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Destroying PFAS by Combining Nanoparticle and Microbial Catalysis

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Many widely occurring water pollutants are especially challenging because they are recalcitrant to biodegradation. An important example today is PFAS, which are the per- and poly-fluorinated alkanoic substances, sometime called the "forever compounds." This talk describes how combining nanoparticle catalysis with microbial catalysis can lead to the complete defluorination and mineralization of PFAS. The first step is the Membrane Catalyst-film Reactor (MCfR), which utilizes self-forming palladium (Pd)-nanoparticle catalysts, H2 gas, and gas-transfer membranes to allow highly efficient reductive-defluorination of the perfluorinated contaminants. The power of the MCfR lies in its ability to adsorb and activate H atoms that attack the C-F bonds. The talk documents rapid and stable reductive detoxification of perfluorooctanoic acid (PFOA). It describes the mechanisms of reductive defluorination and means to overcome some inherent challenges of Pd-based catalysis. The talk then describes how the MCfR is synergistically linked with an O2-based Membrane Biofilm Reactor (MBfR) that oxidatively defluorinates and mineralizes the products from the H2-based MCfR. The synergistic platform makes it possible to completely defluorinated and mineralize PFAS without using hazardous or energy-intensive conditions.