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Direct interfacial polymerization onto thin ceramic hollow fibers

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Abstract

Membrane separation under harsh conditions, such as high-p,T or in the presence of aggressive chemicals, requires a robust membrane support. In academia commonly ceramic disks are used for this purpose, but these disks posses a too low surface-area-to-volume ratio for practical applications. Ceramic hollow fibers potentially provide a much larger specific surface area, but applying a defect free thin selective layer on such structures is more intricate. Here we show the successful preparation of a thin polyamide layer on a thin porous hollow α-alumina fiber by interfacial polymerization of piperazine with trimesoyl chloride. Two aspects of the fabrication method are identified as particularly crucial for obtaining a high quality selective layer: i) the layer the ceramic surface should have a sufficient amount of hydroxyl groups for covalent attachment in order to avoid delamination, and ii) controlled drying steps are necessary to avoid local surplus or lack of liquid on the outer surface of the ceramic. To increase the hydroxyl group concentration, and to facilitate the presence of sufficient reactants in a large volume of small pores, the fibers have been coated with a layer of γ-alumina. Sufficiently long drying steps (20 min) have been employed to avoid uneven drying over the length of the fiber. The obtained fibers show clean water fluxes in the range of 2-5 $\mathrm{L\,m^{-2}\,h^{-1}\,bar^{-1}}$ combined with a retention of Rose Bengal above 99%.

Keywords: Inorganic porous hollow fiber, interfacial polymerization, polyamide

1. Introduction

Interfacial polymerization (IP) is a well-known technique to fabricate extremely thin separation layers on porous supporting structures and has been extensively studied over the past decades [1, 2]. Research has been done on preparing thin selective films on porous polymeric supports, such as polyethersulfone or polyetherimide [3–7]. The use of such membranes in harsh conditions can be limited by the stability of the thin selective layer as well as by the stability of the porous support. In applications involving high-p,T, or in the presence of aggressive chemicals, polymer supports can suffer from plasticization, swelling, or thermal degradation. The thermal-mechanical-chemical stability of an inorganic porous support avoids such problems. Ceramics have been successfully used as support for thin IP films for applications where the mechanical and thermal stability of the ceramic is required, in for example

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