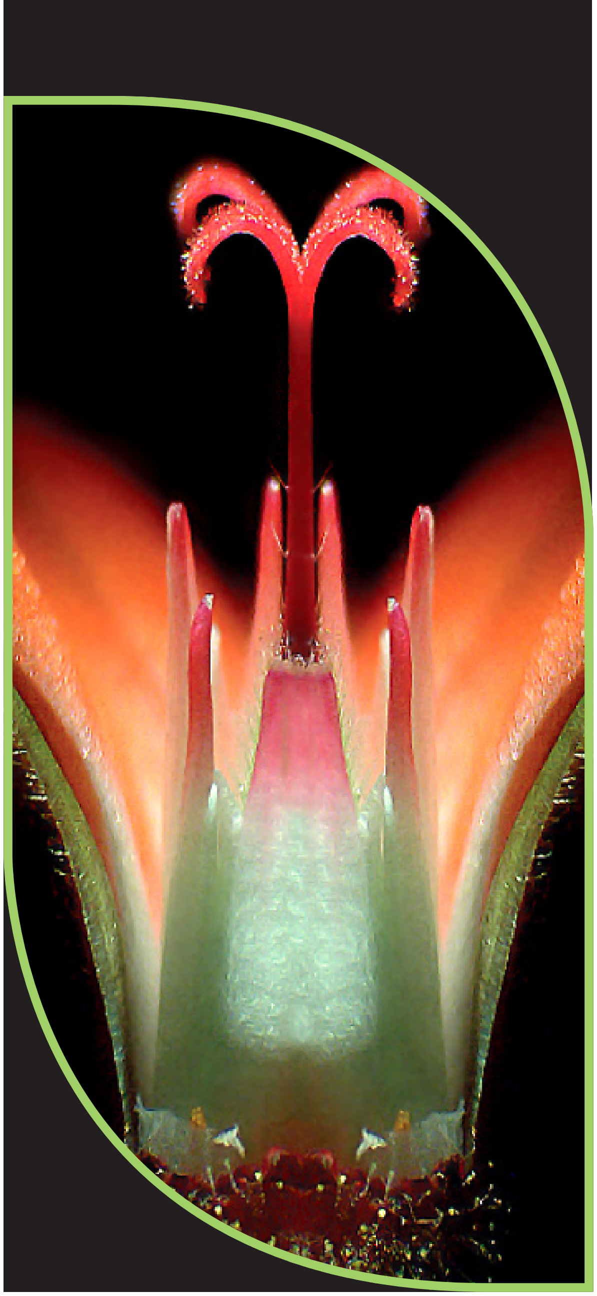

FIBER OPTICS

OSA Educational Resources … *Exploring the Science of Light*

OSA®
Optical Society of America

Optical Society of America (OSA)

Founded in 1916, OSA brings together optics and photonics scientists, engineers, educators and business leaders. OSA is dedicated to providing its members and the scientific community with educational resources that support technical and professional development. OSA's publications, events and services help to advance the science of light by addressing the ongoing need for shared knowledge and innovation. The Society's commitment to excellence and continuing education is the driving force behind all its initiatives.

OSA's Education Outreach

Education outreach is one the most important and significant ways OSA supports and inspires young scientists. A variety of materials and programs have been developed to address the needs of students from elementary school through 12th grade. We invite you to explore the education resource pages at www.osa.org and welcome your comments and suggestions. Contact OSA's educational programming staff at opticseducation@osa.org.

The OSA Foundation

Inspiring the next generation of scientists and engineers

The future's great scientists are among the children of today and tomorrow. These children live and study around the world. Some have the resources and support needed to succeed, but many others do not. The OSA Foundation believes all students should have access to quality education resources and everyone should have the opportunity to explore scientific studies and career paths.

The Foundation focuses on advancing youth science education by providing students with access to science educators and learning materials through interactive classroom and extracurricular activities. To learn more about the Foundation and its funded programs or to request support for your program, please visit www.OSA-Foundation.org, e-mail foundation@osa.org or call +1.202.416.1421.

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OP-TEC National Center for Optics and Photonics Education AMERICAN INSTITUTE OF PHYSICS Information that matters®

FIBER OPTICS

This microscopic image is of a geranium flower being illuminated using fiber optics. A medical syringe was used to insert a fiber optic line into the base of the flower to illuminate it from inside out. This unique technique allows a researcher to examine minuscule details of the flower and learn more about its structure and physical properties. The flower itself is acting like a fiber optic cable by transmitting the light throughout its various parts while minimizing the amount of light that escapes.

This image provides two excellent examples of the power and intensity with which fiber optics can transmit light. First, all of the light used for illumination in this picture is from a single fiber optic cable with a diameter of about the size of a piece of fishing line. In addition, the fine hairs coating the flower are brightly illuminated and act as individual fiber optic cables themselves.

Fiber optics is a means of transporting light in a very directional way. Light is focused into and guided through a cylindrical glass fiber. Inside the fiber, it bounces back and forth at grazing angles to the side walls, walking its way to the end of the fiber where it eventually escapes. The light does not escape out of the side walls because of total internal reflection.

What causes total internal reflection? The fiber has two layers called the core and the cladding. Light is trapped and travels in the core which is made of glass. The cladding is made up of a material with a much lower refractive index than the core. Reflections off of the second layer prevent the light from escaping the fiber because it is difficult for light to pass from a high index material to a lower index material at an extreme angle.

Why is fiber optics so important? Aside from being a flexible conduit used to illuminate microscopic objects, fibers also can be used to carry information in much the same way a copper wire can transmit electricity. But while copper transmits only a few million electrical pulses per second, an optical fiber can carry as many as 20 billion light pulses per second. This means phone, cable and computer companies can handle huge amounts of data transfers at one time, many more than conventional wires can carry.

Definitions

Grazing Angles
The angle between the laser beam and the surface of reflection, typically defined when the laser beam is nearly parallel to the surface. This angle can be as small as 1 degree or less.

Fiber Optic Line
A glass or plastic fiber used to transmit information contained in a beam of light.

Index of Refraction
A number signifying how well a material can refract light. Usually specified as "n" by scientists, the index of refraction of a material depends on its composition and density.

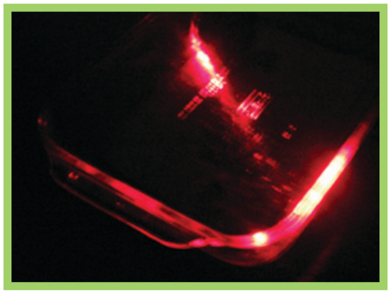
Refraction
When a light ray slows down and changes direction as a result of passing through different mediums – such as water or air.

Total Internal Reflection
A phenomenon occurring when light is incident on an interface between two transparent materials at a very shallow angle. The light must be traveling through a medium with a higher index of refraction than the neighboring medium. At the interface, all of the light is reflected back into the surrounding material and none of the light is transmitted into the neighboring material.

EXPERIMENTS

Fiber optics allow us to transport light in a very directional way using total internal reflection. Want to see this phenomena for yourself?

1. Send Light Through a Glass Baking Dish



What You Need

- Rectangular clear glass baking dish
- Flashlight or key chain laser pointer
- Room with adjustable lighting

What To Do

1) Place the baking dish on a level flat surface.
2) Darken the room.
3) Shine the flashlight or laser down one rim of the dish.
4) Look through the rim of the dish on the opposite side from the light source.
5) Move the light source back and forth along the rim of the other side. What do you see? Did the light travel to the other side or stop at the side of the dish?

2. Make a Light Fountain

What You Need

- Clear plastic bottle with label removed
- Duct tape
- Blue painter's tape
- Sink or bucket
- Thumbtack
- Corkscrew
- Flashlight or key chain laser
- Parent or friend
- Room with adjustable lighting

What To Do

1) Place a 2-inch piece of duct tape on the side of the bottle to create a "patch."
2) Use the thumbtack to punch a hole in the center of the tape patch.
3) Stick a piece of painter's tape over the hole in the bottle. (Later, you will be able to pull off the blue tape without pulling off the duct tape.)
4) Fill the bottle with water.
5) Turn on the flashlight and turn out the lights.
6) With one hand, hold the bottle over the bucket or the edge of the sink. With your other hand, hold the flashlight on the side of the bottle across from the hole.
7) Have your friend or parent remove the blue tape.
8) How does the light enter the bottle and what does it do as it comes out of the hole in the side?
9) Now place the tip of the corkscrew into the hole you have already made and turn it to make the hole a little larger. What do you see?

Career Profiles
PEOPLE CHANGING OUR WORLD

**Peter C. Schultz, Ph.D.,
Peter Schultz Consulting, USA**

Peter Schultz has figuratively seen the fruits of his labors travel millions of miles across the world— and back—infinite times. It has been a source of personal and professional gratification to see how his work in doped fused-silica glasses and their applications in optical fiber has impacted not only telecommunication systems throughout the world, but also telecommunications technology, including the Internet, over the decades.

As co-inventor of this breakthrough fiber in 1972, Schultz believed his process—outside vapor deposition (OVD)—would have a major impact on the world of telecommunications. He did not, however, realize that it would be the fiber and formulation standard for all telecommunication fibers used still today—he knew the rest of the world would first have to catch up to this discovery. "We had to work after that to improve on it, build, make practical production methods and scale up the technology. And when we were doing the work, we recognized that if it were successful, it had the potential of revolutionizing communications. "But we also realized that a lot of other things had to happen because anytime you make an invention that has such a huge impact, it takes time for those ideas to be put to a practical use." Schultz parallels this belief to transistors and television—it took many years, he said, for a practical technology to be developed that could use those inventions. And look where this technology is today, he said.

What his optical fiber discovery subsequently inspired, Schultz explained, was development of the entire system it would work within, e.g., improved lasers, optical amplifier systems, cabling technologies, etc. At the same time, he stressed, no one could have predicted its impact on technology today. "It is exciting, frankly, to look back now and see how it all really did work. The big surprise to most of us was that we could not have dreamed of the Internet being one of the driving forces behind the demand for more bandwidth. Without that, optical fiber communications—the Internet as we know it today—could not exist."

This discovery was made relatively early in his career, working closely with fellow scientists at Corning Inc., Donald B. Keck and Robert D. Maurer. Schultz went on to an exemplary and productive career, including discovering a method still widely used to make planar waveguide devices for photonics applications, and continued R&D on the optical properties of fused silica—data that still are used to determine and resolve contamination problems in fiber manufacture.

Schultz has 26 patents to his name and nearly 30 research papers. He has held research scientist, managerial and leadership roles in private enterprise since 1967, nearly 20 of those years with Corning. Since 1988, Schultz has been president of Heraeus Amersil Inc., Atlanta, a technical glass manufacturer primarily serving the fiber optics and semiconductor markets. With such accomplishments to his credit, who would think that when he was a freshman in high school, a counselor suggested Schultz was not college material.

Written by Kathy L. Woodard for The American Ceramic Society, www.ceramics.org.

**Jennifer Trahan,
Electronics Technician,
SpaceX**

Jennifer Trahan is an electronics technician at SpaceX, a launch vehicle and rocket developer. She is currently employed at their rocket test facilities, where she works closely with test teams to ensure that the necessary communications systems are in place and operational. Jennifer's job utilizes fiber optics, wireless communications, networks, remote cameras, phone systems, servers, and much more.

Prior to earning her degree, Jennifer served in the Army for four years. When she completed her service, she wanted to make a change in her life and decided to return to college. Her brother had gone to Texas State Technical College (TSTC) in Waco, so she decided to check it out. Jennifer fell in love with the school and the telecommunications program. She has always enjoyed working with her hands, so the hands-on training she received in college was perfect! The two-year degree she earned at TSTC gave her the skills and experience necessary to succeed in a unique and fascinating job.

Jennifer says "I find the work I do very rewarding because I know that I am part of the telcommmunications and fiber optic infrastructure that allows us to connect people all over the world. It is even more rewarding to know that the rockets I work on each day will one day travel into space!"

Additional OSA Resources for Students, Teachers and Parents

OPTICS: Light at Work

This 15 minute DVD is geared toward 12 and 13 year old students, and is a great resource for raising awareness of optical science, along with its applications and many career opportunities. In addition to introductory information about the science of optics, the video highlights real world applications of optical technology, from everyday items like remote controls, cell phones and bar code scanners, to space exploration, innovations in solar energy and new frontiers in medicine. A variety of career options are highlighted through clips from a diverse group of scientists currently working in the field. Helpful advice and encouragement to students is included throughout.

Laser Technology: Changing Daily Life, Forging New Opportunities

This 42-minute CD-ROM traces the fast-paced history of the laser and includes exciting visual depictions of laser applications. Targeted to high school and post-secondary students, the CD focuses on the characteristics of diode, solid-state and gas lasers and the properties that make them useful in a variety of applications including telecommunications, entertainment, biomedicine and the military.

Optics Discovery Kit

The Optics Discovery Kit provides educators with classroom tools and optics lessons. The kit features 11 experiments that demonstrate basic principles of optics. Components include: lenses, color filters, polarizers, optical fibers, a mirror, a hologram, a diffraction grating and an anamorph. Also included are teacher and student guides. The new updated version will be available January 2008.

Terrific Telescopes Kit

Terrific Telescopes is an education packet based upon the Hands-On Optics (HOO) program. The kit's activities give students the opportunity to learn about the properties of lenses such as the focal length and the "flippoint". The lessons and materials also demonstrate how to use a single lens and other household objects as magnifiers. Students are encouraged to discover how to combine two lenses together to create a simple refracting telescope. The educator-led activities include demonstrations of how light bends and how lenses are used to create colorful images. A teacher's guide with step-by-step instructions is included with the kit.

Optics Suitcases

Developed by the OSA Rochester Local Section, the Optics Suitcase is an innovative, interactive presentation package designed to introduce middle school students to a variety of science concepts. The suitcase provides students with packets of materials that can be taken home to show to friends and family members as a reinforcement of the classroom lessons. To view the Suitcase Teaching Guide, and to read articles about outreach programs that have successfully used these materials, visit: www.opticsexcellence.org.

Educational Website

OSA hosts an educational website for students, teachers and parents. All material is designed to spark students' interest in science. The site features optics experiments, tutorials, demonstrations, games, optical illusions, career profiles, reference materials and more. Visit www.opticsforkids.org to continue your exploration of optics.

For more information about ordering any of these products please contact opticseducation@osa.org.