Electronic Supporting Information (ESI)

Porous copper surfaces with improved superhydrophobicity under oil and their application in oil separation and capture from water

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Preparation of superhydrophobic porous copper surfaces. The copper samples were treated with 1mol L^{-1} HCl aqueous solution for 10 min, followed by rinsing with deionized water to get rid of the impurities, oxide/hydroxide layer on the surface of copper substrates. The freshly cleaned copper samples were immersed into a 0.065 M $K_2S_2O_8$ and 2.5 M KOH mixed aqueous solution at 60°C for 30 min. The copper samples were then taken out from the immersion solution and washed with deionized water, and dried in air. A black film was obtained, uniformly growing on the surface of copper substrates. The as-prepared CuO-grown copper samples were then immersed in a 1.0 wt% 1H, 1H, 2H, 2H-perfluorodecyltriethoxysilane (PFTS) ethanolic solution at room temperature for 30 min. After removed from the solution, the samples were heated at 80°C for 30 min.

Instruments and Characterization. The surface scanning electron microscopy (SEM) images were recorded on a Sirion 200 FEI instrument. The specimens were sputtering-coated with gold prior to SEM imaging. X-ray diffraction (XRD) data were collected on XRD diffractometer (D8 Discover, Bruker-AXS) with $Cu_{K\alpha}$ radiation (λ = 1.54056 Å). X-ray photoelectron spectroscopy (XPS) measurements were carried out on a PHI 5000 Versa Probe UlVAC-PHI instrument with a monochromatic $Al_{K\alpha}$ X-ray source, and the spectra were referenced to the adventitious C 1s peak (284.6 eV). The sessile drop method was used for water contact angle (CA) measurements using a Dataphysics OCA15Pro contact-angle system at ambient temperature. Water droplet (3 μL) was dropped carefully onto the surface to measure static, advancing and receding CA. The average CA value was determined by measuring 5 times at different spots of the same sample. Water roll-off angle (RA) was measured under the same temperature and humidity as the static water CA measurements, and the volume of the droplet was 5 μL. The viscosities of oils were recorded on a viscometer (Brookfield DV-II+Pro).

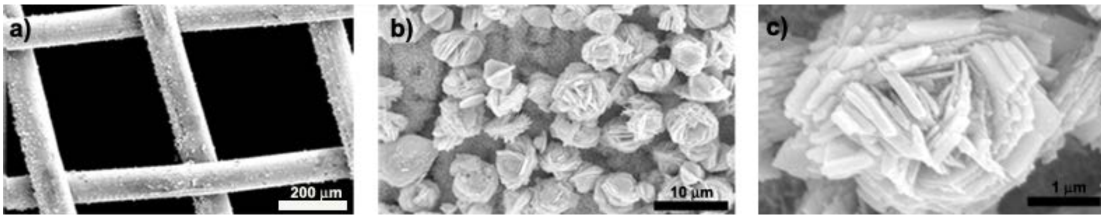

Fig. S1 SEM images of the CuO-grown copper mesh at low resolution (a), at higher resolution (b), and close-up image of an individual flower-like spherical structure (c).

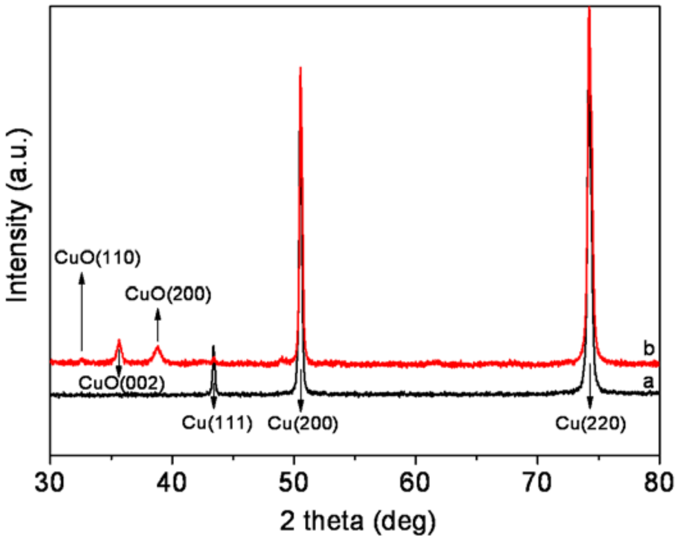

Fig. S2 XRD patterns of Cu (a) and CuO-grown Cu (b).

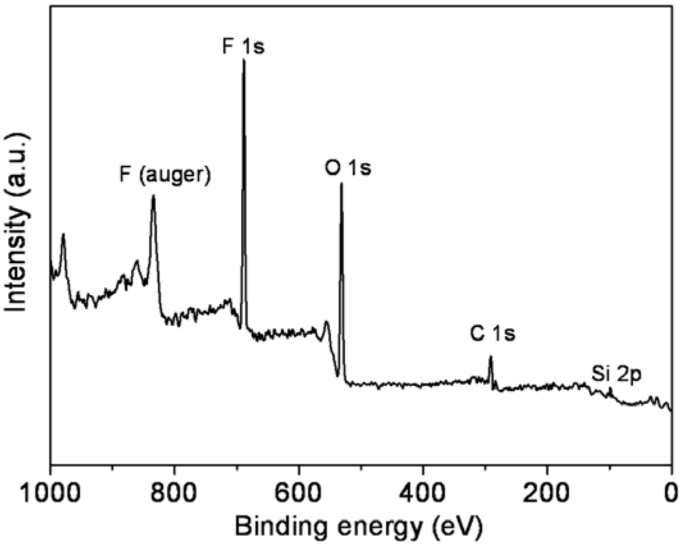

Fig. S3 XPS survey spectra for the surface of the PFTS-modified CuO-grown copper sample.

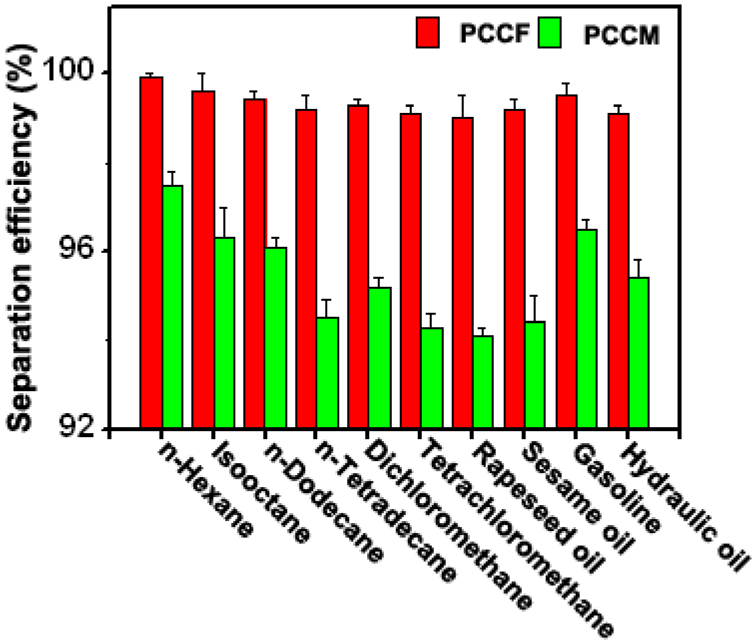

Fig. S4 The separation efficiency of PCCF and PCCM for a selection of oils.

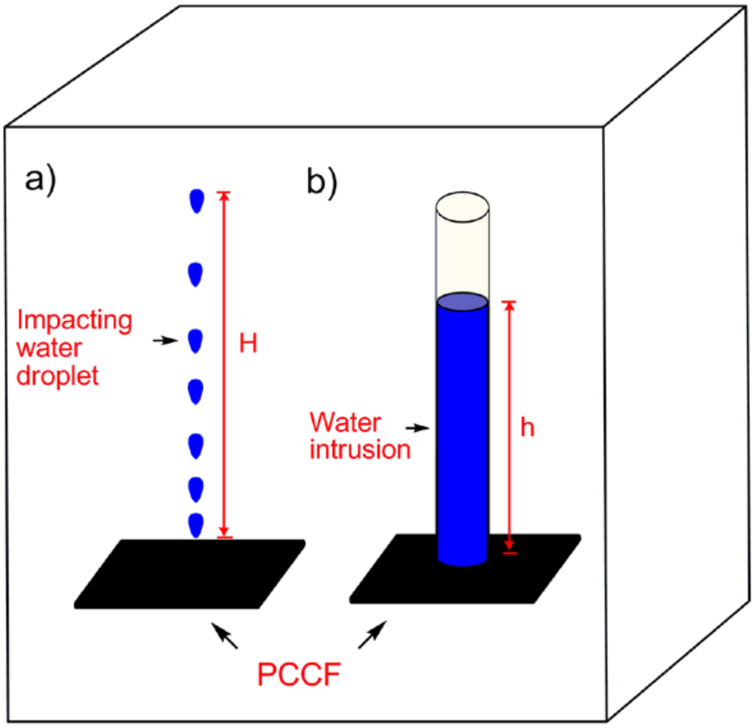

Fig. S5 Schematic illustration of the critical water impact dynamic pressure (a) and water intrusion pressure (b) on PCCF.

Table S1. Viscosities of the oils at room temperature (25±1°C).[1-8]

Oil	Viscosity (mPa s)	
	This work	Literature
n-Hexane	0.26	0.29
Isooctane	0.47	0.49
Rapeseed oil	77.3	78.8
Sesame oil	61.9	60.4
n-Dodecane	1.36	1.34
n-Tetradecane	2.05	2.08
Dichloromethane	0.41	0.38
Tetrachloromethane	0.79	0.82
Gasoline [a]	0.47	0.45
Hydraulic oil [b]	46.1	46.6

[a] The viscosity of gasoline is given at 20°C.

[b] Hydraulic oil is a sample of classification HM, ISO 46. Its viscosity is given at 40°C in $mm^2\ s^{-1}$.

Table S2. Comparison of wettability, impacting dynamic pressure and intrusion pressure of the PFTS-modified CuO-grown copper foam and mesh with same pore diameter and different thickness.

Parameter	Cu foam	Cu mesh
Pore diameter as-received (μm)	450±31	450±29
Thickness as-received (mm)	1.7±0.2	0.1±0.02
Static water CA in air (°)	157.6±3.2	156.9±2.3
Water RA in air (°)	5.0±0.6	7.2±0.9
Advancing water CA in air (°)	159.4±2.9	158.3±3.1
Receding water CA in air (°)	154.7±2.4	151.8±2.5
Static water CA under isooctane (°)	171.2±2.7	170.3±2.1
Water RA under isooctane (°)	< 1	< 3
Advancing water CA under isooctane (°)	N/A (rolled off)	172.1±1.8
Receding water CA under isooctane (°)	N/A (rolled off)	169.2±2.3
Impacting dynamic pressure (kPa)	1.88±0.04	0.28±0.01
Intrusion pressure (kPa)	1.13±0.01	0.45±0.01

Movie S1 A video for oil/water separation studies of PCCF.

Movie S2 Process for oils capture on water surface and underwater.

References

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