Electronic Supplementary Information (ESI)

Superhydrophobic solar selective absorber used in flat plate solar collector

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Flat plate solar collector: Solar collector is a device that absorbs thermal energy from the sunlight and converts it into usable heat. As one of the most common solar collectors, flat plate solar collector mainly consist of solar selective absorber (SSA), glass cover, thermal insulation board, copper pipe and backboard. Figure S1 is the structural diagram of flat plate solar collector. As the core part of solar collector, SSA possesses the characteristic of high absorptivity for solar radiation and low emissivity for thermal infrared radiation.

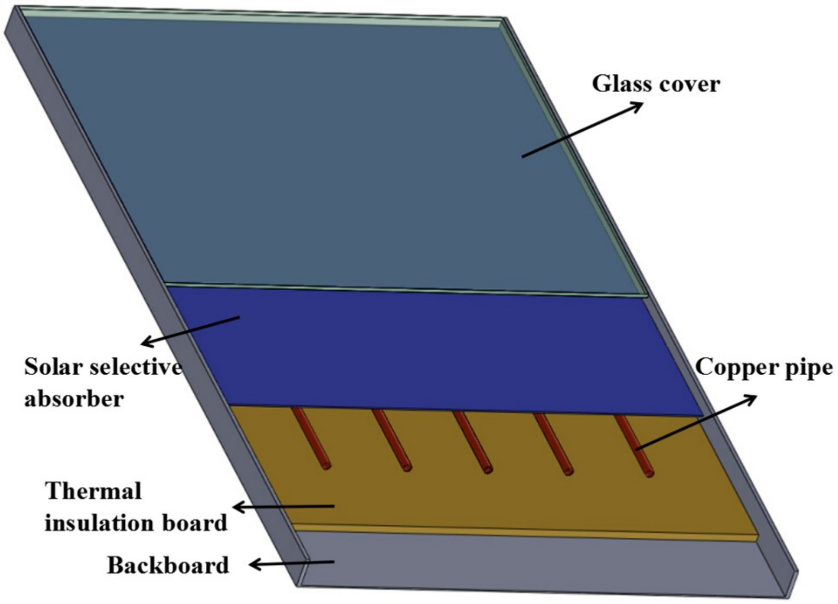

Figure S1 Structural diagram of flat plate solar collector

Fabrication of coatings with different sizes of SiO_2 nanospheres: Tetraethoxysilane (TEOS) was added into absolute ethanol, and ammonia solution (NH_4OH, 30 wt%) was added into absolute ethanol, followed by ultrasonic oscillation for 10 min to obtain two kinds of even solutions. Mixed the two kinds of solutions into a sealed flask and stirred in 50 ^oC constant temperature water bath for about 1 h to form SiO_2 collosol. Then the SiO_2 collosol was poured into a beaker and stirred in opening state at the room temperature until the ammonia was exhausted. 1H, 1H, 2H, 2H-perfluorooctyltriethoxysilane which has low surface energy was added into the SiO_2 collosol with a mass fraction of 1% and stirred for about 2 h in sealed state at the room temperature, then the SH SiO_2 collosol was obtained. Finally, the SH SiO_2 collosol was coated on the SSA by dip-coating, spraying or spin-coating and dried in air for at least 2 min, and the self-cleaning SSA was obtained.

The volume percents of the TEOS and ammonia solution to obtain different sizes of SiO_2

nanospheres under different temperatures are present in Table S1.

Table S1 Experimental conditions for preparation different sizes SiO_2 nanopheres

SiO_2 nanosphere/nm	TEOS/%Vol	Ammonia solution/%Vol	Temperature/^oC
80	5.83	5.83	Room temperature
100	4.08	7.19	50
150	4.08	7.19	30
300	3.45	10.3	Room temperature

Scanning electron microscope (SEM): In the paper, the different SiO_2 collosols have been coated on the glass substrate by dip-coating method using the self-developed vertical lift coating machine. The soaking time is 1 min, the pulling speed is 2 cm/min, and the drying time is about 2 min after pulling. A Hitachi S-4800 SEM was used to acquire surface images at an accelerating voltage of 2 kV. The SEM images of different sizes SiO_2 nanoparticles corresponding to table S1 are shown in Figure S2.

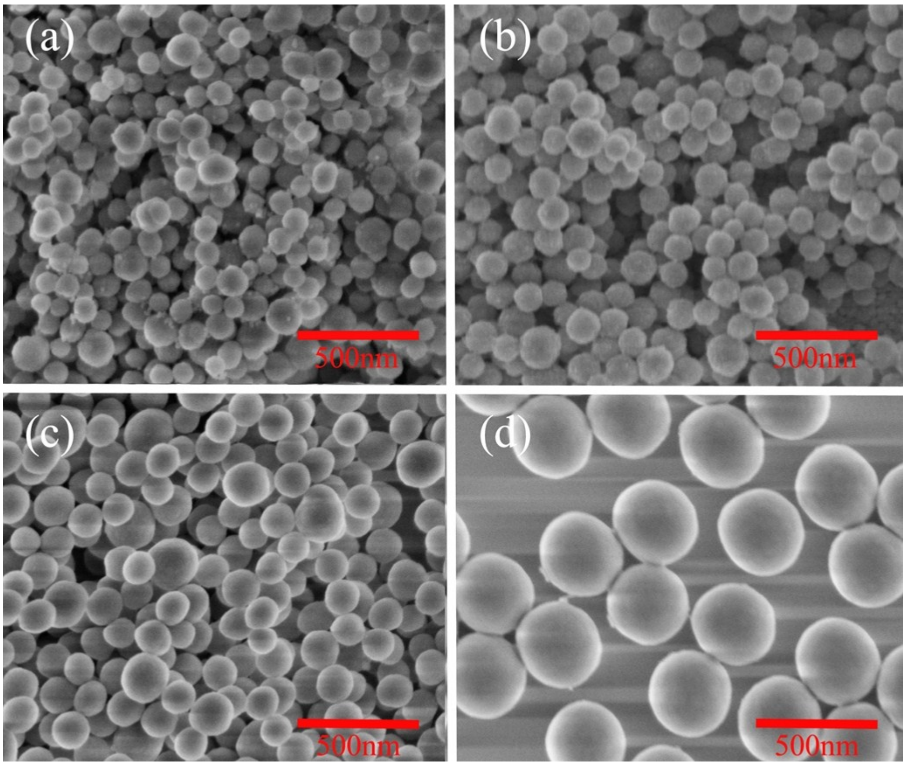

Figure S2 SEM images of SiO_2 nanoparticles with the sizes of (a) 80 nm, (b) 100 nm, (c) 150 nm and (d) 300 nm

Water contact angle: The water contact angles are measured at ambient temperature via the sessile-drop method using an optical contact angle meter (Dataphysics OCA 20LHT, water droplet is 5 μL). Water contact angles of SiO_2 Sol with different sizes corresponding to figure S2 are shown in Figure S3. The water contact angles of the coatings with 80 nm and 100 nm SiO_2 nanospheres are 156^o and 157^o respectively, which are both superhydrophobic. The water contact angles of the coating with 150 nm and 300 nm SiO_2 nanospheres are 147^o and 96^o, which are hydrophobic. The different wettabilities are affected by the surface morphology of the coatings. From the figure S2(d), we can see that the SiO_2 nanospheres are almost flat on the surface of the glass, and it has not covered the glass in some places. Therefore, the coating with 300 nm SiO_2 nanospheres doesn't construct the same roughness structure as other sizes and it can't form superhydrophobic state.

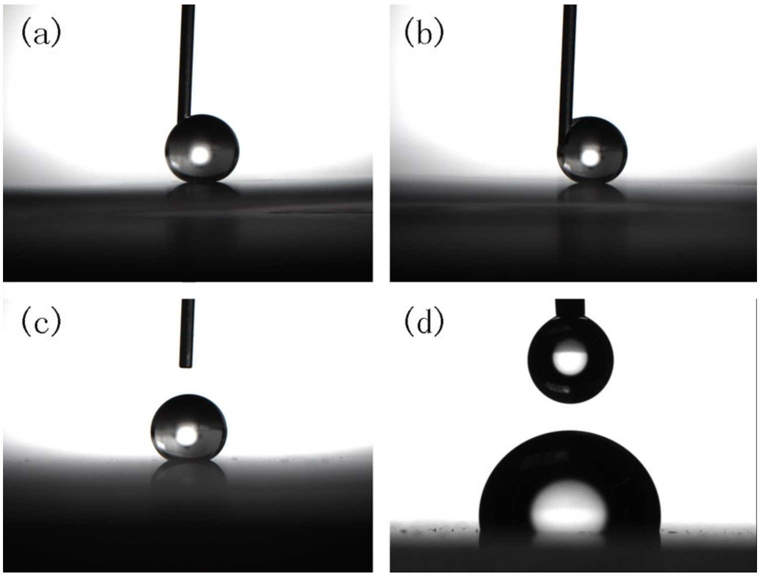

Figure S3 Water contact angles of SiO_2 Sol with the sizes of (a) 80 nm, (b) 100 nm, (c) 150 nm and (d) 300 nm

Coating methods: The superhydrophobic surface can be formed by dip-coating, spraying or spin-coating methods. And also the different morphologies of the coatings can be obtained by different coating methods. In order to compare the different morphologies, the coatings was made by dip-coating, spraying and spin-coating method. The dip-coating process is the same as the above description. The spraying used pump sprayer was worked under 0.2 Mpa pressure with the 15 cm distance from the substrate. Spin-coating was carried out at 2000 rpm for 45 seconds. Figure S4 shows SEM images of SiO_2 coatings formed by the three methods. It can be seen that there are some different in the SEM images. Coating formed by dip-coating method has relatively rough structure made by random distributions of nanospheres. Coating formed by spraying method is relatively thick, which is mainly affected by the spraying conditions. Coating formed by spin-coating method produces uneven thickness in the middle and edge. In addition, the morphologies of coatings change with the different preparation conditions.

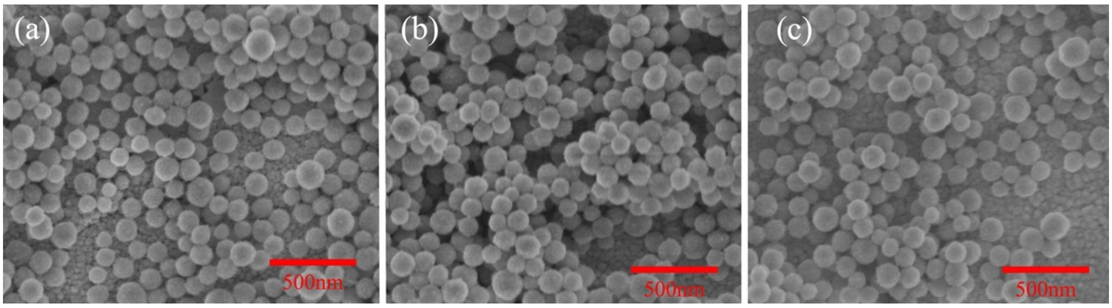

Figure S4 SEM images of SiO_2 coatings formed by (a) dip-coating, (b) spraying and (c) spin-coating method

Sandwich structure of "substrate + adhesive + coating": In order to improve the mechanical properties of coatings, we have propose the sandwich structure of "substrate + adhesive +coating" which can connect coating and substrate effectively by adhesive. Figure S5 shows schematic diagram of the sandwich structure. The SSA was coated with organosilicon and superhydrophobic coating sequentially, then the sample with the sandwich structure which has good superhydrophobic property was obtained.

Figure S5 Schematic diagram of the sandwich structure

In order to test the mechanical property of this structure, the tape peeling test and sandpaper abrasion test have been carried out. The processes of tests were the same as the reference 1. Figure S6 show water contact angles of the samples with sandwich structure after tape peeling tests and sandpaper abrasion tests respectively. From the Figure S6 (a), it can be seen that after five times of tape peeling tests the water contact angles of the sample can still be 150°. From the Figure S6 (b), it can be seen that the water contact angles of the sample change from 156° to 150° after five abrasion cycles, which indicates that the sample maintains superhydrophobic property. The results show that the introduction of organosilicon improves the adhesion and abrasion resistance of the coatings to some extent.

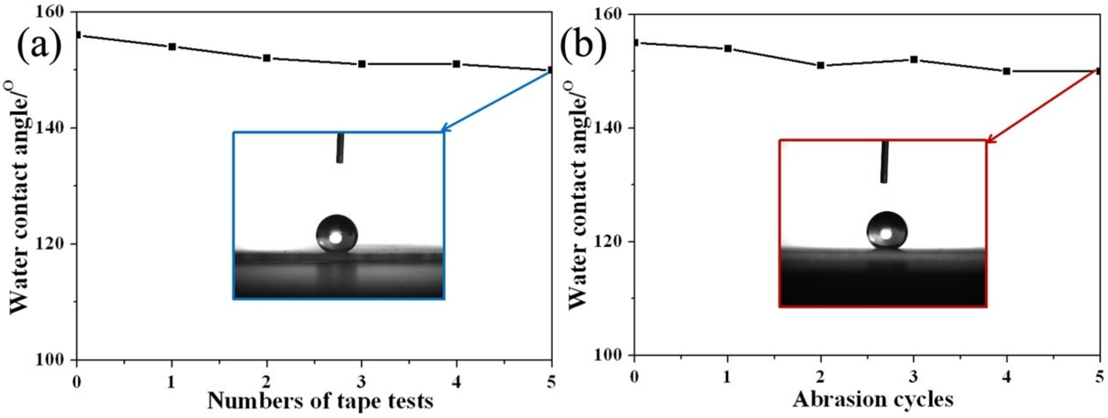

Figure S6 Water contact angles of the samples with sandwich structure after (a) tape peeling tests and (b) sandpaper abrasion tests

1. Y. Zhu, J. Shi, Q. Huang, L. Wang and G. Xu, *Chem. Commun.*, 2017, **53**, 2363-2366.