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Aerogels

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Ethanol and Acetone Aerogels

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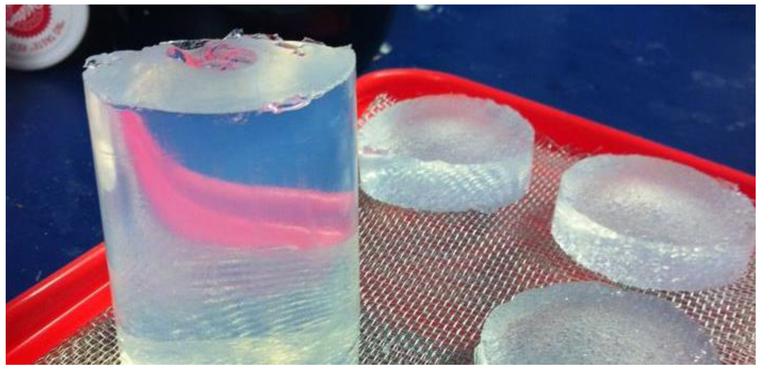
Abstract

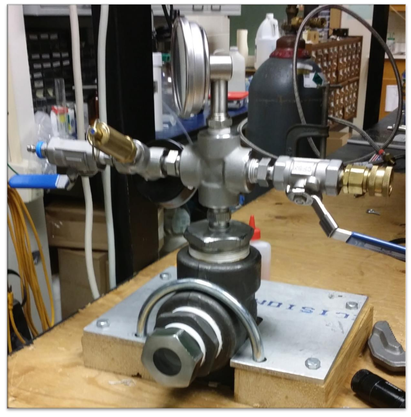
An aerogel is a very porous solid with a number of interesting properties, such as electrical and thermal insulation and very low density.
There are three main goals of this research: to compare acetone-exchanged and ethanol-exchanged aerogels in several areas, including durability and ease of production; to determine the porosity of the aerogels (how large the pores of the gels are); and to investigate several applications of the aerogels, including photodetection and, more commonly, insulation. Following are our results to date on creating ethanol and acetone based aerogels and examining their properties.

Production

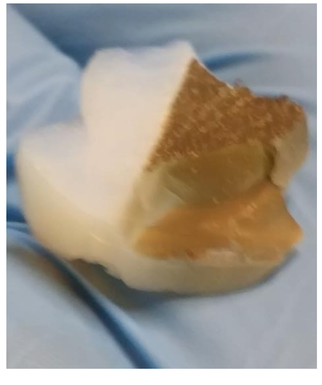
Sol-gels, seen below, are made from a solution of TEOS (Tetraethyl Orthosilicate) in water. They are the gelatinous material from which aerogels are produced. The cylinder of gel is cut into pucks.



The pucks sit in ethanol (or acetone), which is exchanged every day for fresh ethanol; this replaces the water in the gels with the ethanol. The choice of exchange fluid influences shrinkage of pores. After five exchanges, we place the gels into the manuclave, which serves as the supercritical dryer, shown below.



The ethanol (or acetone) is then exchanged with liquid CO_2 under about 900 psi of pressure. When the CO_2 has been completely exchanged with the ethanol/acetone, the pressure inside the manuclave is increased until the CO_2 reaches a supercritical state. The pressure is then slowly released to dry the gels, seen below.



Analysis and Conclusions

Production proves to be the most difficult stage of our investigation. The production process involves a significant amount of time (15 days total for a batch of gels), and quality is difficult to keep consistent. Producing gels without cracks or major imperfections requires immense care. Further experimentation with the particulars of the drying process will lead to more consistent production. Acetone-aged gels are currently in production and tests have hinted at greater durability. Efforts at analysis have been hampered by the short supply of quality finished aerogels.
So far, we have attempted to measure porosity using interferometric means (below are pictured the patterns produced by lasers shining through the gels, and the FFTs of those patterns.) We can also make use of Rayleigh scattering, which is a result of the size of the pores. This investigation is on-going, and more data is needed to make determinations of porosity.