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Facile Fabrication of Superhydrophobic/Superoleophilic Microporous Membranes by Spray-coating Ytterbium Oxide Particles for Efficient Oil-Water Separation

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Abstract

For oil-water separation, micron-sized stainless steel membranes were fabricated by spray-coating using dispersions of ytterbium oxide (Yb_2O_3). The operational parameters such as particles concentration and annealing temperature were optimized to achieve the best separation efficiency. Scanning electron microscopy (SEM) images of (Yb_2O_3) particles revealed that annealing at 200ºC results in sharp-edged grains that are uniformly distributed on the surface. These findings were further corroborated by X-ray diffraction (XRD) and selected area electron diffraction (SAED) analyses that confirmed the highest degree of crystallinity for the particles annealed at 200ºC. The analyses with Fourier Transform Infra-Red (FTIR) spectroscopy showed that annealing does not alter the bonding chemistry of the particles. SEM of the surface-modified membrane showed that the particles completely cover the target surface and are distributed uniformly. Wettability studies with water and oil clearly demonstrated that the membranes coated with Yb_2O_3 particles acted to be simultaneously superhydrophobic (contact angle of ~ 150º) and superoleophilic (near-zero contact angle). By measuring water contact angle of coated membranes annealed at different temperatures, a relationship between crystallinity and hydrophobicity was also established. These findings were reflected in oil-water separation studies performed under gravity where the modified membrane allowed all of the oil to pass through but completely blocked the water having a separation efficiency close to 100%. This