Novel Spinel Oxide Coatings on Stainless-Steel Mesh for Efficient Oil-Water Separation

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The depletion of water resources and environmental hazards associated with aging oil wells, including the release of oil-contaminated water, present grave threats to marine ecosystems and human health. Additionally, with approximately 14,000 oil spills annually, action is needed for innovative strategies in sustainable water management and oil extraction practices. A new solution to this challenge was a specially developed, anti-fouling stainless-steel mesh (SSM) surface coated with Co-NiFe2O4 spinel ferrites for efficient oil-water separation. A mechanically robust Co-NiFe2O4 coating, featuring a distinctive cluster structure composed of nanoneedles on stainless steel mesh, was synthesized using the hydrothermal technique. This involves chemical reactions conducted in a high-temperature and pressured environment. The resulting modified mesh surface efficiently separates oil/water mixtures with a remarkable separation efficiency rate of 99%. The SSM has exhibited superhydrophilicity/superoleophilicity in air and superoleophobicity underwater, displaying an oil contact angle (OCA) underwater measuring 151°. Advocating for mesh recyclability through reduce, reuse, and recycle principles not only minimizes traditional cleaning needs but also fosters environmental sustainability, as the results demonstrate the ability to produce this nanocomposite cost-effectively. This study introduces a novel superoleophobic/superhydrophilic mesh surface, fabricated through a straightforward, simple process, as a potentially highly effective material for oil-water separation due to its self-cleaning surface. This material shows significant potential for practical use in critical scenarios, such as oil spill mitigation, produced water separation, and the rejuvenation of aging oil wells.

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