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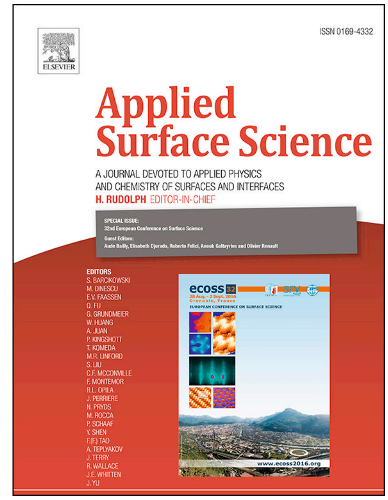

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On-demand oil-water separation via low-voltage wettability switching of core-shell structures on copper substrates

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Abstract

A copper mesh with dendritic copper-oxide core-shell structure is prepared using an additive-free electrochemical deposition strategy for on-demand oil-water separation. Electrochemical manipulation of the oxidation state of the copper oxide shell phase results in opposite affinities towards water and oil. The copper mesh can be tuned to manifest both superhydrophobic and superoleophilic properties to enable oil-removal. Conversely, switching to superhydrophilic and underwater superoleophobic allows water-removal. These changes correspond to the application of small reduction voltages (< 1.5 V) and subsequent air drying. In the oil-removal mode, heavy oil selectively passes through the mesh while water is retained; in water-removal mode, the mesh allows water to permeate but blocks light oil. The smart membrane achieved separation efficiencies higher than 98% for a series of oil-water mixtures. The separation efficiency remains high with less than 5% variation after 30 cycles of oil-water separation in both modes. The switchable wetting mechanism is demonstrated with the aid of microstructural and electrochemical analysis and based on the well-known Cassie-Baxter and Wenzel theories. The selective removal of water or oil from the oil-water mixtures is driven solely by gravity and yields high efficiency and recyclability. The potential applications for the relevant technologies include oil spills cleanup, fuel purification, and wastewater treatment.

Keywords: Core-shell, Oil-water separation, Switchable wettability, Underwater superoleophobic, Superhydrophobic, Stimuli responsive