

AEROGELS

BACKGROUND INFORMATION VERSION 052917.1



OVERVIEW

The following slides present background information on aerogel and its role in nanotechnology. They may be presented as part of a lecture introducing the Aerogel activity.

AEROGEL'S NICKNAME: "SOLID BLUE SMOKE"

Aerogel resembles a hologram.

Is it there or not?

Aerogel is a highly porous, solid material.

Aerogel has the lowest density of any solid known to man. It is one thousand times less dense than glass.



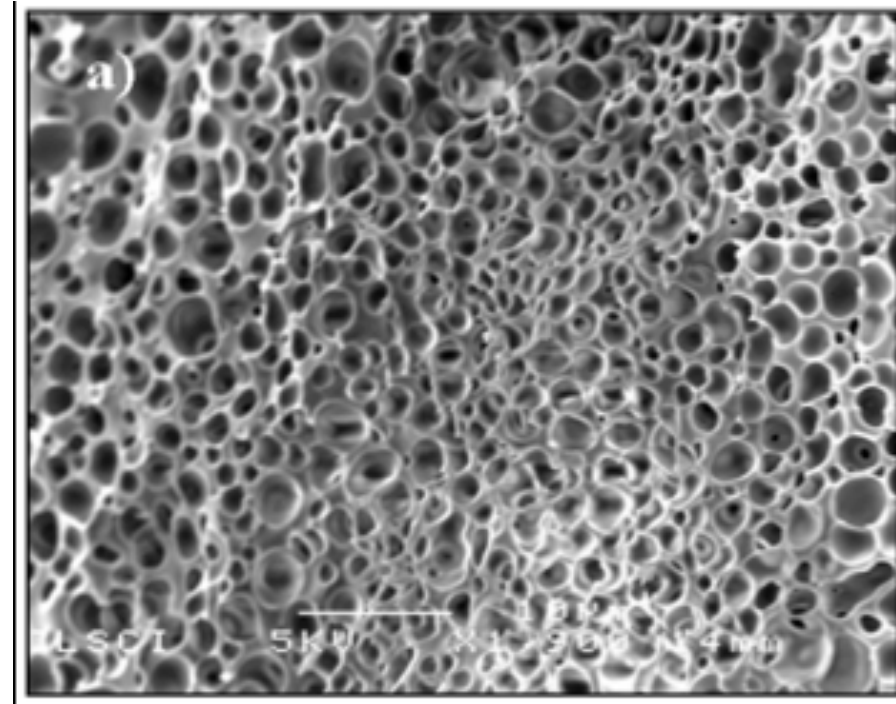
NASA Jet Propulsion Laboratory, California Institute of Technology, Pasadena, California

AEROGEL IS A PRODUCT OF NANOTECHNOLOGY

Aerogels are made of 10nm silica spheres.

They weigh only slightly more than air. In fact, one form is 99.8% air.

About 8,000 of these air bubbles would fit across a single human hair



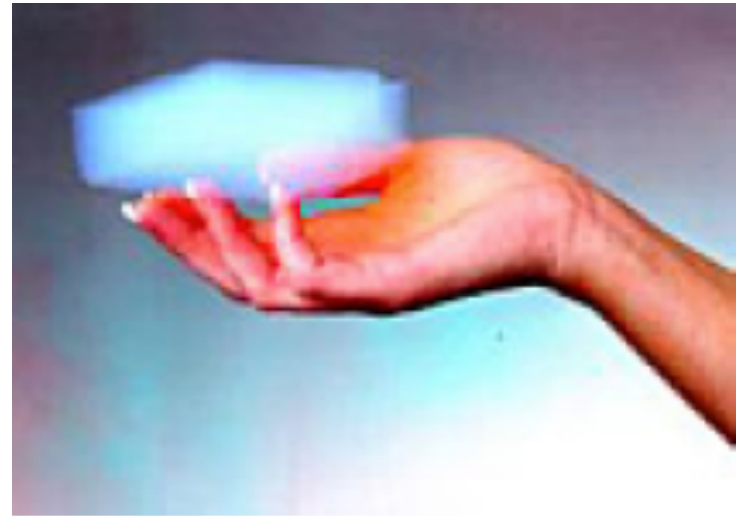
Scanning electron microscope image of aerogel

WHY IS AEROGEL BLUE?

The size of the air bubbles is similar in size to the molecules in air and the air pockets in glaciers. They all scatter blue light more than red, making them look blue.



Gray Glacier, Torres del Paine National Park Chile



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HOW IS AEROGEL MADE?

- Labs make aerogels by suspending silicon dioxide in alcohol and water to form a gel.
- The liquid is removed with carbon dioxide under high pressure and temperature.
- Aerogels are expensive to make.

EXTREME PHYSICAL PROPERTIES OF AEROGEL

Property	Silica Aerogel	Silica Glass
Density (kgm ³)	5-200	2300
Specific Surface area (m ² /g)	500-800	0.1
Optical Transmission at 632.8nm	90%	99%
Thermal conductivity (1/C at 20-80 deg C)	0.016-0.03	1.2
Acoustic Impedance (kg/m ² /s)	10 ⁴	10 ⁷
Refractive Index at 632.8 nm	1.002-1.046	1.514-1.644

AEROGEL IS EXTREMELY STRONG FOR ITS WEIGHT

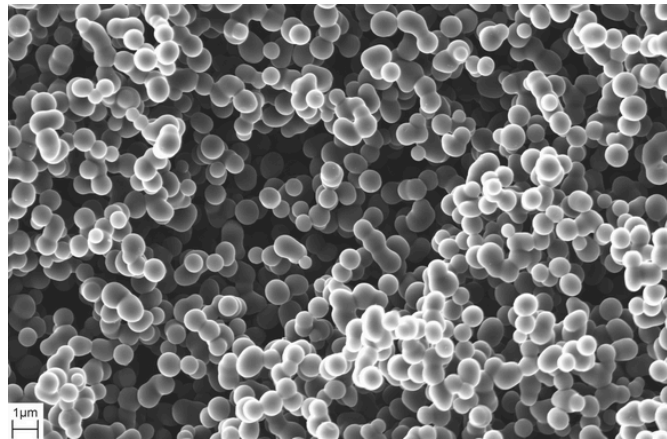
A 2.5 kg brick supported on top of a piece of aerogel weighing only 2 grams- over 1000 times lighter!



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WHY IS AEROGEL SO STRONG?

- Aerogel has a high surface area to volume ratio.
- All of the tiny spheres that make up aerogel provide more structural support than regular glass that has less surface area per volume.



Aerogel structure
German Aerospace Center (DLR)

AEROGEL IS AN EXTREME INSULATOR

- All those tiny glass bubbles filled with air make aerogel an amazing insulator.
- 40 times better than fiberglass

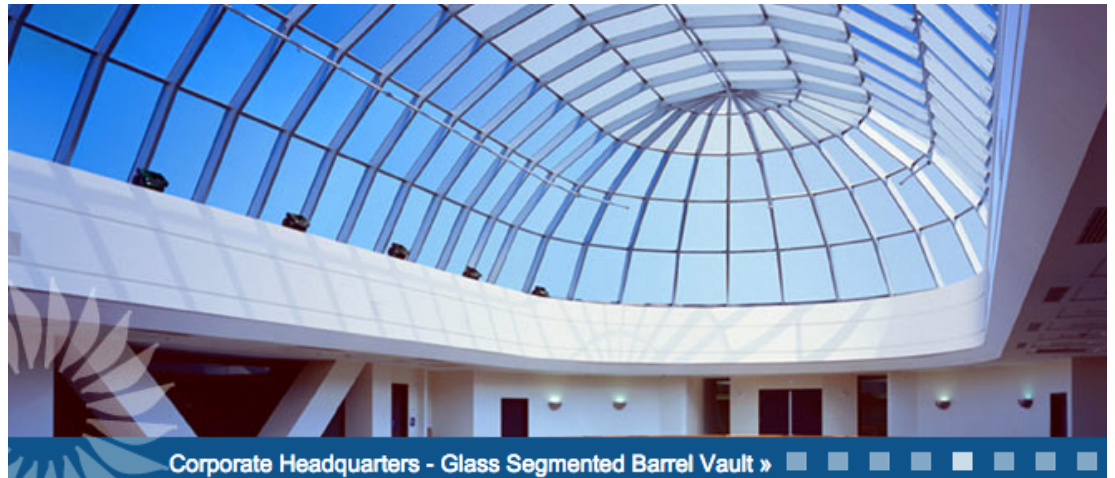


Crayons on Aerogel over a flame

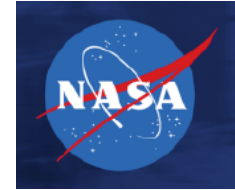
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AEROGEL IS TRANSPARENT

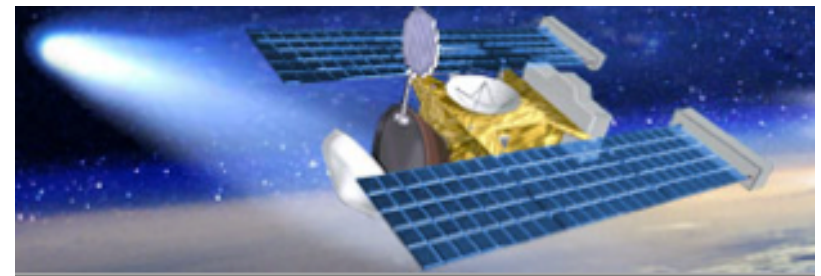
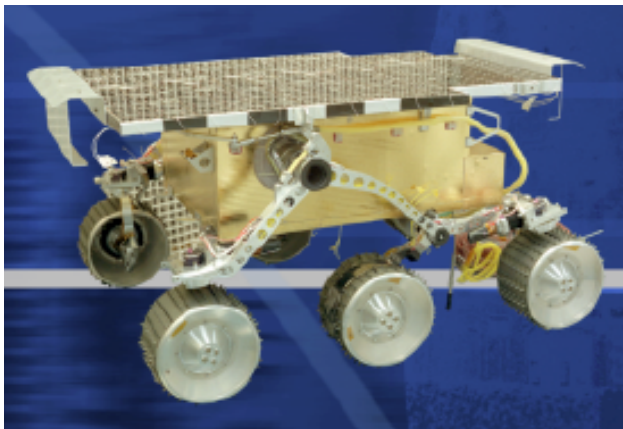
- Aerogel panels are used for daylighting. Buildings are designed to save money by using natural light and thus reducing lighting costs.
- Aerogel is transparent and allows light in through panels
- Keeps building warm



AEROGEL IS EXTREMELY LIGHTWEIGHT



- Aerogel has extremely low density
- NASA uses aerogel because it is so lightweight which makes rocket payloads less expensive to send into space.
- Was used on the Mars Pathfinder rover and on the Stardust probe



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CATCHING COMET DUST

- The challenge of the Stardust mission was to gather dust from comet Wild 2. The problem was how to slow down the comet particles from their high velocity without changing their shape and chemical composition.
- These particles were travelling six times faster than a rifle bullet but were stopped by a block of aerogel.



CATCHING COMET DUST

- When a particle hits the aerogel, it buries itself in the material, creating a carrot shaped track up to 200 times its own length.
- Since aerogel is mostly transparent, scientists can use the tracks to find the tiny (10 micron) particles.



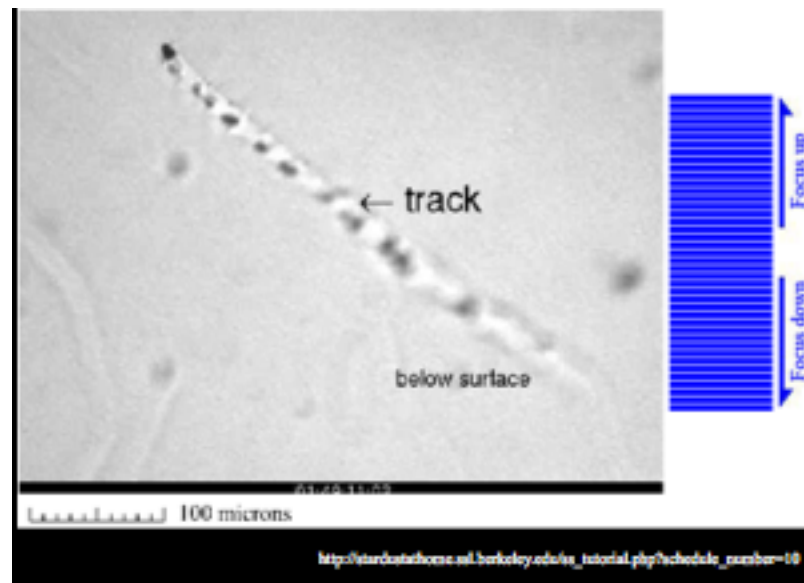
Particle captured in Aerogel

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CITIZEN SCIENCE

You can help look for comet dust!

(Computers can't tell the difference between cracks in the aerogel and tracks made by comet particles; humans can)



<http://stardustathome.ssl.berkeley.edu/>

PHOTO CREDITS AND REFERENCES

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