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Supporting Information

Robust and antireflective superhydrophobic surfaces prepared by CVD of cured polydimethylsiloxane with candle soot as a template

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Experimental section

Materials

Commercial used wax and cotton thread were employed to fabricate candles. 7101 slides (25.4 mm × 76 mm × 1.2 mm), whose water contact angle (WCA) was 5.5±0.5° were used as substrates. α, ω- dihydroxypolydimethylsiloxane (Sylgard 107) with a viscosity of 20 000 cps was purchased from Jiangxi Xinghuo Organic Silicone Plant (China). Triacetoxy(methyl)silane was obtained from Aladdin Industrial Corporation (Shanghai, China). Hydrochloric acid (HCl) and Dibutyltindilaurate (DBTDL) was obtained from Shanghai Lingfeng Chemical Reagent CO., LTD (China). Sodium hydroxide (NaOH) was obtained from Nanjing Chemical Reagent CO., LTD (China). Ethanol and n-hexane were got from Wuxi Yasheng Chemical Co., LTD (China). All of the reagents were used as received. The water in this experiment was high pure with a resistivity of 18.25 $M\Omega\cdot cm^{-1}$.

Methods

The cured polydimethylsiloxane (PDMS) was created through mixing triacetoxy(methyl)silane, α, ω- dihydroxypolydimethylsiloxane and dibutyltin dilaurate (DBTDL), in which DBTDL was adopted as a catalyst to accelerate the curing reaction. The mass ratio of α, ω-dihydroxypolydimethylsiloxane, triacetoxy(methyl)silane and DBTDL was 50: 10: 3 and the mixture was stirred and poured into a petri dish. The curing process was at room temperature in air for more than 48 h.

An experimental CVD reaction chamber with an inner diameter of 100 mm and a height of 100 mm was made from stainless steel 304. On the cover of the reaction chamber, a hole with a diameter of 5 mm was created for air in and out. This chamber was put into a muffle furnace that provided heat for CVD reaction. In a typical preparation process of superhydrophobic surfaces, the gap between the substrate and the bottom was 75 mm. Before used in the CVD process, the cured PDMS was cut into small ones with each mass of about 2 mg. The PDMS after a curing reaction was put on the bottom of the reaction chamber and the substrate was put above the bottom in the chamber horizontally with the soot side down. The glass slide was moved horizontally through the middle of the candle flame to obtain soot template. The heat treatment included a heating speed of 5 °C/min and holding time for 80 min. Later, the samples were cooled to room temperature. After CVD process, the substrate was carefully rinsed with water to remove large aggregates that were weakly attached on the surface.

Characterization

Static WCA (5 μL Milli-Q water droplet) and sliding angles (SA) (12.5 μL Milli-Q water droplet) were measured with the JC2000CS measuring instrument equipped with a CCD camera at room temperature. Thermogravimetry/Differential Scanning Calorimetry (TG/DSC) was performed with a thermal analysis system (PERKIN-ELMER, USA) and the samples were heated from room temperature to 800 °C at a heating rate of 10 °C·min^{-1} in air with a gas flow rate of 20 mL·min^{-1}. The morphologies of the as-prepared samples and EDS spectra were investigated by field emission scanning electron microscopy (FE-SEM, Hitachi, S-4800) equipped with EDS unit. Fourier Transform Infrared Spectroscopy (FT-IR) measurements of the samples were carried out on a FT-IR spectrometer (Nicolet Nexus 670) in air. The transmittance of the samples was measured on a UV-VIS-NIR spectrophotometer (UV-3600, SHIMADZU). Before transmittance measurement, the upper sides of the slides were rinsed with alcohol.

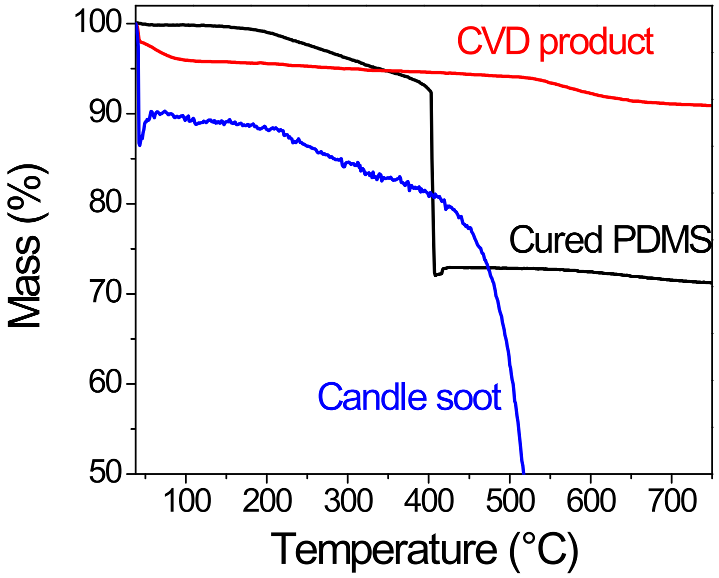

Fig. S1. TG curves of the CVD product, cured PDMS and candle soot.

It is observed that cured PDMS has completely decomposed when the temperature is 400 °C. The CVD product decomposes at a temperature about 535 °C, which is more thermally stable than the candle soot that can be oxidized when the temperature is higher than 400 °C.

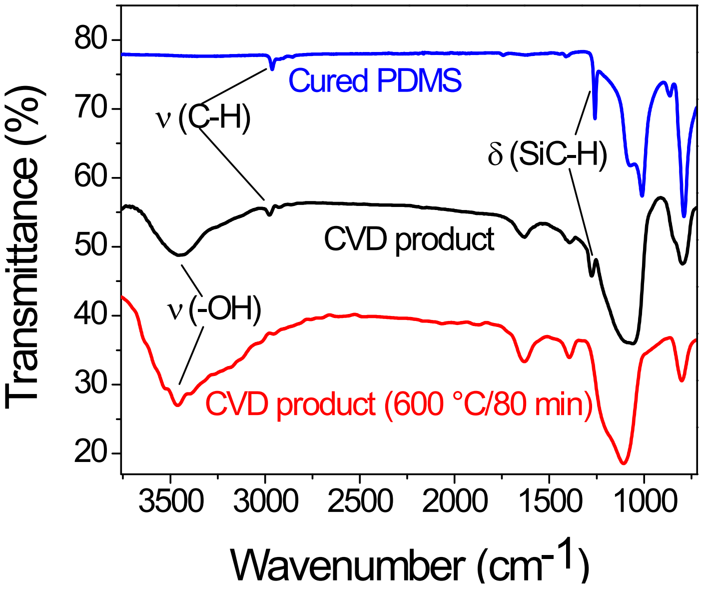

Fig. S2. FT-IR of the cured PDMS, CVD product and the CVD product after 600 °C treatment for 80 min.

It is observed that alkyl groups are attached to the CVD product and provide low surface energy for the CVD product. After heat treatment at 600 °C for 80 min, the alkyl groups have been oxidized.

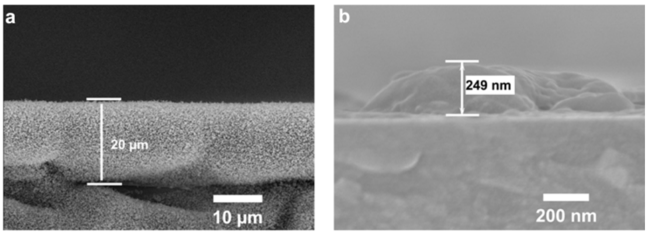

Fig. S3. SEM images of the cross section for the candle soot substrates and the superhydrophobic surfaces prepared with 7.2 mg PDMS.

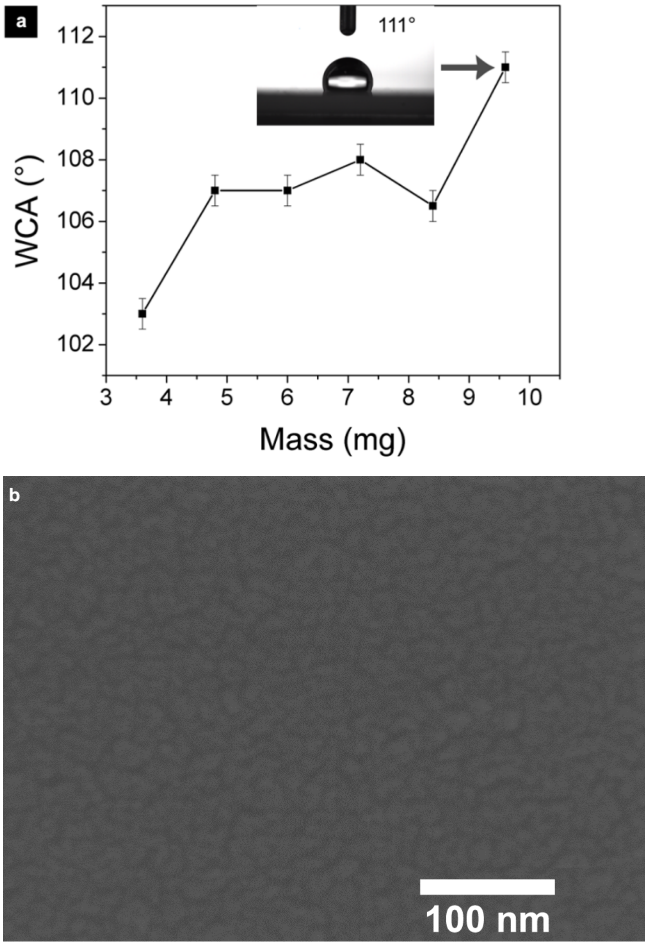

Fig. S4. (a) WCA of the bare glass slides after CVD of different amount of cured PDMS at 405 °C. (b) SEM image of the bare glass slide without candle soot after CVD of 7.2 mg PDMS.

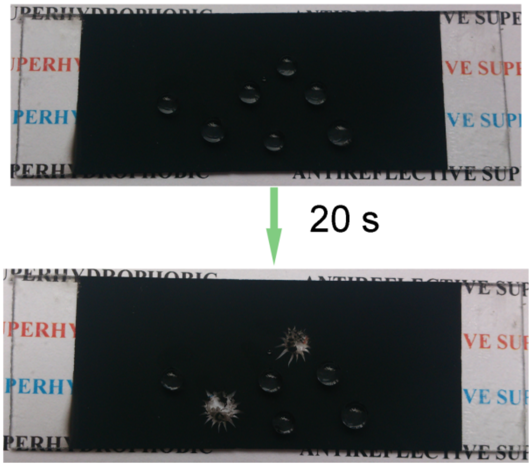

Fig. S5. Water droplets on substrates with candle soot. After placement for 20 s, the substrates are damaged.

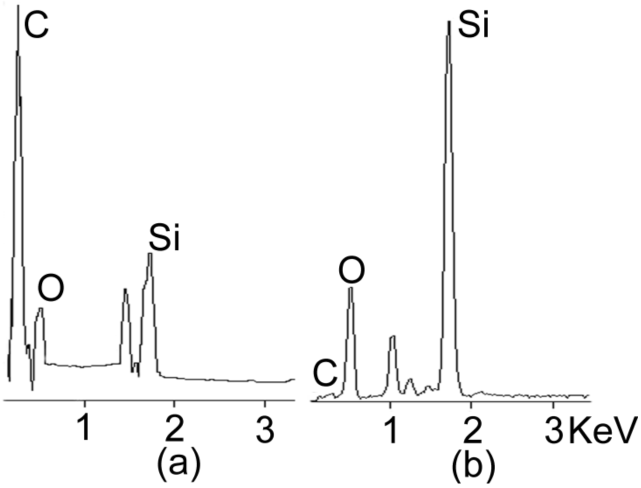

Fig. S6. EDS spectra of the candle soot after CVD of cured PDMS at 370 °C (a) and 405 °C (b).

The mass ratio of element: C/Si is 20.48 for a) and 0.32 for b), respectively. This result indicates that at 370 °C, part of unoxidized candle soot existed accompanied by the CVD particles and the candle soot has been oxidized after heat treatment at 405 °C.

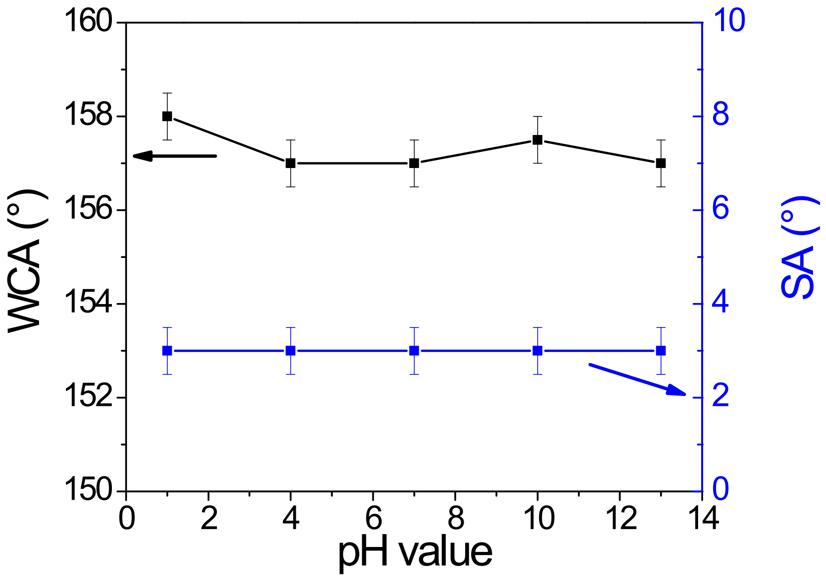

Fig. S7. The dependence of the WCA on the aqueous solutions of different pH values.

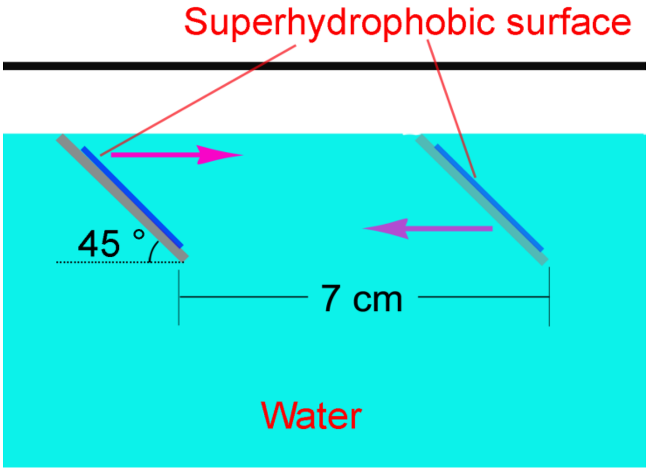

Fig. S8. Sketch of the pushing and pulling test of the superhydrophobic substrates in water.

Movie S1. After CVD at 370 °C, the adhesive force of the surfaces was enhanced and the superhydrophobicity could be kept even after the soot was removed by water.

Movie S2. The dyed water droplets were bounced off upon contacting the surfaces.