

S1. Chemical reaction of the boehmite sol

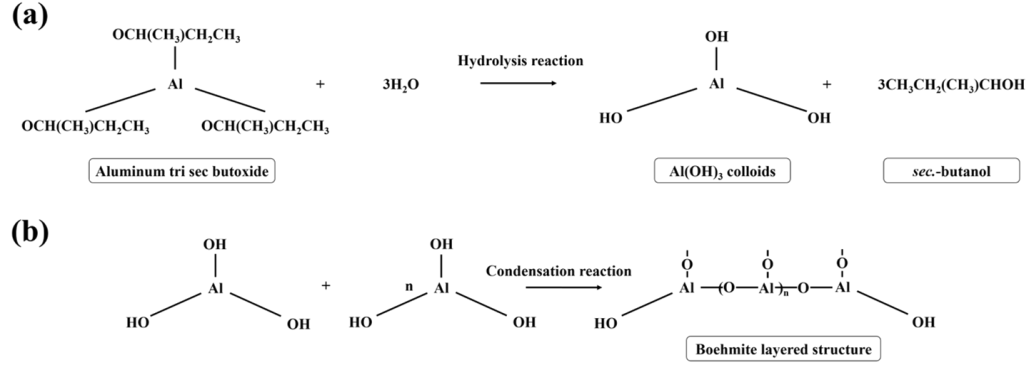


Figure S1. Sol-gel reaction of the boehmite, (a) hydrolysis, and (b) poly-condensation.

S2. Formation of membrane layer

S2.1 Mathematical model

Gu et al.[1] described the formation of a membrane layer on a porous substrate using the following model (S1):

$$L_m = 2 \left(\frac{\varepsilon_s \gamma K_m}{\eta \alpha R} t \right)^{1/2} \quad (\text{S1})$$

where L_m is the membrane thickness, ε_s is the porosity of the substrate, γ is the surface tension of the liquid solution, K_m is the permeability of the formed membrane, η is the viscosity of the solution, α is the ratio of the particle concentration in the solution to that in the wet membrane, R is the pore radius of the substrate, and t is the dip-coating time.

S2.2. Effect of PVA concentration on surface area

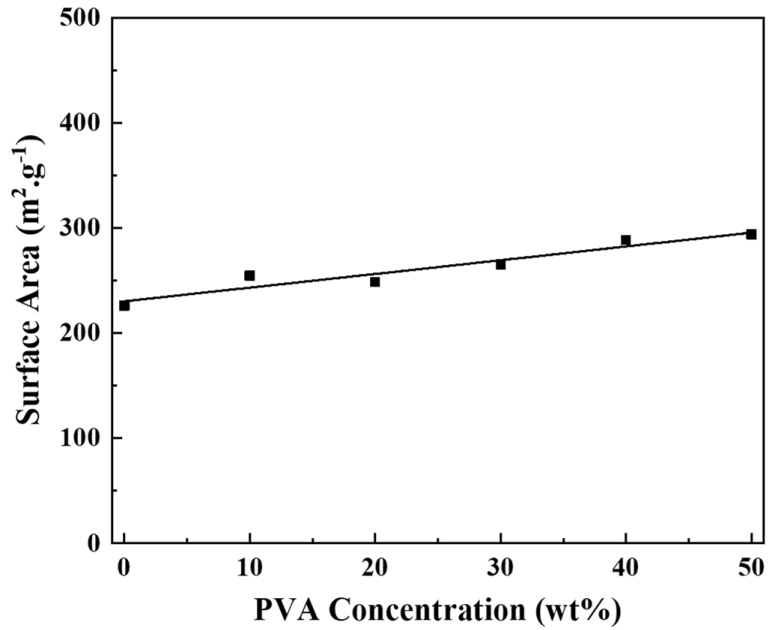


Figure S2. Schematic presentation of surface area of unsupported γ -Al₂O₃ membrane A and PVA concentration in boehmite sol.

S3. Calculation of permeate flux

Hagen-Poiseuille model[2] described the effects of membrane thickness, pore size, and porosity on the permeate flux using the following equation (S2):

$$j = \frac{\Delta P d_m^2 \varepsilon}{32 \mu L \tau} \quad (S2)$$

where j is the pure water flux, ΔP is the transmembrane pressure, d_m is the pore diameter, ε is the membrane porosity, μ is the liquid viscosity, L is the membrane thickness, and τ is the tortuosity of the membrane.

References

- [1] Y. Gu and G. Meng, "A model for ceramic membrane formation by dip-coating," *J. Eur. Ceram. Soc.*, vol. 19, no. 11, pp. 1961–1966, 1999, doi: 10.1016/s0955-2219(99)00013-8.
- [2] P. Marchetti, A. Butté, and A. G. Livingston, "An improved phenomenological model for prediction of solvent permeation through ceramic NF and UF membranes," *J. Memb. Sci.*, vol. 415–416, no. December, pp. 444–458, 2012, doi: 10.1016/j.memsci.2012.05.030.