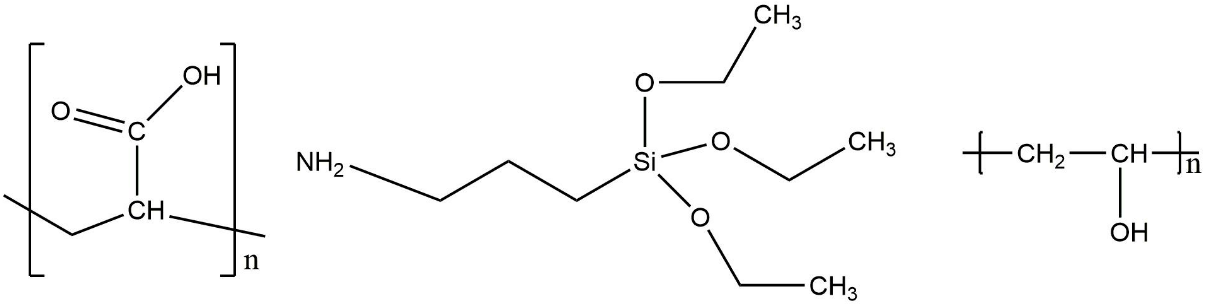


Fig. S20. (a) SEM image of the chained nano-SiO_2 particles. (b) TEM image of the chained nano-SiO_2 particles. The particle diameter is 10～20 nm.



PAA KH550 PVA

Fig. S21. Molecular structures of PAA, KH550 and PVA. The molecular weight of PAA, KH550 and PVA is 72.06, 221.37 and 44.05, respectively.

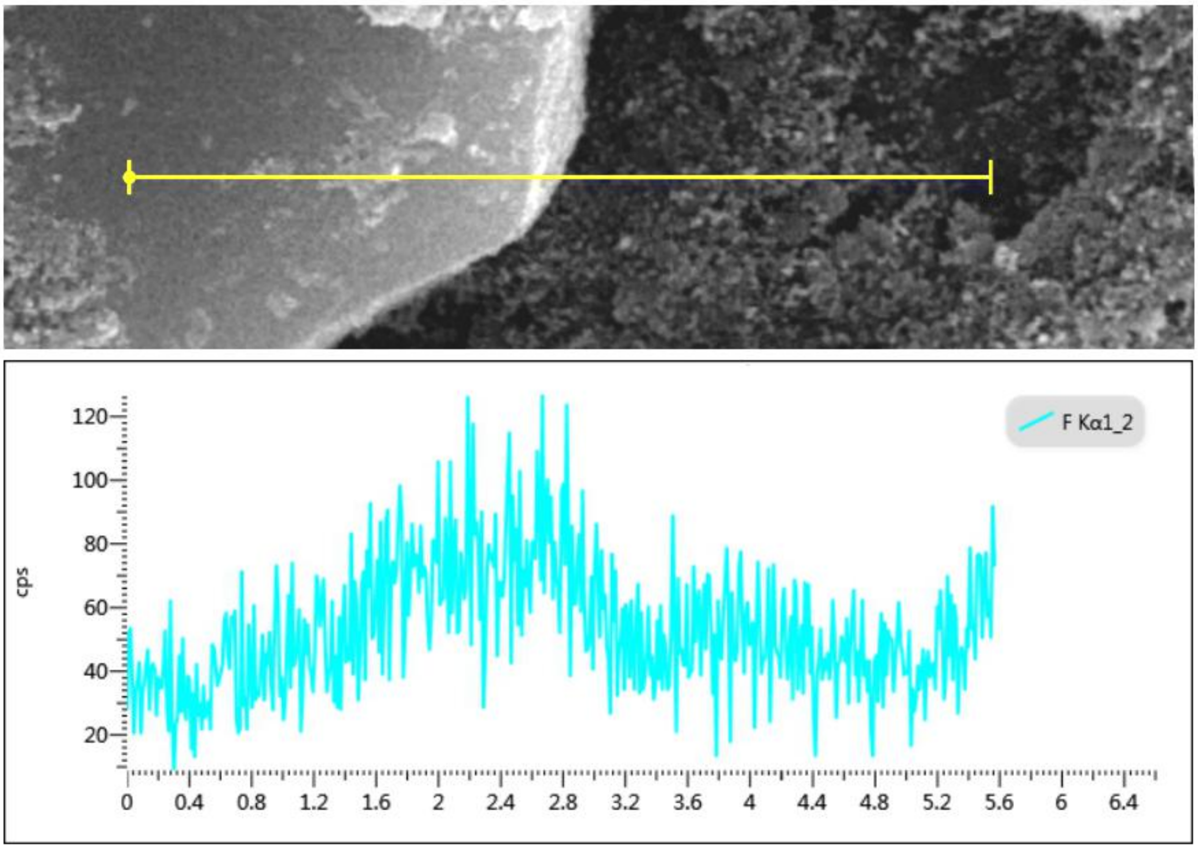


Fig. S22. Linear distribution for the chemical element of F on SAS. In this image, SiC@PAA particles are shown on the left side of the image, and the nano-SiO_2 superamphiphobic coating on the right side. In this work, nano-SiO_2 particles are modified with PFDTES, and there exist a monolayer of PFDTES covered on the surfaces of nano-SiO_2 particles. Therefore, the result shows that there are some nano- SiO_2 particles covered on the surface of SiC@PAA microparticles.

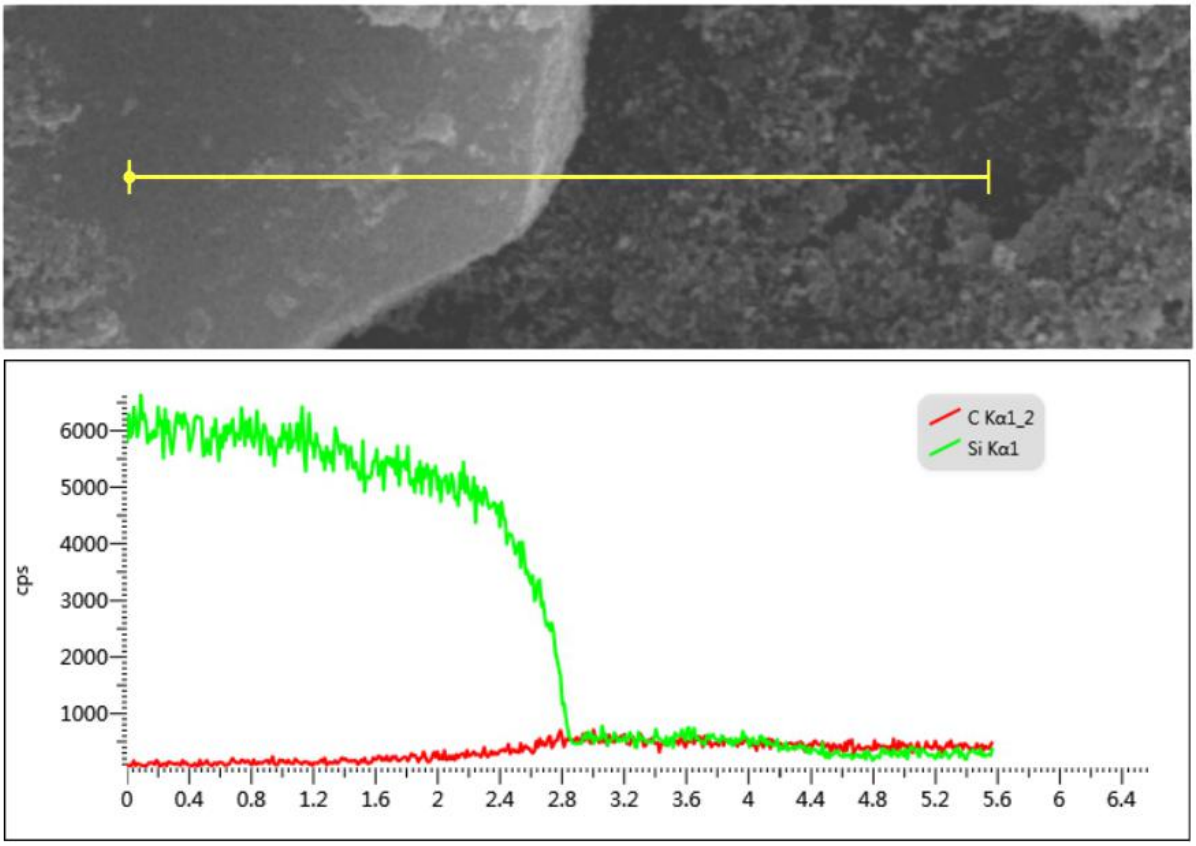


Fig. S23. Linear distribution for the chemical element of C and Si on SAS.

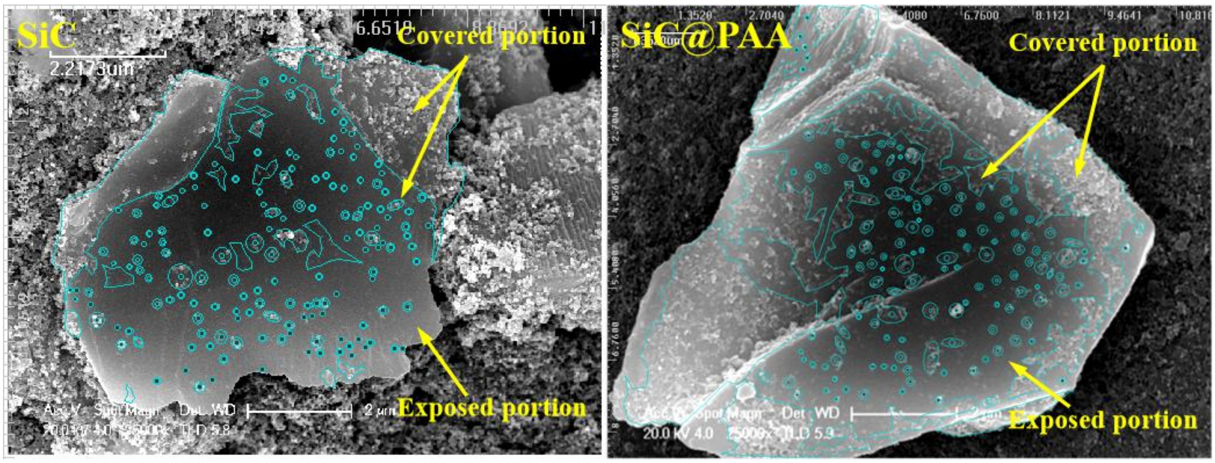


Fig. S24. Percentage statistics for exposed portion of SiC and SiC@PAA particles. In this figure, the selected regions in the cyan wireframe are the covered portion, and the other regions are the exposed portion. For SiC particle, the visible particle surface area we measured is ～40.59 μm^2, the coating coverage area is ～14.59 μm^2, and the calculated coverage rate is ～35.94%. Then, the percentage for the exposed portion of SiC particle is ～64.06%. For SiC@PAA particles, the visible particle surface area we measured is ～57.42 μm^2, the coating coverage area is ～28.03 μm^2, and the calculated coverage rate is ～48.82%. Then, the percentage for the exposed portion of SiC@PAA particle is ～51.12%.

In this work, we selected the covered portions of SiC/SiC@PAA particle, and these regions are named A_1, A_2 and A_3 ······A_i. Then, the sum of the covered areas (A_s) could be described as:

$$A_s = \sum_{i \geq 1} A_i$$

Furthermore, the visible particle surface area is named A_p, and the coverage rate (R_m) can be described as:

$$R_m = \frac{\sum_{i \geq 1} A_i}{A_p} \times 100\%$$

Then, the percentage of exposed portion (R_e) for SiC/SiC@PAA particle is described as:

$$R_e = 1 - R_m$$

Supporting Movies:

Movie S1: Shows the water/oil self-cleaning property of SAS
Movie S2: Shows the self-induced jump phenomenon of SOS
Movie S3: Shows the self-induced jump phenomenon of SCS
Movie S4: Shows the self-induced jump phenomenon of SAS
Movie S5: Shows the self-induced jump phenomenon of SVS
Movie S6: Shows the self-induced jump phenomenon of SHS
Movie S7: Shows the superhydrophilicity of PAA