Supplementary Information

Materials

PTFE nanoparticles with average diameters of 100 nm were offered by 3M Co. Ltd. (USA). T300 carbon fiber plain clothes were supplied by Toray Co. Ltd. (Japan). Carbon fiber felt with an area density of 10 g/m^2 was purchased from Conmat Composite Factory. Basic hydrochloric acid (HCl), sulfuric acid (H_2SO_4), sodium hydroxide (NaOH) and acetic ether (AC) were purchased from aladdin Co. Ltd. (China). Epoxy (E-51) was purchased Yueyang Baling Petrochemical Company. 4,4-Diaminodiphenyl methane (DDM) was provided by Shanghai SSS Reagent Co. Ltd. (China). Multiwall carbon nano-tubes were offered by Time Nano Co. Ltd. (China).

Tensile test

The tensile strength and modulus of the CB/CeO_2/PVDF/CF superhydrophobic CFRP samples were tested according to GB/T 3354-2014 standard. The nominal sizes of the test specimens were 250 mm × 25 mm × h mm, with h being the composite thickness. The test was carried out by universal testing machine with a tensile speed of 2mm/min. Tensile strength is calculated by：

$$\sigma_t = P/(\mathrm{b} \cdot \mathrm{h})$$

With P denoting the maximum load, b the width of specimen and h the thickness of specimen.

As for tensile modulus:

$$E_t = (\mathrm{L_0} \times \Delta P)/(\mathrm{b} \times \mathrm{h} \times \Delta L)$$

With ΔP denoting the change of load, $\mathrm{L_0}$ the scale distance and ΔL the elongation of the specimens.

Conductivity

Body conductivity was tested by cutting the nanocomposites into 30 mm × 30 mm square specimens (as shown in Figure S1), and two across flats were covered with a thin layer of conductive silver adhesive. Then, copper wires were fastened at the middle point of the silver adhesive covered slats. After that, the specimen was processed with 120°C for 2h to cure the adhesive. Subsequently, digital source table (Keithley 2450 Sourcemeter) was utilized to measure conductivity by connecting electrodes with copper wires.

Four probes tester (RTS-8, 4 probes tech Co. Ltd.) was used to measure the surface electrical conductivity of the composite samples, cut to round shapes with a 10 mm radius. 5 different points were tested for each sample.

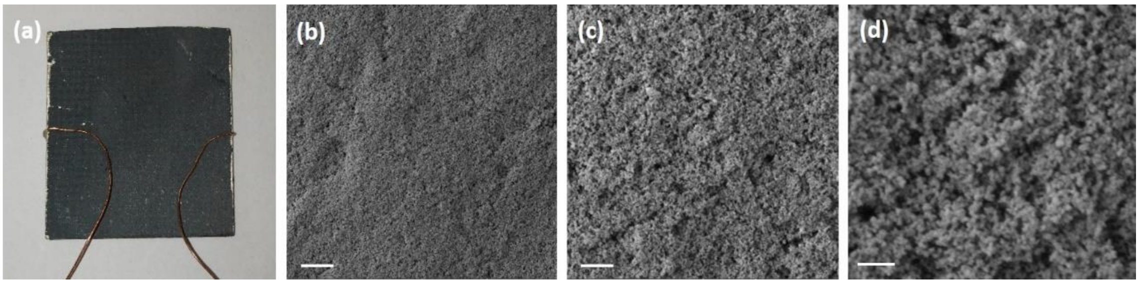

Fig. S1 (a) Picture of prepared sample to test body conductivity. (b-d) are SEM images of Never-Wet coating. Scale bars are 25μm for (b), 1μm for (c) and 500nm for (d).

Never-Wet coating

Never-Wet coating is a commercial product of Ross Nanotechnologies. The coating was prepared in following steps: first, a piece of smooth aluminum flake was cleaned and dried; then, the base coating of Never-Wet coating was sprayed to flake surface. After dried in ambient temperature for 30min, top coating was sprayed on the base coating.

After another placement of 30min, the prepared coating can be utilized to processing different tests. The morphology of the coating is shown in Figure S1, the surface is mainly made up of particles with a size of ~60nm. The nanoparticles uniformly distributed on the surface, and constructed nanoscale rough structures, which is pivotal for superhydrophobicity of the coating.

Mechanical stability tests

Fig. S2 shows the two kinds of mechanical stability tests employed: sandpaper abrasion test and tape peeling test. In the sandpaper abrasion test, a square sandpaper with 600 meshes was employed as an abradant to closely contact the surface. The abradant was driven to move along the surface with a load of 500g on it (Supplementary Fig. S2a and movie S1). A strong bonding tape (VHB 4910, 3M) was used to test the coatings adhesion. The tape was applied by rolling a 2 kg steel roller on the tape once (Supplementary Fig. S2c and movie S2). The process was repeated with contact angle and sliding angle measurements following each cycle. A fresh piece of tape was used for every five peel off cycles.

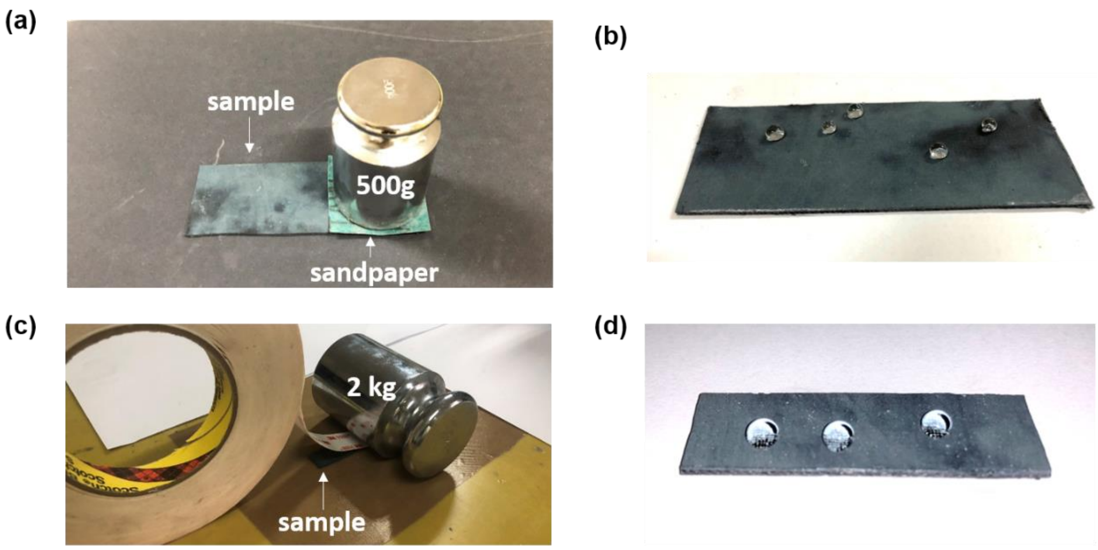

Fig. S2 Tests to access mechanical robustness of the prepared samples. (a) Picture of sandpaper abrasion test. (b) Water drops beaded up on the surface and rolled off easily even after 30 abrasion cycles. (c) Application of a strong adhesive tape on to the nanocomposites. (d) Water drops beaded up on the surface after 30 tape peel cycles

Drop impact test

For testing liquid impalement resistance of the both superhydrophobic surfaces, we used water drop and jet impact tests. The drop impact tests were performed by releasing individual water drops (~7μL) from a certain height to enable gravitational acceleration of the drops, and thus achieve different impact speeds. Supplementary Movies S4-7 show the drop impacts at different speeds. At low speed (e.g. ~1.4 ms^{-1} in Supplementary movie S4), the impact is characterized by droplet spreading, recoil and complete bounce off from the surface. At higher speeds the impact We_l is high enough for the droplet to splash and atomize (e.g. ~6.3 ms^{-1} in Supplementary movie S7).

Water jet impact test

Maximum attainable drop speed in gravity enabled acceleration is limited by terminal velocity. Thus, for higher and longer speed liquid impact tests, we employed water jet. The setup shown schematically in Supplementary Fig. S3 was used to obtain stable and controllable water jet with high speed. A high-pressure water gun was used to force water through a nozzle with a diameter of 2.5 mm.

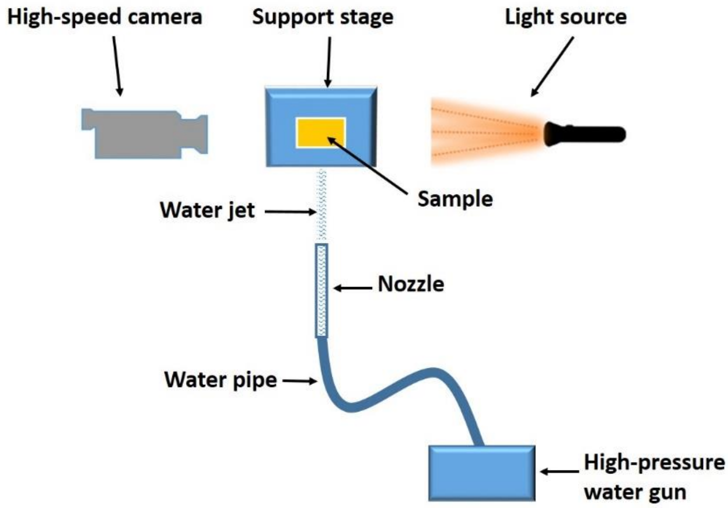

Fig. S3 Schematic of water jet impact setup.