

## Supporting Information

### Robust diamond mesh with unique wettability properties

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## Experimental Section

***Fabrication of the Superhydrophobic-Superoleophilic diamond mesh:*** The diamond meshes were fabricated in a 2.45 GHz microwave plasma CVD system on commercial copper mesh substrates. The copper meshes have square pores with sizes from 50  $\mu\text{m}$  to 350  $\mu\text{m}$ . The copper wire diameters are in the region of 50–110  $\mu\text{m}$ . To enhance the diamond nucleation, the substrate meshes were subjected to a supersonic pretreatment for 30 s in acetone mixed with a suspension of nanocrystalline diamond powder (an average grain size 200 nm). The typical deposition parameters of CVD diamond films are as follows: the flow rates of  $\text{H}_2$ ,  $\text{CH}_4$  and  $\text{O}_2$  are 295, 7, and 1 in sccm, respectively; the reaction pressure is 130 torr; the microwave power is 1.7 kW; the growth temperature is about 800  $^\circ\text{C}$ .

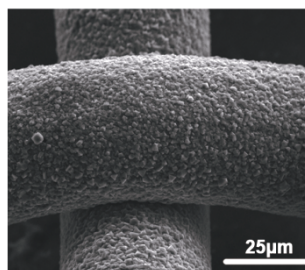
***Water-Oil Separation Experiments:*** The as-prepared superhydrophobic-superoleophilic diamond meshes sealed a glass tube with a diameter of 20 mm, and a beaker was placed beneath. The mixed water and various oils were poured onto the diamond mesh, and subsequently, the spontaneous separation occurred quickly.

***Chemical Inertness of the Diamond Mesh for Wettability:*** For the recyclability tests, the diamond mesh were immersed into 8.4 M  $\text{HNO}_3$  or 6.2 M  $\text{NaOH}$  solution for about 20 minutes, and after being washed by absolute ethanol and dried by nitrogen gas, the wettability of water for the diamond meshes was characterized by contact angle measurements. The recyclability processes were examined for more than 100 cycles. To further study the stability of superhydrophobicity of diamond mesh with time scale, the meshes were immersed in the strong acid and basic solutions for long time from hours to several days, and then were taken out for contact angle measurements.

**Instruments and Characterization:** The scanning electron microscopy (SEM) images were obtained on a scanning electron microscope (JEOL JEM-6700F at 3 KV). The Raman spectra were recorded by a Renishaw Raman system with a 514 nm laser excitation and a spectral resolution of  $\sim 2 \text{ cm}^{-1}$ . Rigaku D/max-RA X-ray diffraction (XRD) was used to analyze the crystal structure of diamond mesh. Wettability measurements were carried out by the drop shape analysis system of DSA 10 MK2, KRUSS. For the measurements, the 8  $\mu\text{L}$  water droplets with varying pH values or 10.0  $\mu\text{L}$  oil droplets were dropped onto the meshes, and the static CAs were taken from an average of data from selected three points on each sample.

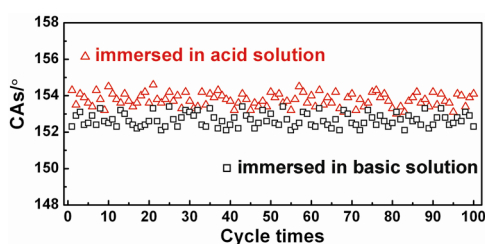
## Figures

**Fig. S1.** SEM image of two crossed copper wires of a diamond mesh fully covered with diamond film.



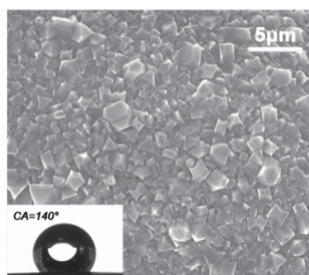
**Fig. S1**

**Fig. S2.** The recyclability test of wettability for 100 cycles for the diamond mesh repeatedly immersed in strong acid (pH=1) and basic (pH=12) solutions, respectively.



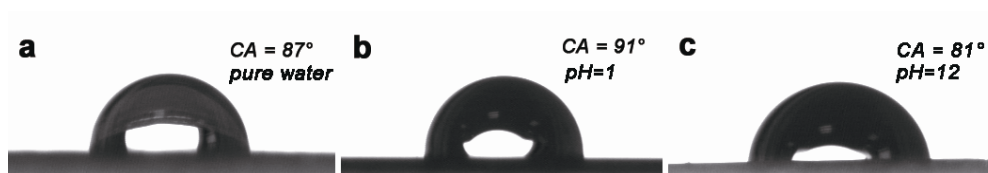
**Fig. S2**

**Fig. S3.** Surface SEM image of a diamond film with an average grain size of 1.7  $\mu\text{m}$ , covered on the copper wire. The inset shows the photograph of a water droplet on the diamond mesh surface.



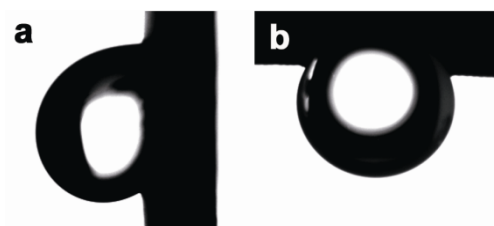
**Fig. S3**

**Fig. S4.** Photographs of water droplets with different pH values on the mechanically polished CVD diamond film substrates.



**Fig. S4**

**Fig. S5.** Photographs of a water droplet (pH=1) on a diamond mesh with different tilt angles: (a) 90°, (b) 180°.



**Fig. S5**