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Engineering Mechanical Strength: Integrating Freeze Casting and Tape Casting for LSCF Asymmetric Membranes Assembly

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Abstract

Dense membranes' performance lies in the material properties and design features; thinner membranes present faster transport rates than their thicker counterparts. Nevertheless, mechanical issues limit the use of thin membranes. Thus, the strategy is to assemble the dense functional membrane to non-functional porous supports to provide mechanical strength. This work combined freeze casting and tape casting to produce LSCF asymmetric membranes. The porous supports were manufactured by freeze casting, evaluating the freezing method, solids load, and binder concentration through an experimental design, and assessing the manufacturing variables interplaying with the mechanical properties, porosity, and permeability. The freezing method remarkably changes the pores' direction, connectivity, stress strength, deformation, and permeability of the porous substrates. The mechanical performance of the standalone dense membrane is low (0.45±0.01 MPa), and the porous support structural reinforcement is up to 13-fold more resistant. The dense membrane, manufactured by tape casting, was also assembled to the porous support. The assembly setup was chosen based on heightened factors regarding the tape and porous support. The membranes were successfully coupled, and no cracking or delamination was observed at the interface after depositing the humid tape onto the pre-sintered porous support and co-sintering afterward.

Keywords: freeze casting, tape casting, LSCF, asymmetric membranes, porosity-morphology control.

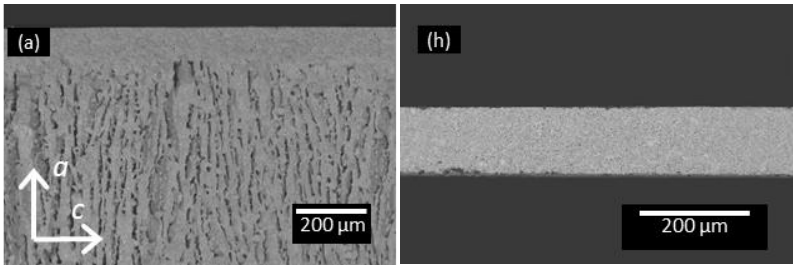

Figure 1: Typical SEM micrographs of cross sections of the asymmetric structures (membrane + substrate) of LSCF (a) and transversal section dense membrane of LSCF.

References

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