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Ultrafast Adsorption of Tiny Oil Droplets Within Water by Superhydrophobic-Superoleophilic Conical Micro-arrays

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ABSTRACT

Although floating oil with large particle sizes can easily be separated from water by membrane separation methods, tiny oil droplets with tremendously small volume force and density gradient at oil-water interfaces within water lead to barriers of oil-water separation. Consequently, tiny oil droplets remain in the water, resulting in energy waste, environmental pollution and biological health hazard. Traditional super-wetting membranes with extremely small pore sizes were easily blocked during the oil-water separation process. Inspired by the cactus and rice leaf, we developed a superhydrophobic-superoleophilic surface with conical micro-arrays to realize ultrafast adsorption of tiny oil droplets within the water. The tiny oil droplets transport directionally from the apex to the bottom of the conical microcolumn driven by Laplace pressure and wettability gradient force. By adjusting oil volume and structure size, the oil droplet movement velocity is up to 14.5 mm/s and the oil-water separation efficiency reaches 99.99% without external pressure. Additionally, the large difference in movement velocity is helpful to realize the separation of different oil phases. This work provides the theoretical basis and technical support to fabricate underwater apparatus for the highly efficient collection of tiny oil droplets and phase separation of multiphase oil mixture.

KEYWORDS

Conical microcolumn; superhydrophobic-superoleophilic; wettability gradient; oil absorption capacity; oil-water separation

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