SUGGESTED REFERENCES

- *Glass Online – A Brief History of Glass*
  http://www.glassonline.com/infoserv/history.html
- *Center for Glass Research*
  http://cgr.alfred.edu/facts.html
- *Museum of Glass*
  http://www.museumofglass.org/education/learn-about-glass/science-and-glass/
- *Remarkable properties of glass formed in space*
  http://science.nasa.gov/headlines/y2003/14apr_zeroglass.htm

  The Very Large Telescope Project
  http://www.eso.org/projects/vlt/

NATIONAL SCIENCE EDUCATION STANDARDS

Grades K - 4

Physical Science
Properties of objects and materials
Properties of earth materials

Grades 5 - 8

Science in Personal & Social Perspectives
Science & technology in society

Grades 5 – 8

Science & Technology
Abilities of technological design
Understanding about science and technology

**Source: National Science Education Standards, 1996, National Academy Press*

CREDITS

EDUCATOR ADVISORY PANEL

Patricia Heydet-Kirsch, Ed.D.

PRODUCTION CREDITS

WRITER/PRODUCER:	Jon Glassman
ASSOCIATE PRODUCER:	Judi Sitkin
EDITOR:	Stuart Scoon
NARRATORS:	Cyrilla Baer Pond & Andrew Forman

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Science Screen Report FOR KIDS

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GLASS - 21ST CENTURY TECHNOLOGY

ABET
Accreditation Board for Engineering and Technology
www.abet.org

National Science Foundation
Presidential Awards for Excellence in Mathematics and Science Teaching

JETS
Junior Engineering Technical Society
www.jets.org

SYNOPSIS

Phoenicians may have been the first to produce transparent glass about 3000 years ago. The natural phenomenon that creates glass occurs when rocks with high silica content are heated until liquefied, about 1800 degrees Celsius, then rapidly cooled without allowing time for the elements to crystallize. High temperature phenomenon, such as volcanic eruptions, lightning strikes and meteorite impacts are known to create glass.

Today's engineers are developing extremely thin glass that is both durable and scratch resistant. While telecommunications systems require speed and accuracy, glass is proving to be important in developing semiconductors, optical fibers, and multiplexing. Precisely engineered glass is also used in terrestrial and extraterrestrial telescopes. The Very Large Telescope in Chile uses four individual mirrors, each over eight meters in diameter, to see outerspace.

CURRICULUM UNITS	RUNNING TIME
CHEMISTRY	12 minutes
■ EARTH SCIENCE	
■ ENGINEERING	
■ PHYSICS	

BACKGROUND

Our daily lives are filled with products made from glass – eyeglass lenses, drinking glasses, camera lenses, and windows. Most glass art objects are still made by glassblowing. In the 1920's kitchen, items like baking pans and teapots were increasingly made from glass. Specifically, they were made from borosilicate glass to ensure heat resistance. Its ability to withstand extreme temperature changes made glass useful in the medical field.

Today's optoelectronic engineers are developing extremely thin glass that is durable and scratch resistant. Ranging from .7 to 20 millimeters thin, borosilicate glass has remarkable refractory and physical qualities. This glass is used in laptop computers and cellular phones.

The Atacama desert in Chile, South America, is home to The European Southern Observatory's "Very Large Telescope." The approximately 350 clear, starry nights per year allow for astounding clarity when stargazing. The telescope has four individual mirrors – each one is a little over eight meters in diameter. They operate in tandem to record one huge image. The mirrors are the largest monolithical glass in the world. Each mirror is 17 centimeters thin and weighs 22 metric tonnes, has a "zero thermal expansion coefficient", and will not change its geometry due to temperature change. Zerodur glass ceramic crystals that contract when heated are embedded in the glass. This action counteracts and negates the natural effect of the rest of the glass expanding under the same conditions.

In the dynamic industry of semiconductor development, speed and clarity rule. Optical lithography has helped to make these chips less expensive and more efficient. Transistors and memory elements are transferred onto a "wafer" of an integrated computer chip using ultra-violet light, with the help of an ultra-violet light mask. There are now wafers with a structural size of up to 100 nanometers. That is 10,000 times smaller than a millimeter. Invisible to the human eye, the only way to see them is through precision lenses and data transfer technology.

In the communications industry, speed, quality of sound and cost are paramount. With the number of Internet users growing, the 'information highway' is getting very crowded. Still, data needs to be transmitted faster and accurately over greater distances. Optical fibers play a key role in transmitting data. At the beginning and end of a fiberglass cable, the optical fibers are positioned for coding and de-coding information. Multiple fibers reside within each cable to allow for greater transmission of data.

CRITICAL THINKING EXERCISES

1. Research the use of obsidian, and what it may have been used for during the Stone Age. Research other historic uses for glass. Develop a timeline to include the uses for glass. How does the timeline support the idea that understanding the chemistry of glass has influenced its historical use?
2. How would communications be different in your home if glass were not available on the planet Earth?
3. Compare and contrast the formation of glass in the natural environment, and in the scientific laboratory. How do you think the natural environment may have influenced early scientists as they learned to make glass?
4. Discuss recycling glass.
    A. Glass is 100% recyclable.
    B. Recycling glass saves 25-32% of the energy used for its manufacturing.
    C. Every day, Americans recycle about 13 million glass jars and bottles.
5. Analyze the glass recycling in your home for one week, keeping a list of all glass your family recycles. Is your family conscious of recycling? Does your recycling plan need revising?

ADVANCED ORGANIZERS

Prior to viewing this program, students should have some understanding of the following Benchmarks for Science Literacy, Oxford University Press which are excerpted and, in some cases, abbreviated below. Refer to the Benchmarks for more information.

Benchmark 3: The Nature of Technology
Section A. Technology and Science, Grades 3 - 5

- Throughout all of history, people everywhere have invented and used tools. Most tools of today are different from those of the past but many are modifications of very ancient tools.
- Technology enables scientists and others to observe things that are too small or too far away to be seen otherwise and to study the motion of objects that are moving very rapidly or are hardly moving at all.
- Measuring instruments can be used to gather accurate information for making scientific comparisons of objects and events and for designing and constructing things that will work properly.
- Technology extends the ability of people to change the world: to cut, shape, or put together materials; to move things from one place to another; and to reach farther with their hands, voices, senses, and minds. The changes may be for survival needs such as food, shelter, and defense; for communication and transportation; or to gain knowledge and express ideas.

**Benchmarks can be found at www.project2061.org/tools/benchol/bolintro.htm*

VOCABULARY

Benign . . . . . Having little or no detrimental effect; harmless.
Borosilicate . . . . . A salt that is derived from both boric acid and silicic acid and occurs naturally in dumortierite.
Malignancy . . . . . Characterized by uncontrolled growth; cancerous, invasive, or metastatic.
Mask . . . . . A type of stencil applied to the surface of a semiconductor to permit selective etching or deposition; used in the manufacture of integrated circuits by photolithography.
Melanomas . . . . . A dark-pigmented, usually malignant tumor arising from a melanocyte and occurring most commonly in the skin.
Molten . . . . . Liquefied by heat; in a state of fusion; melted.
Monolithical . . . . Of or pertaining to an integrated circuit formed in a single chip.
Multiplexing . . . . . Relating to or being a system of simultaneous communication of two or more messages on the same wire or radio channel.
Nanometers . . . . . One billionth (10-9) of a meter.
Optical fibers . . . . Glass (or plastic) threads that transmit data.
Optoelectronic . . . Electronics dealing with devices that generate, transform, transmit, or sense optical, infrared, or ultraviolet radiation, such as cathode-ray tubes, electroluminescent and liquid crystal displays, lasers, and solar cells.
Refractory . . . . . Difficult to melt or work: resistant to heat.
Semiconductor . . . Various solid crystalline substances, such as germanium or silicon, having electrical conductivity greater than insulators but less than good conductors, and used especially as a base material for computer chips and other electronic devices.
Silica . . . . . A white or colorless crystalline compound, (SiO_2), occurring abundantly as quartz, sand, flint, agate, and many other minerals and used to manufacture a wide variety of materials, especially glass and concrete.
Wafer . . . . . A thin slice of semiconductor used as a base material on which single transistors or integrated-circuit components are formed.

CAREER POSSIBILITIES

- CHEMIST
- COMPUTER SCIENTIST
- ENGINEER
- GLASS BLOWER
- OPHTHAMOLOGIST
- OPTOMETRIST
- PHYSICIST