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High performance stainless steel-ceramic composite hollow fibres for microfiltration

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Abstract:

Stainless steel (SS) is an attractive material for membrane applications due to its excellent mechanical strength and chemical resistance. Compared to inorganic materials such as ceramic, SS is highly flexible and tough, and is easy to handle at industrial scale. Porous stainless steel hollow fibres can be fabricated by using the phase-inversion and sintering technique. While the sintering conditions have been well studied, the improvement in achieving smaller pore size of SS hollow fibres is still limited, constraining their practical applications. In our study, we introduce ceramic nanoparticles to fill up the large pores around SS particles. A phase-inversion assisted co-extrusion technique has been used to fabricate dual-layer SS/SS-ceramic hollow fibres in one step. The outer layer is a mixture of stainless steel and yttria-stabilized zirconia (YSZ), creating a separating layer with small pore sizes. The inner layer consists of SS, provides a strong mechanical strength to the hollow fibres. The mean pore size of the composite hollow fibre membranes can be reduced to approximately 300 nm, much smaller than the pore size of single-layer SS hollow fibres, which is generally larger than 1 μm. With improved mechanical strength compared to pure ceramic hollow fibres, the dual-layer SS/SS-YSZ hollow fibre membranes are also highly porous and the pure water flux can reach as high as ~3000 LMH bar^{-1}, making them attractive in microfiltration for value-added products.