# Model Development for Carbon Dioxide Supercritical Drying of Aerogel Sheets for Application in Energy Efficient Windows

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Transparent aerogels have the potential to drastically and affordably improve the energy efficiency of homes by incorporation into double-pane windows, but have historically been limited by low optical quality.[5] The AeroShield material is an ultra-clear silica aerogel based on a uniquely optimized nanostructure developed at MIT, significantly reducing barriers to adoption.[1-4] However, the scale-up of this material for application in windows remains a challenge due to practical limitations of the common manufacturing process. In particular, the supercritical drying process employed in the original development of this ultra-clear aerogel relied primarily on diffusion to displace solvent with carbon dioxide. While this process was suitable for small monolithic aerogels (on the order of centimeters), it presents challenges for successfully drying large area sheets. This study aims to develop a model for the extraction of solvent from the pores of aerogel sheets using advection over the surface of the gel in a vessel initially completely filled with solvent. The extraction vessel is connected to a secondary mixing loop that allows for the gradual increase in the $CO_2$ concentration in the flow over the gel. A one-dimensional model representing pure diffusion within the gel was first developed to determine the concentration profile within the gel. This simple model was then extended to higher dimensions through a system of partial differential equations solved using the finite difference method, representing mass transfer within the gel and in the external solvent-supercritical $CO_2$ flow. The models help inform the design and optimization of drying parameters, including the flow rate and arrangement of gels within the vessel, in order to increase size and volume of ultra-clear aerogel production.

References

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