Supplementary Information for

PH-responsive bidirectional oil/water separation material

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1. Experimental Section.
2. Fig. S1
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Experimental Section

Materials
Copper mesh films were purchased from a local wire mesh store. \( n \)-Octadecyl thiol (96%) was purchased from Across organics. \( \text{CuSO}_4 \cdot 5\text{H}_2\text{O} \), \( \text{H}_2\text{SO}_4 \), \( \text{NaOH} \) and \( \text{HNO}_3 \) were analytical-grade reagents and used as received. \( \text{H}_2\text{SO}_4 \) and \( \text{NaOH} \) were used to regulate the acid-base property of the aqueous media.

Fabrication of Superhydrophobic Copper Mesh Film
The pristine copper mesh films were immersed in diluted \( \text{HNO}_3 \) (10% v/v) to remove any surface oxide layer and sequentially cleaned with deionized water and acetone for at least three times. Then, the copper mesh films were dried in a stream of nitrogen gas for 5 min prior to use. The Cu nanoparticles were coated on the copper mesh film via a typically electrochemical deposition process. The copper mesh films were applied as the working electrode whereas a platinum sheet (2.0 cm × 2.0 cm) was used as the auxiliary electrode. The reference electrode was a saturated calomel electrode. All of the electrodes were immersed in a solution containing 0.04 M \( \text{CuSO}_4 \) in 0.5 M \( \text{H}_2\text{SO}_4 \). The distance between the working electrode and the counter electrode, put vertically, was kept at 2.0 cm in the electrolyte. Electroplating process was performed at a current density of 0.017 A/cm\(^2\) for 240 s at room temperature.

After Cu nanoparticles were electrochemically deposited on the mesh films, the copper mesh substrates were coated with a layer of Au via using a sputter coater. Then the copper meshes were immersed in a mixed thiol ethanol solution of \( \text{HS(CH}_2)_9\text{CH}_3 \) and \( \text{HS(CH}_2)_{10}\text{COOH} \) for about 10 h. The total concentration of the thiols in the ethanol solution is 1 mM and the concentration fraction of \( \text{HS(CH}_2)_9\text{CH}_3 \) and \( \text{HS(CH}_2)_{10}\text{COOH} \) was set as 3:2. After the thiol modification, the copper mesh films were removed and washed with anhydrous ethanol and dried in a drying oven.

Characterizations. The water CA and SA were measured with a 5 μL deionized water droplet at ambient temperature with a DSA100 contact angle meter (Kruss Company, Germany). The average CA and SA values were obtained by measuring the sample at five different positions, and the images were captured with a traditional digital camera. Scanning electron microscopy (SEM) images were obtained on JEOL JSM-5600LV scanning electron microscopes with Au-sputtered specimens. X-ray energy dispersive spectrometer (EDS) attached to the SEM was used for the examination of the chemical composition of the as-prepared fabric.
Fig. S1 Schematic illustration of the shapes of the water droplets on the as-prepared copper mesh both in the air and underwater environment. (a) As-prepared copper mesh shows superhydrophobic property in the air to acidic and neutral water droplets however shows superoleophilic property underwater. (b) As-prepared copper mesh shows superhydrophilic property in the air to basic water droplets however shows superoleophobic property under base solution.
Table S1. Summary of philic/phobic natural at various interface\textsuperscript{23}

<table>
<thead>
<tr>
<th>Solid-air-water interface</th>
<th>Solid-air-oil interface</th>
<th>Solid-water-oil interface</th>
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<tbody>
<tr>
<td>Hydrophilic ((\gamma_{SA} &gt; \gamma_{SW}))</td>
<td>Oleophobic if (\gamma_{OA}\cos\theta_0 &lt; \gamma_{WA}\cos\theta_W)</td>
<td>Oleophobic if (\gamma_{OA}\cos\theta_0 &gt; \gamma_{WA}\cos\theta_W)</td>
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<tr>
<td>Hydrophobic ((\gamma_{SA} &lt; \gamma_{SW}))</td>
<td>Oleophilic if (\gamma_{SA} &lt; \gamma_{SO})</td>
<td>Oleophilic if (\gamma_{OA}\cos\theta_0 &gt; \gamma_{WA}\cos\theta_W)</td>
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