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Freeze-drying Silica Based Aerogels Using Cryoprotectants and Eutectic Solvent Mixtures

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ABSTRACT

Silica based aerogels have unique properties, including good thermal insulation and convective inhibition. A sol-gel process can be used to produce semi-opaque, monolithic gels, which can then be dried to produce aerogels. Multiple drying methods are available industrially, however, these methods require high temperatures and pressures, specialized equipment, and are time consuming. This project aims to experimentally study the possibility of a new method for drying wet gels through a freeze-drying process, with the use of cryoprotectants, eutectics, and polymers to inhibit and control ice formation and growth during drying. Silica wet gels were produced using tetraethylorthosilicate (TEOS), ethanol, water, and hydrochloric acid/ammonia hydroxide. After gelation the gels were subjected to solvent exchanges with varying concentrations of cryoprotectants, eutectics, polymers and combinations of the three. A customized freeze-dryer was used to obtain silica aerogels from wet gels, with monolithicity and porosity of the resulting aerogel measured by SEM and BET. The results indicated that the addition of cryoprotectants, eutectics, and polymers yielded monolithic foams which were structurally stable and had measurable porosity and surface area. Using the processes developed in this work would allow for simpler, more cost effective methods for drying wet gels to be developed; these methods could be used to produce freeze-dried aerogels with better properties and have potential for industrial implementation.

KEYWORDS

Silica aerogel, characterization, freeze-drying, eutectic mixture, cryoprotectant