

# I'm Under a Lot of Stress Here!

## Overview

Structural engineers and other scientists are always trying to find ways to make structures lighter and stronger. In order to do this, they need to know what parts of a building (or a bridge or other object) experience the most stress and which parts of these same structures don't feel any stress and might not be necessary in their construction. By utilizing a phenomenon called stress birefringence, students will observe various objects under stress.



## Students Will Learn...

- ◆ Certain materials change the polarization of light when stressed.
- ◆ You can use two polarizing filters to examine the stress in certain plastics.
- ◆ Different shapes have different strengths and weaknesses.

## What you need

*For each group of 2-3 students:*

- ❑ 2 polarizing filters
- ❑ Plastic wrap
- ❑ Clear plastic knife, fork, spoon
- ❑ Clear plastic wrap
- ❑ Other clear plastics and glass (optional)
- ❑ Extra copy of "STUDENT HANDOUT: I'm Under a Lot of Stress Here!"

*For each student:*

- ❑ Copy of "STUDENT HANDOUT: I'm Under a Lot of Stress Here!"

## GO: I'm Under a Lot of Stress Here!

1. Distribute materials and handouts to each group of students.
2. Students will complete the "STUDENT HANDOUT: I'm Under a Lot of Stress Here!"  
Assist students as needed.

## What's Really Happening Here...

Birefringence is a complicated phenomenon. Birefringent materials have different indices of refraction when light passes through them in different directions. When unpolarized light enters a birefringent material, the light splits into two rays, because of these different indices of refraction.

You can see this effect with the calcite in your kit. Draw a small dot on a piece of paper and place your calcite over the dot. You will see two images. Remember that each dot is due to light polarized in a different direction. Take your polarizing filter, hold it over the calcite, and observe the dots. Slowly rotate your polarizing filter and you will see one dot disappear, then both dots



will be visible, and then the other dot will disappear as you continue to rotate the filter! This is due to the fact that each dot is caused by light polarized in a different direction. When you stress certain materials, they become birefringent. The stress can then give rise to the marks you see in the plastic.

### **Going Further**

There are many substances that show stress marks. You can examine eyeglasses, protractors, clear rulers, CD cases, plastic wrap, and many other objects. Have students explore objects under stress in the world around them.



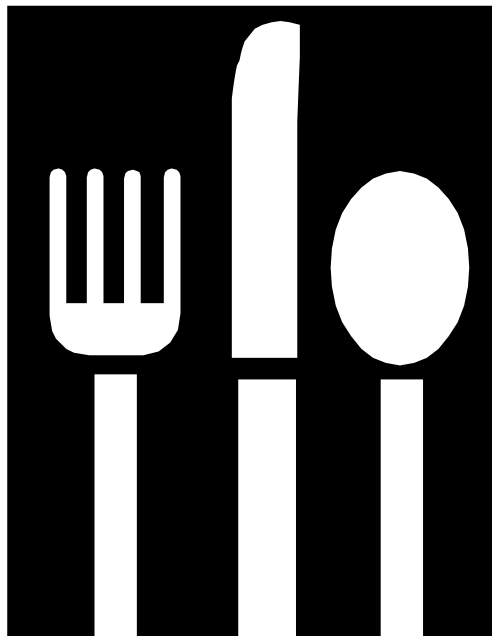
# STUDENT HANDOUT: I'm Under a Lot of Stress Here!

## What You Need

- ❑ 2 polarizing filters
- ❑ clear plastic knife, fork, spoon
- ❑ clear plastic wrap
- ❑ other clear plastics and glass (optional)

## What To Do

1. Hold the two polarizing filters about 6 inches apart. Rotate the filters until no light makes it through the filters.
2. Have your partner hold the plastic wrap between the filters. Slowly stretch the plastic wrap. What do you observe as the plastic wrap is stretched close to the breaking point?
3. Place the clear plastic fork, knife and spoon between the filters, one at a time. Sketch the patterns you see on the picture below.



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4. No light makes it through the two filters before you put the material in between them. What do you think is happening to create the patterns you see?

5. Try putting other clear objects between the filters (such as someone's glasses, a plastic bottle, etc.) What do you observe?

6. Gently bend the plastic utensils (without breaking them!) and observe what happens. How do you think you could use polarizing filters to find the points of stress in an object?



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