SmartFilter: A Universal Non-Fouling MNMP and Non-Polar Pollutant Wastewater Filter

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Non-Polar Organic Contaminants (NPOCs) such as Micro/Nano-sized Microplastics (MNMPs), oils and Benzene, Toluene, Ethyl Benzene, Xylene (BTEX) are emerging contaminants that are critical threats to marine environments, often bypassing conventional wastewater filtration systems. Currently, the primary method of filtration is physical separation through ultra small pores that indiscriminately filter out both pollutants but also harmless organic/inorganic matter. Unfortunately, given the polluted nature of wastewater, such filters are easily fouled and clogged, rendering such filtration systems ineffective, especially in developing regions. Instead of relying on size exclusion, which indiscriminately filters both target and non-target contaminants, this project introduces the Smart Filter, which selectively absorbs NPOCs/MNMPs/oils/BTEX using a special oleogel coating, capturing contaminants thousands of times smaller than the pore size through thermodynamic surface free energy forces. For instance, through this system, MNMPs are selectively adsorbed onto the oleogel extraction phase, NPOC molecules are absorbed, and oils/BTEX are directly integrated into the extraction phase, all while maintaining negligible fouling by leaving non-target organic/sediment matter behind. This novel physical/chemical mechanism results in over 99% removal efficiencies of target pollutants across thousands of liters of real-life wastewater effluent while maintaining low-costs, biodegradability, scalability, and modularity, thereby filling the void in wastewater filtration of emerging contaminants that once existed with a novel and effective solution.

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