

National Aeronautics and Space Administration



Guide Lites

The Colors of Ice

www.youtube.com/nasaclips

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The Colors of Ice

Polarizing filters, like those found in sunglasses, are used to reduce glare. Polarizing filters in photography are used to make lighted background objects, like the sky, appear darker. Double refraction, or birefringence, is an interesting, colorful phenomenon related to polarized light as it passes through certain types of crystalline structures.

Birefringence is a process in which light moving in different directions, or polarizations, travels at different speeds within a material. The light waves are split into unequally reflected or transmitted waves. When light is emitted from a source, the waves of light vibrate in all directions and orientations. When this same light passes through a piece of polarizing film, only light waves moving in one direction can pass through the filter. All other waves are blocked.

When one piece of polarizing film is placed on top of another, the films will be either transparent or opaque to light depending on whether the films are parallel or perpendicular to each other. By rotating one film while leaving the other stationary the light will be blocked or travel through both films. When the light is blocked, the filters are described as being cross-polarizers.

Light traveling through certain kinds of crystals is split into two waves. Each wave travels at a different speed. The light from each wave is refracted or bent as it passes through the crystal, creating a double image of anything viewed through the transparent medium. When these crystals are placed between cross-polarizers they display a multitude of colors. These colorful displays can be analyzed to help scientists understand the crystalline structure of the material.

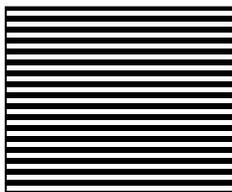


Figure 1: Only horizontally-oriented light can pass through this film.

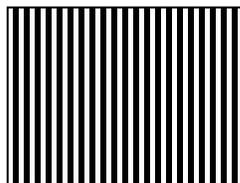


Figure 2: Only vertically-oriented light can pass through this film.

Although the polymer structure of plastics is not crystalline, stressing plastic by compressing or stretching it often produces birefringence. Exposing materials such as clear cellophane tape or molded clear plastic, to a pair of polarizing filters produces the same birefringence as seen in crystals. Engineers can use this process to analyze a structure by building a plastic scale model and applying force to the structure. Polarized filters are then used to see where the stress is greatest. The colored bands indicate places where stress fractures are likely to occur. This same process is often used to identify the crystal structure of gemstones, such as diamonds, before they are cut and polished.

Dr. Peter Wasilewski, scientist at NASA Goddard Space Flight Center, uses polarized light to study the size, structure, and orientation of ice crystals. He also uses polarized light to create a unique art form he calls Frizion. Participants can learn more about his art by researching the web site at: www.frizion.com.

Figure 3: Dr. Peter Wasilewski, Frizion



Objective:

In this activity participants learn about light refraction and birefringence by viewing sculptures of transparent tape through polarized film.

Materials:

- art wire or floral wire to make wire sculptures
- several rolls of transparent tape (do not use “invisible” tape)
- light source such as a light table, overhead projector, or a large bright lantern
- two 15 cm x 15 cm pieces of polarizing film
- digital camera (optional)

Engage:

Ask participants to create their own unique, colorful artwork using polarized filters. Give the participants several strands of art wire to create a wire sculpture no more than 15 cm (about 6 inches) high. The sculpture should then be covered with strips of cellophane tape. Overlap the tape in different directions, forming several layers over the entire structure. Be sure to test the tape beforehand. Some types of tape, such as “invisible tape” will not work. Place the sculptures in front of one piece of polarizing film. Rotate a second piece of film in front of the sculpture while shining a bright light through the film from behind the stationary piece. Document the brilliant colors using digital photography.

Explain:

To learn more about the birefringence, watch the NASA eClips™ video segment, *Launchpad: Thin Ice – Looking at Birefringence*, which can be viewed or downloaded at: www.nasa.gov/education/nasaclips. This segment can be viewed in high definition using the following direct link to YouTube/NASA eClips™: http://www.youtube.com/nasaclips#p/c/D7BEC5371B22BDD9/7/VVQJak_TkTI .

Extend:

To learn more about NASA’s study of ice and snow, watch the NASA eClips™ video segment, *Real World: History of Winter -Abiotic Conditions*, which can be viewed or downloaded at: www.nasa.gov/education/nasaclips.

This segment can be viewed in high definition at the following direct link to YouTube/NASA eClips™: <http://www.youtube.com/nasaclips#p/c/887C1C3BAAD53F17/1/6fk15NgtKmY> .

To learn more about winter biomes, watch the NASA eClips™ video segment, *Our World: Snowpits*, which can be viewed or downloaded at: www.nasa.gov/education/nasaclips

This segment can be viewed in high definition at the following direct link to YouTube/NASA eClips™: <http://www.youtube.com/nasaclips#p/c/31002AD70975DC1B/0/ADdsB217LPA> .

