Electronic Supplementary Material (ESI) for Soft Matter.

Preparation of polymer-based foam for efficient oil-water separation based on surface engineering

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1. Experimental Procedures

1.1 Cell morphology characterization

Image-Pro Plus 6.0 software was used to analyze the SEM images. The average diameter D of the cells in the micrographs was calculated using Eq. (1) [1].

$$D = \frac{\sum d_i n_i}{\sum n_i} \tag{1}$$

where n_i is the number of cells with a perimeter-equivalent diameter of d_i. To ensure the accuracy of the average cell size measurement, i is greater than 150.

The volume expansion ratio of each sample was calculated as the ratio of the density of the original sample, ρ_s, to the measured density of the foam sample, ρ_f. The densities (ρ_f) of the foam samples were determined from Archimedes' law by weighing the polymer foam in water with a sinker using an electronic analytical balance (HANG-PING FA2104) and using Eq. (2) to calculate the density.

$$\rho_f = \left(\frac{a}{a+b-c} \right) \rho_w \tag{2}$$

where a, b, and c are the weights of the specimen in air without the sinker, the totally immersed sinker, and the specimen immersed in water with the sinker, respectively, and ρ_w is the density of water.

The void fraction was calculated using Eq. (3).

$$\varphi = \left(1 - \frac{\rho_f}{\rho_s}\right) \times 100\% \tag{3}$$

where ρ_s and ρ_f are the density of solid and foam samples, respectively.

The open-cell content was measured by an automatic true density meter (AccuPyc II 1340) in accordance with ISO4590. According to the principle of gas displacement, the open cell ratio of the foamed samples was tested. The number of tests was 5, and the test was stopped when the error was less than 0.01%. The open-cell content was obtained from the average of the last 5 measurements.

1.2 Oil adsorption test

Cut five kinds of samples into several cuboids with a mass of 0.04g, then place the samples in a burning cup with different kinds of oil. Take the samples every 30s, remove the oil from the surface of the samples, and weigh the samples until the sample mass

no longer changes. The oil was removed by mechanical squeezing and extracted the residual oil by a vacuum pump. The adsorption capacity of the foams was evaluated using Eq. (4).

$$Q_e = M_e - M_0 \tag{4}$$

where M_0 and M_e, respectively, represent the initial and instantaneous foam weight (g/g). A certain amount of oil is injected into the bottom of the solution, and then the foam absorbs oil. The oil removal efficiency (η) can be calculated by Eq. (5).

$$\eta\% = \frac{m_e - m_0}{m} \tag{5}$$

where m, m_0 and m_e, respectively, represent the oil weight, initial foam weight, and weight after oil adsorption.

Table S1. The bulk density of the oils

Oils	*Sunflower oil*	*Petroleum ether*	*n-hexane*	*Carbon tetrachloride*	*Ethyl alcohol*	*Toluene*	*Diesel oil*	*Crude oil*
Density (g/cm^3)	*0.935*	*0.75*	*0.66*	*1.595*	*0.79*	*0.866*	*0.84*	*0.873*

2. Results and Discussion

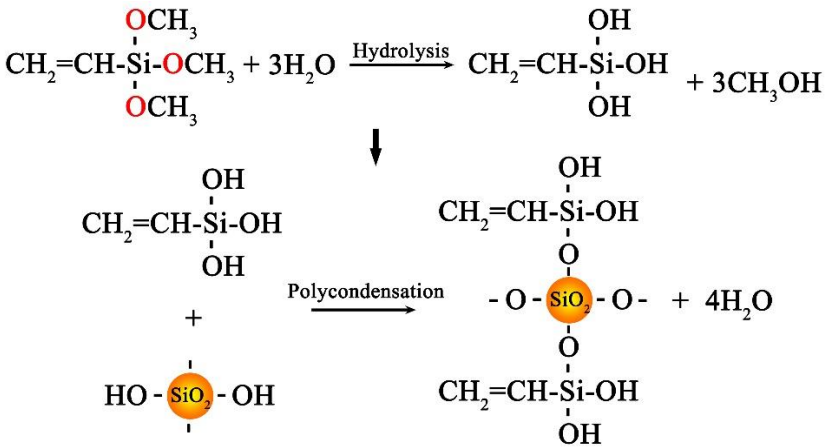

Fig. S1. Hydrothermal reaction mechanism of surface modification of silica particles.

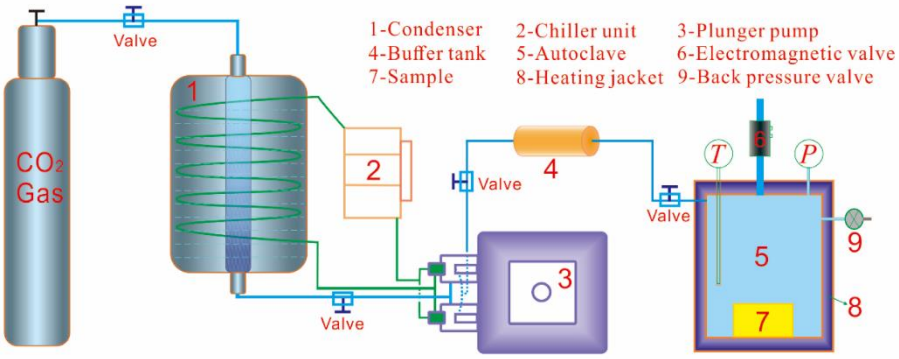

Fig. S2. Schematic illustration of the supercritical CO_2 setup employed [2].

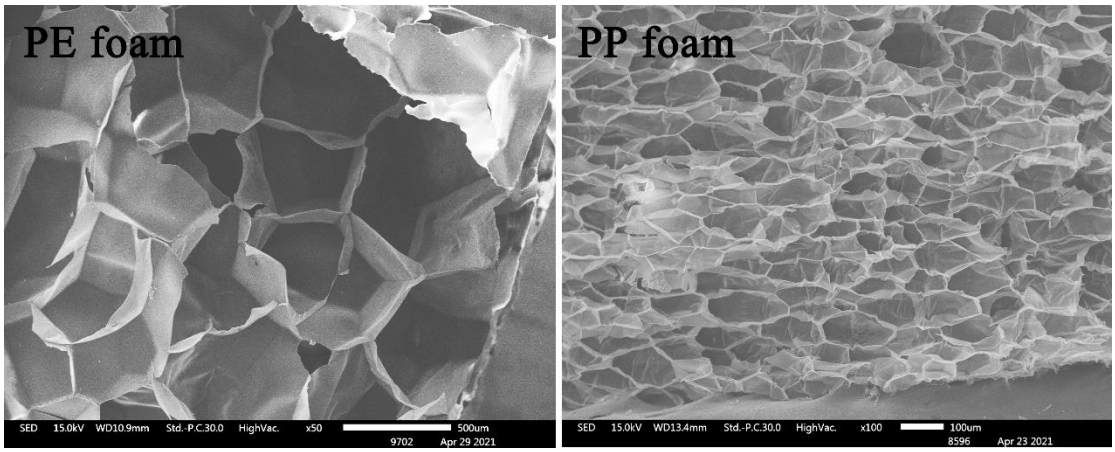

Fig. S3. SEM images of the PE foam and PP foams.

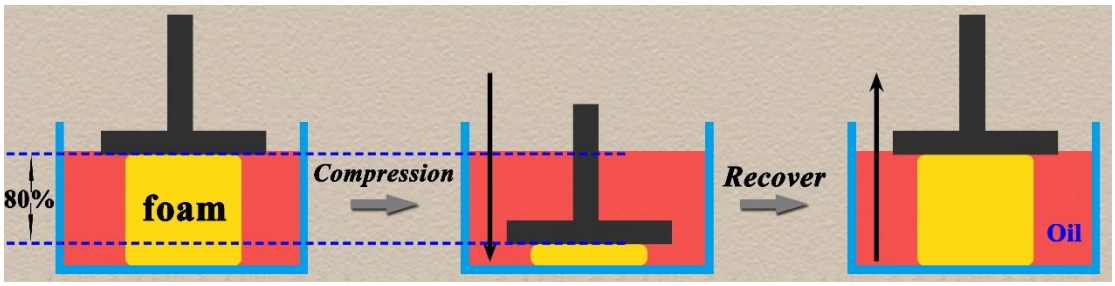

Fig. S4. Schematic diagram of the cyclic compression of the modified foam immersed in the oil.

Table S2. The values of second order kinetic constant (k) for diesel oil adsorption

	PP/PBMA-co-HEMA[3]	*PP/PTFE foam*[4]	*kapok fiber*[5]	*PP/CB10 foam*[6]	*PE(0.3) foam*
second order kinetic constant k/(g/(g·min))	*0.212*	*0.162*	*1.14*	*0.44*	*0.488*

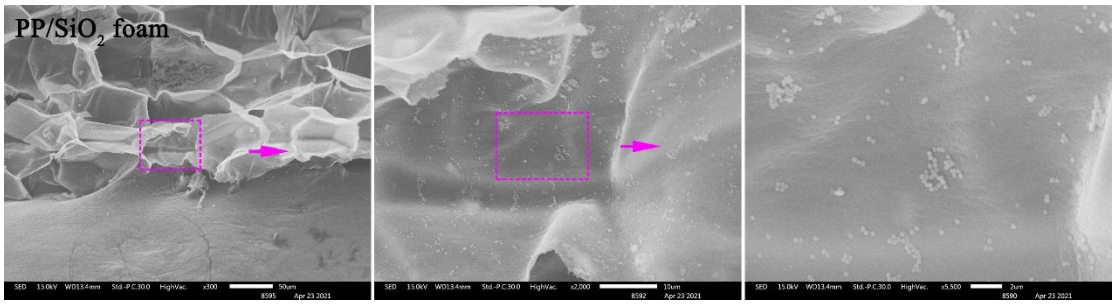

Fig. S5. SEM images of the PP/SiO_2 foams.

References

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