Electronic Supplementary Information

Fabrication of Silica Gel Coated Quartz Fiber Mesh for Oil/Water Separation under Strong Acidic and Concentrated Salty Conditions

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This Supplementary Information section contains:

1. Experimental section.
2. Discussion about synthesis of silica gel & Figure S1
3. Video of oil-water separation

1. Experimental section

Preparation of Silica Gel Coated Quartz Fiber Meshes

Firstly, the commercial quartz fiber (5× 5 cm) was washed by ethanol (analytical grade, Beijing Chemical Co. Ltd., Beijing, China), acetone (analytical grade, Beijing Chemical Co. Ltd., Beijing, China), deionized water respectively, and then immersed into BTSE solution for 10 minutes. BTSE solution, consisted of deionized water, ethanol, and BTSE (Nanjing Capatue Chemical Co. Ltd., Nanjing, China) in a volume rate of 40:10:1, had been stirred sufficiently at ambient temperature. Secondly, the as-prepared mesh was carefully transferred into a mixed pre-gel solution for 30 minutes. Then it was drawn out slowly and dried at 50 ℃ for 2 hours. The mixed pre-gel solution was prepared by adding PAM adhesive agent (0.26 wt.% of the solution, number average molecular weight M_n=3 000 000, Sinopharm Chemical Reagent Co. Ltd., Shanghai, China) into a 15 wt.% Na_2SiO_3 ($Na_2SiO_3 \cdot 9H_2O$, analytical grade, Sinopharm Chemical Reagent Co. Ltd., Shanghai, China) aqueous solution, then the pH value of the mixed pre-gel solution was adjusted to 9 by adding 3 mol/L H_2SO_4 (analytical grade, Beijing Chemical Co. Ltd., Beijing, China) aqueous solution under sufficiently stirring. Finally, the as-prepared mesh was washed by 3 mol/L H_2SO_4 aqueous solution and deionized water, thus the superhydrophilic and underwater superoleophobic mesh was obtained.

Oil/water Separation Experiments

The as-prepared mesh was anchored between two polytetrafluoroethene (PTFE) fixtures, which were attached with two glass tubes. The diameter of each glass tube was 30 mm. The whole apparatus was placed vertically upon a beaker. The oil/water mixture (water/oil=1:1 v/v) was poured into the upper glass tube. Water permeated the mesh driven by gravity directly, while oil was obstructed by water barrier forming at the surface of the mesh. The filtrate was collected in the beaker. In the experiment, hexane, petroleum ether, gasoline, diesel, engine oil, and crude oil were chosen as oil phases, while gradient concentration sulfuric acid (H_2SO_4), sodium chloride (NaCl) aqueous solutions were alternates of deionized water.

Instrumentation and Characterization

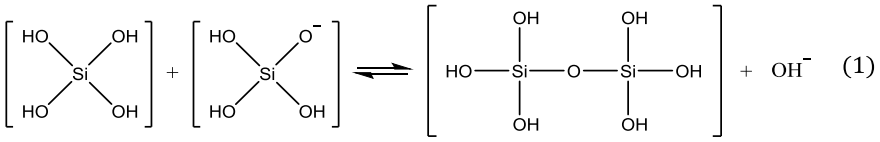
The SEM images of as-prepared meshes were obtained using a field-emission scanning electron microscope (Phenom^{TM} microscope, Phenom-World BV, The Netherlands). Contact angles were measured on a contact angle measurement machine (OCA15 machine, Data-Physics, Germany) at ambient temperature. The oil droplets (2 μL) were dropped carefully onto the surface of materials, which were immersed in water, to measure underwater OCAs. The average value of measurements performed at 5 different positions on each sample was adopted as the contact angle presented.

Oil/water separation efficiency was evaluated by measuring oil content in filtrate collected in the beaker. The oil concentration of water was measured using an infrared spectrometer oil content analyzer (Oil480, Beijing Chinainvent Instrument Tech. Co.

Ltd., China). CCl_4 (Spectrum pure grade, Tianjin Aoran Fine Chemical Research Institute, Tianjin, China) was used to extract oil from filtrate.

2. Discussion about Synthesis of Silica Gel

In order to ensure complete sol-gel reaction and conduct more conveniently, 5%, 10%, 15%, 20% gradient concentration of sodium silicate (Na_2SiO_3) aqueous solutions were chosen to obtain the optimal sol-gel time. The formation of silica gel proceeded through a simple process as shown in [equation S1]:



(1)

When the concentration of aqueous solutions were 5% and 10%, the gelation process could react incompletely or proceed for a long time ; besides, the as formed gel was easily broken. When the concentration ascended to 15%, the gelation process proceeded rapidly and the silica gel became solid (see **Figure S1**). However, at the concentration of 20%, the gelation speed was so fast that we couldn't operate the next coating treatment. Therefore, 15% concentration of Na_2SiO_3 aqueous solution was chosen as the optimal concentration to control the sol-gel time in the ensuing experiments.

Figure S1. The image of silica gel which was fabricated at the concentration of 15% and cut into cube.

3. Video of oil-water separation

Video 1. Crude oil-deionized water separation process of the silica gel coated quartz fiber mesh. Water permeates the mesh driven by gravity directly within 1 minute, while oil is obstructed by water barrier forming at the surface of the mesh.