Membranes

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Selective and Efficient Removal of Fluoride from Water: In Situ Engineered Amyloid Fibril/ZrO_2 Hybrid Membranes

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Abstract: *We report a new strategy for efficient removal of F^- from contaminated water streams, and it relies on carbon hybrid membranes made of amyloid fibril/ZrO_2 nanoparticles (< 10 nm). These membranes exhibit superior selectivity for F^- against various competitive ions, with a distribution coefficient (K_d) as high as 6820 mL g^{-1}, exceeding commercial ion-exchange resins (IRA-900) by 180 times and outdoing the performance of most commercial carbon-activated aluminum membranes. At both low and high (ca. 200 mg L^{-1}) F^- concentrations, the membrane efficiency exceeds 99.5 % removal. For real untreated municipal tap water (ca. 2.8 mg L^{-1}) under continuous operating mode, data indicates that about 1750 kg water m^{-2} membrane can be treated while maintaining drinking water quality, and the saturated membranes can be regenerated and reused several times without decrease in performance. This technology is promising for mitigating the problem of fluoride water contamination worldwide.*

of efficient technologies for fluoride decontamination remains a challenge.[2]

To date, there exist several methods for fluoride removal, including chemical precipitation,[3] adsorption,[4] reverse osmosis,[5] and electrodialysis.[6] In contrast, methods based on adsorption involve simple operational procedures, are easy to implement, require lower energy, and when optimized, may still enable efficient performance.[7] Recently, nanosized hydroxides of metals such as Zr^{IV}, Fe^{III}, and Mn^{IV}, have emerged as new-generation adsorbents for the purification of diverse pollutants.[8] The most representative of them, zirconium oxide (ZrO_2), can remove highly toxic metallic pollutants with high efficiency.[9] Nonetheless, fluoride detoxification using these hydroxides remains a work in progress because of the intrinsic features of the fluoride ion, especially its light atomic weight and its halogen-specific structure.[10] The resulting weak selectivity and low capacity of ZrO_2 dramatically reduces their applicability in this context. More-