

Aerogel

Aerogel is a solid with the lowest density of any solid on earth, in some cases only three times as dense as air (aerogel density $\sim 0.095 \text{ g/cm}^3$). It is highly porous and also known as “frozen smoke” - however it feels like Styrofoam to the touch, and not gel. Aerogel is synthesized by carefully removing liquid solvent from a highly porous gel structure (commonly silica) and replacing the liquid with air or CO_2 . Since it is largely composed of gas, it is a great insulator. Aerogel has been known as an extraordinary “space-age” material for years but only recently have advances been made to solve common problems. Manufacturers now combine aerogel with other fibers to put its highly insulating properties to good use in clothing and industry.

DISPLAY: AEROGEL AND AEROGEL PRODUCTS

Discussion:

- *An obvious application for Aerogel is insulation. Where could you use Aerogel material as insulation in your day to day life? (clothing, insulating a house, etc.). Do you think it could be used in its pure form or would need to be incorporated into fibers? Why? (delicate on its own, needs additional strength)*
- *Aerogel is commonly composed of a widely spaced lattice of silica (other forms besides silica also exist). Aerogel can also absorb impacts or hold other molecules. Can you think of other applications for aerogel besides insulation?*
 - *shock impact: bomb proof armor, was also used to collect dust from a comets tail by NASA!*
 - *Aerogel could hold catalysts used in gas chemical reactions*
 - *could be the “ultimate sponge” to soak up environmental pollutants*
 - *other?*

RESOURCES

An interesting resource from NASA on how aerogel was used to collect comet dust, includes activity “aerogel-lo”:

<http://solarsystem.nasa.gov/docs/Aerogello.pdf>

Aerogel insulating blanket video: <http://www.aerogel.com/video.html>

YouTube Video: “Penn & Teller Tell A Lie - Flamethrower vs. Aerogel”

Purchase a sample (\$30-\$40):

<http://www.teachersource.com/Nanotechnology/Nanotechnology/Aerogel.aspx>

<http://www.buyaerogel.com/>

FANTASTIC resource on the history and science of aerogel, including podcasts, videos and detailed instructions on materials and recipes for making your own aerogels! (which is a somewhat expensive process due to the supercritical drying step however): <http://www.aerogel.org/>

Aerogel insulator insoles source: “polarwrap” on amazon.com or other site

RELATED STANDARDS

Investigation and experimentation

Grade 8 physical sciences #8 a-d (Density and buoyancy)

Chemistry grade 9-12 #7 a-d (chemical thermodynamics)

Physics grade 9-12 #3c (heat and thermodynamics)

Excerpt from “Making your own aerogels” from aerogel.com

The General Process

Generally speaking, making aerogels goes something like this:

1. Identify what kind of aerogel you want to make
2. Find a procedure (“recipe”) for making that kind of aerogel
3. Mix up a bunch of chemicals in beakers
4. Pour the mixture into a mold and wait for a gel to set
5. Soak the gel under pure solvent to purify the gel and allow it to strengthen
6. Depending on the procedure, you might also soak the gel in solutions containing functionalizing agents such as waterproofing agents or crosslinkers
7. Solvent exchange the gel into the appropriate solvents by soaking
8. Dry the gel, either supercritically or evaporatively, depending on the recipe