COMET

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Aerogel

Background

Aerogel, a silicon-based substance generated by only a few scientists throughout the world, has progressively been proving itself a very useful substance to space scientists. One thousand times less dense than glass, a figure achieved by being made of 99 percent air, it is the most lightweight solid known. Despite its weight, Aerogel is particularly strong and is able to withstand the jostling of space travel and exposure to the extreme environment of space. Continued improvements to the fabrication process make it simpler and safer to produce.

One of the useful properties of Aerogel is its superior insulation power. One inch of Aerogel has the insulating power of six inches of fiberglass. Aerogel has been utilized for this during previous space missions, including the Mars Pathfinder mission.

However, Aerogel has also proven itself as an excellent collector of high-speed particles. Although very tiny, the particles move so swiftly that they are very difficult to collect without damaging the particles or the collector itself. Tests done in labs on Earth and on the Space Shuttle show that, if engineered properly, Aerogel virtually eliminates both of these issues. When a particle hits Aerogel, it buries itself in the material, creating a carrot-shaped track as it comes to a stop. Because Aerogel is almost completely transparent, it is relatively easy to find these tracks and locate the particle at the tip of the "carrot."

Because Aerogel has so many unique properties, it is particularly difficult to find a substance that models it accurately. In this activity, "aerogel-lo" is used as an example, although there are many differences between the two. Among these are its high water content, which would not allow it to travel intact in the extreme environment of space, and its relatively large weight.

Topics

Aerogel Technology

Objective

Students will:

- Compare and contrast aerogel-lo and Aerogel.

Overview

This demonstration uses gelatin and steel pellets to show how STARDUST's Aerogel collector will capture comet particles. Then use a Venn Diagram to compare and contrast aerogel-lo and Aerogel.

Key Question

How is Aerogel used to capture fast-moving particles?

Key Concept

- Technology helps scientists in research

Materials & Preparation

- 1 packet unflavored gelatin
- Hot water
- 2 clear plastic cups (NOT the soft, opaque plastic ones)
- A spoon
- A plastic straw
- A scrap of clean pantyhose and tape to secure it
- Steel pellets (available at sporting goods stores)
- Safety goggles for you and each student

1. For a successful demonstration, the gelatin must have the right consistency.
2. Follow the directions on the gelatin packet to achieve the proper consistency.
3. Pour the gelatin into two cups, one for class, one for practice. Be sure to prepare the gelatin before doing the activity in class. This does two things; first it allows enough time for the gelatin to set. Second, you have time to test the gelatin and make another batch if it does not have the right consistency.
4. To test the consistency, attach a clean scrap of pantyhose over one end of the straw using

tape. This precaution is to keep you from inhaling a pellet by mistake.

5. After putting on safety goggles, place a pellet in the straw.
6. Tip the straw so the pellet slides to the covered end. Pinch the straw, trapping the pellet at the top of the covered end.
7. Blow the pellet into the aerogel-lo with a quick, sharp blow.
8. Gelatin has the right consistency if the pellet enters the gelatin easily, the gelatin stops the pellet, and the track from the pellet remains visible. If the pellet bounces off the bottom of the container, the gelatin is too watery. Make another batch of gelatin using less water. If the pellet bounces off the surface of the gelatin or hardly penetrates it, add more water to the next batch.
9. **CAUTION:** This demonstration can be dangerous if not done correctly. Have your students wear safety goggles.
10. Put on safety goggles and take out the cup of gelatin, straw, and pellets.
11. Place a pellet in the straw. Tip the straw so the it slides to the covered end. Pinch the straw, trapping the pellet at the top of the covered end.
12. Hold the cup so students can see it or pass the cup around the room.
13. Take a big breath and at the same time, stop pinching the straw and blow the pellet into the aerogel-lo with a quick, sharp blow. Shoot several pellets into the cup.
14. Have students observe track marks made by the pellets.
15. If possible, show the image of the track from the STARDUST website at: http://stardust.jpl.nasa.gov/spacecraft/Aerogel.html.
16. Give students a copy of the Aerogel fact sheet and discuss Aerogel with the students.
17. Using a Venn Diagram have students compare and contrast the aerogel-lo to Aerogel.

Management

This activity should be done as a teacher demonstration.

Reflection & Discussion

1. What makes Aerogel special?
2. How does Aerogel stop a comet particle?
3. What did scientists and engineers have to consider when picking a material to capture comet particles?

Transfer/Extension

1. Research Aerogel and write a report about its development and how it has been used in past space missions.
2. Find a picture of the STARDUST spacecraft then design and build a model of the spacecraft.

STUDENT WORKSHEET

Aerogel Fact Sheet

What is Aerogel?

Aerogel is a lightweight, nearly transparent substance that has many uses in space science. At one-thousand times less dense than glass, a result of being made of 99 percent air, it is the lightest solid in existence. It has superior insulating qualities (an inch of Aerogel insulates as well as six inches of fiberglass!), and has proven particularly useful for collecting small particles traveling at high velocities.

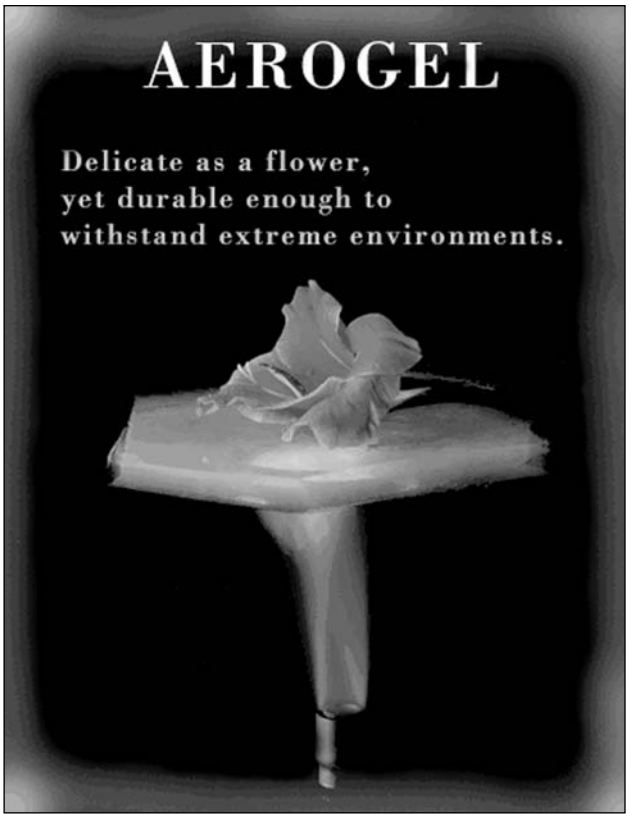


Image courtesy of Ernest Orlando Berkeley National Laboratory.

How does Aerogel act as a mechanism for capture?

Aerogel has proven itself as an excellent collector of high-speed particles. Although very tiny, these particles move so swiftly that they are very difficult to collect without damaging the particles or the collector itself. Tests done in labs on Earth and on the Space Shuttle show that, if engineered properly, Aerogel virtually eliminates both of these issues. When a particle hits Aerogel, it buries itself in the material, creating a carrot-shaped track as it comes to a stop. Because Aerogel is almost completely transparent, it is relatively easy to find these tracks and locate the particle at the tip of the "carrot."

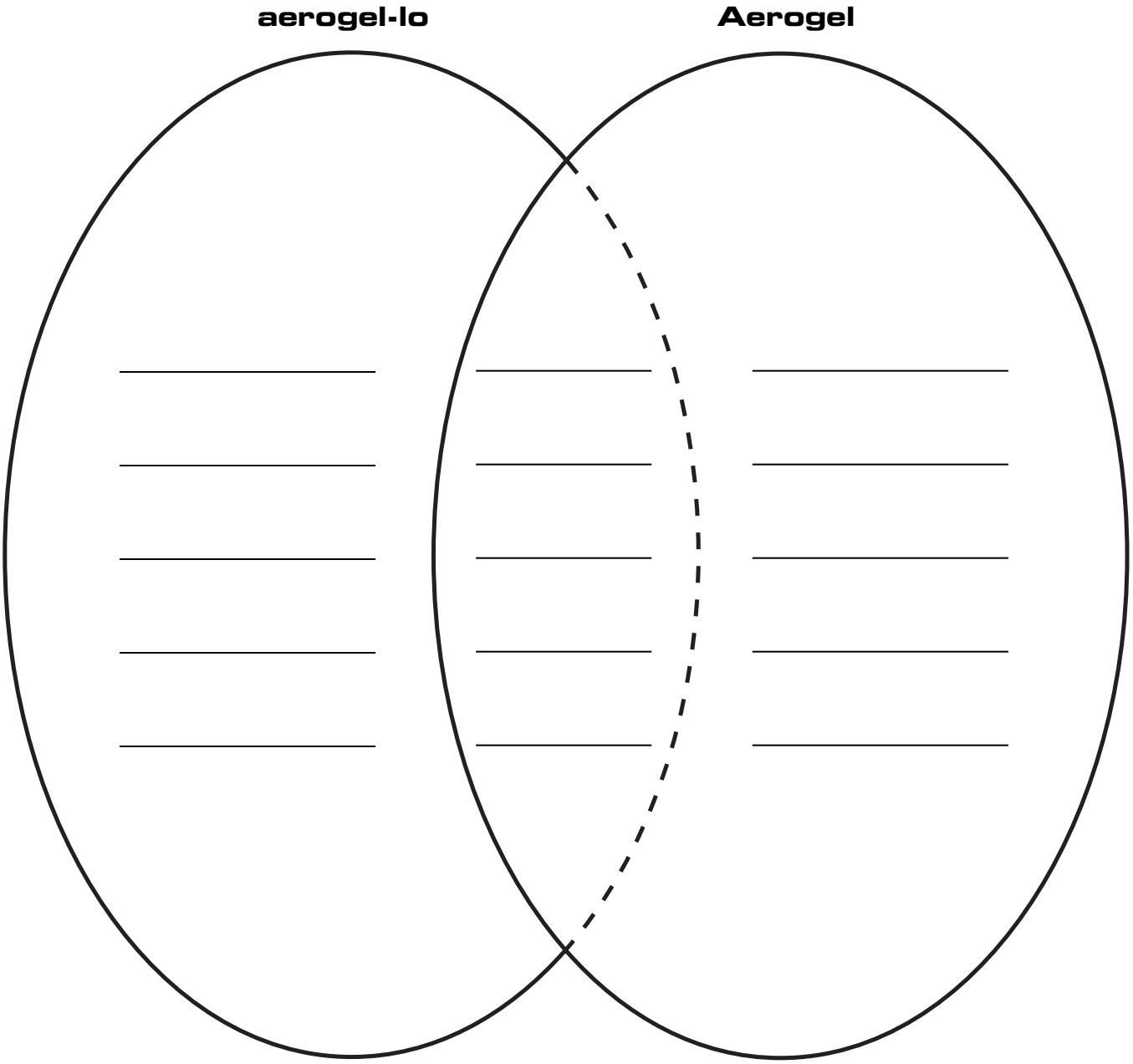
The limitations of the aerogel-lo model

Because Aerogel has so many unique properties, it is particularly difficult to find a substance that models it accurately. In this activity, "aerogel-lo" is used as an example, although there are many differences between the two. Among these are its high water content, which would not allow it to travel intact in the extreme environment of space, and its relatively large weight.

Aerogel

Student Procedures

1. Observe track marks made by the pellet in the teacher demonstration.
2. If possible, view the image of the track from the STARDUST website at: http://stardust.jpl.nasa.gov/spacecraft/Aerogel.html.
3. Read the Aerogel Fact Sheet and discuss Aerogel.
4. Using the Venn Diagram compare and contrast aerogel-lo to Aerogel.



Challenger Center Programs

The internationally acclaimed **Challenger Learning Center** Network currently consists of state-of-the-art, innovative educational simulators located at 49 sites across 29 states, Canada, and the United Kingdom. Staffed by master teachers, the core of each Center is a two-room simulator consisting of a space station, complete with communications, medical, life, and computer science equipment, and a mission control room patterned after NASA's Johnson Space Center. See *www.challenger.org* for information.

A joint initiative of Challenger Center for Space Science Education, the Smithsonian Institution, and NASA, ***Voyage — A Journey through our Solar System*** is a space science exhibition project that includes permanent placement of a scale model solar system on the National Mall in Washington, DC, and at locations all over the world. See *www.voyageonline.org* for information.

Space DaySM launches new *Design Challenges* created by Challenger Center each school year. The inquiry-based challenges are designed to inspire students in grades 4-8 to create innovative solutions that could aid future exploration of our solar system. See *www.spaceday.org* for information.

Challenger Center's ***Journey through the Universe*** program provides under-served communities with diverse national resources, including K-12 curriculum materials, teacher workshops, classroom visits by scientists from all over the country, and Family Science Nights. See *www.challenger.org/journey* for information.

The **MESSENGER** spacecraft (MErcury Surface, Space ENvironment, GEochemistry and Ranging) is to be launched in 2004 and go into Mercurian orbit in 2009. Challenger Center is one of the partner organizations charged with MESSENGER education and public outreach activities. See *www.messenger.jhuapl.edu* for information.

Through the Challenger Center **Speakers Bureau, Voyages Across the Universe**, staff members speak to student audiences of 30-1,000, conduct workshops for 100-300 educators, give keynote and featured presentations at conferences, as well as conduct Family Science Nights at the National Air and Space Museum, and other facilities across the nation, for audiences of 300-1,000 parents, students, and teachers. See *www.challenger.org/speakers* for information.

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