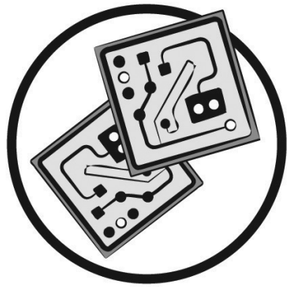
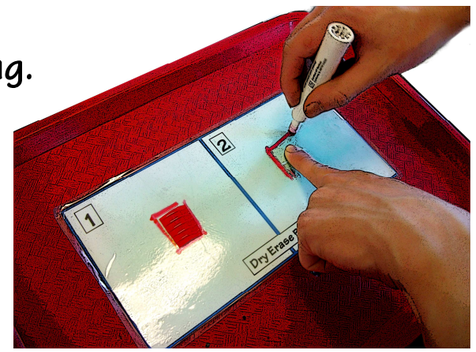


# Shrinkers

1. Always wear safety goggles.

CAUTION: THE BURNER AND THE PAN ARE HOT - Use care!

2. Find the Dry Erase Board. Use a towel to wipe off any writing.
3. Take a piece of plastic 1. Trace its outline onto the space of the dry erase board labeled 1. KEEP THE PLASTIC.
4. Take a piece of plastic 2. Trace its outline onto the space of the dry erase board labeled 2. KEEP THE PLASTIC.
5. READ THIS STEP COMPLETELY BEFORE DOING IT.
   - Drop the piece of **plastic** 1 into the center of the pan.
   - Cook it for a total time of 1 minute. Use the spatula to turn the plastic over every 10 seconds during cooking.
   - Use the spatula to remove the plastic from the pan and drop it into the bowl of water.
6. Remove the plastic from the water and compare it with the outline you drew on the paper.
   - How do the shape, size, and thickness of the cooked plastic compare with those of the original plastic?
7. Repeat steps 4 and 5 with the piece of plastic 2.
   - How do the two plastics react differently to cooking?
8. Put the plastic pieces in the "Used Plastic" cup.







## Why do the plastics shrink differently?

## A Closer Look

Both plastic 1 and plastic 2 are made of a mixture of polystyrene plastic and rubber. Polystyrene molecules are made of long zigzag-shaped chains of carbon atoms. In these plastics the polystyrene forms a porous skeleton, its holes are filled with rubber.

Plastic 1 came from a plastic cup. As the cup was made, the plastic was stressed in one direction. When heated, the plastic softens and shrinks in that direction. Plastic 2 came from a plastic tray. As the tray was made, the plastic was stressed in two directions. When heated, the plastic softens and shrinks in both directions.

# Talking Points: Shrinkers

## Extensions

Do this:

1) Make certain the visitor notices that plastic 1 shrinks in only one direction, while plastic 2 shrinks in two dimensions.

2) When the visitor chooses pieces of plastic 1 and plastic 2, take a permanent marker and draw a "happy face" on each.
   *As the plastics shrink, the face on plastic 1 will be deformed, while the face on plastic 2 will retain its shape but shrink.*

## Applications

Plastics are widely used in society. We see this in the choice of a plastic cup and a deli container for Plastic 1 and Plastic 2.

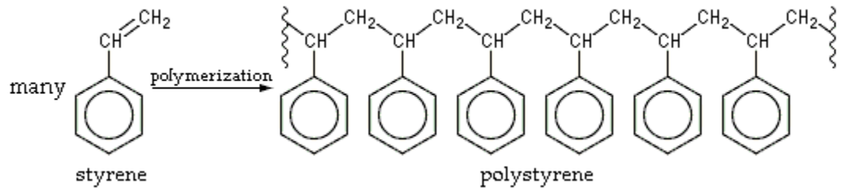
**Polystyrene** is chemically not reactive. This makes it useful for applications like food and drink; it does not react with materials we will later eat or drink.

While pure polystyrene is very brittle (it is the material used for CD or DVD covers, which break when bending is attempted), it can be mixed with rubber to form more flexible plastics (like those in plastic cups or deli containers).

When produced as a foam, polystyrene is used in various packing materials. In addition to CD covers, the brittle pure form is also used for items like disposable razor handles.

## In-Depth Information

Polystyrene is a **polymer** (a very long molecule made up of many repeating units) produced by connecting many single molecules of styrene:




Different varieties (called **isomers**) of polystyrene are possible by controlling the successive positions of adjacent benzene rings as the polymer is formed. These isomers each have distinct properties.

The flexible plastics used in this experiment are produced by combining polystyrene with rubber. The polystyrene forms a porous "skeleton", with the holes filled with rubber (either natural or synthetic). The rubber permits a certain degree of "bending" to occur that is not possible in pure polystyrene.

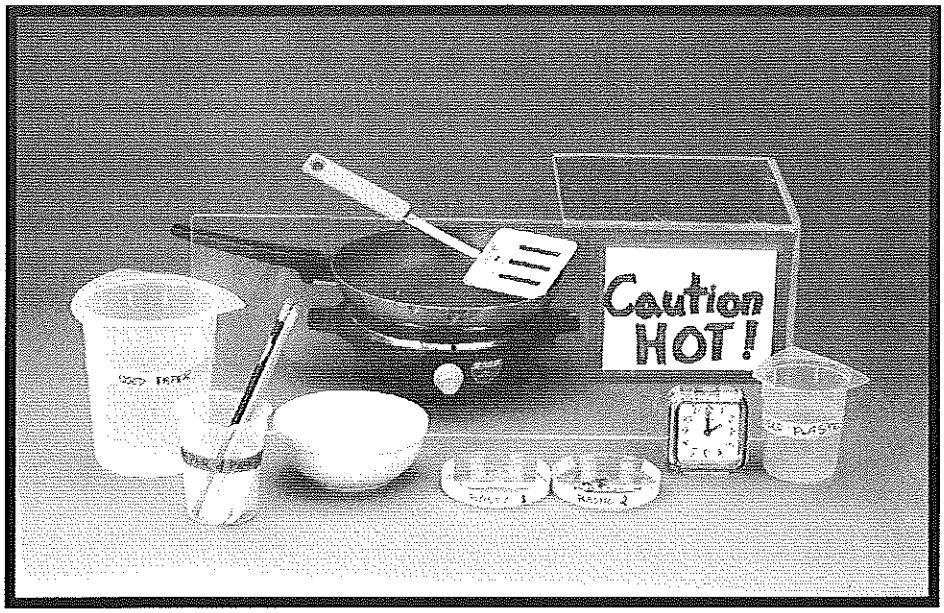
The successive chains of the polystyrene molecule are held together by "van der Waals" attraction, which is much weaker than the chemical bonds that hold the adjacent carbon atoms in the chain. Other variables include the isomer of polystyrene used, the average length of the chain, the structure of the polystyrene "skeleton", the type of rubber used, and the amount and location of open space in the structure.

Heating softens the rubber and further overcomes the "van der Waals" attraction so that shrinkage can occur. Whether it is in one or two directions depends on the details of composition, structure, and production method.

EXPERIMENT

# Shrinkers

*Visitors use heat to shrink samples of polystyrene. They compare samples from containers that were shaped in different ways during manufacture.*




## OBJECTIVES:

Visitors learn how industry can shape polystyrene molecules by heating and stretching them to form containers.

| SCIENCE TOPICS | PROCESS SKILLS | VOCABULARY |
|---|---|---|
| Properties of Molecules | Observing | Atom |
| Polymers | Investigating | Molecule |
| | Inferring | Polymer |

# Shrinkers

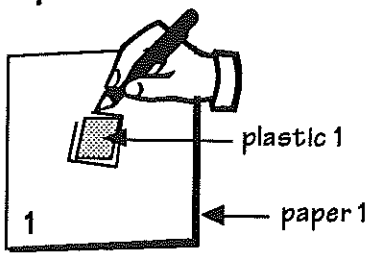
## Procedure:

1. Always wear safety goggles.

CAUTION: THE BURNER AND THE PAN ARE HOT - Use care!

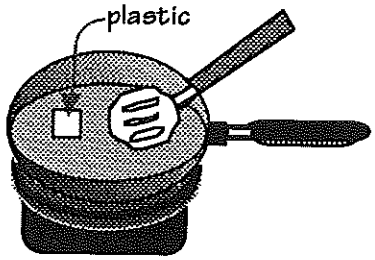
2. Take two pieces of paper. Write "1" in a corner of one piece of paper. Write "2" in a corner of the other piece.

3. • Take a piece of plastic 1. Trace the outline of the piece onto paper 1.
   • Take a piece of plastic 2. Trace the outline of the piece onto paper 2.




4. Fill the bowl halfway with cool water from the faucet.

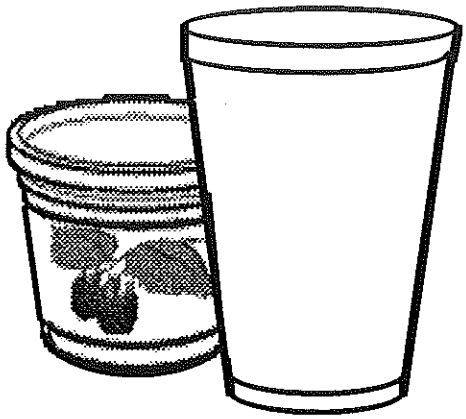
5. READ THIS STEP COMPLETELY BEFORE DOING IT.
   • Drop the piece of plastic 1 into the center of the pan. Cook it for a total time of 1 minute. Use the spatula to turn the plastic over every 10 seconds while it's cooking.
   • Use the spatula to remove the plastic from the pan and drop it into the bowl of water.




6. Remove the plastic from the water and compare it with the outline you drew on the paper.
   How do the shape, size, and thickness of the cooked plastic compare with those of the original plastic?

7. Repeat steps 5 and 6 with the piece of plastic 2.
   How do the two plastics react differently to cooking?

8. Put the plastic pieces in the "Used Plastic" beaker. Put the paper in the "Used Paper" beaker.



# How do you make a plastic cup?

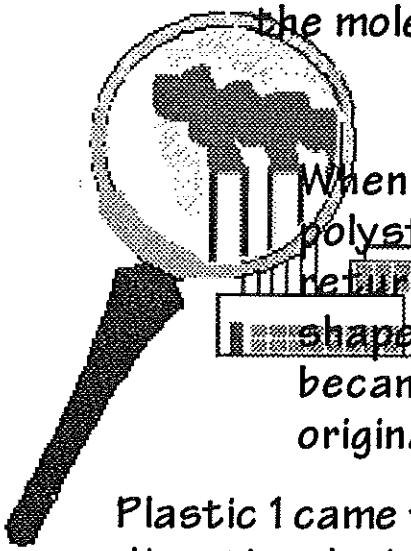
## A Closer Look:

Both plastic 1 and plastic 2 are made of polystyrene (recycle-code 6). Polystyrene molecules are made of long zigzag-shaped chains of carbon atoms.

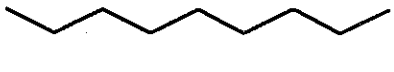
polystyrene molecule

Polystyrene is used to make many kinds of containers, including plastic cups, yogurt containers, and plastic deli and fast-food containers.

During the manufacturing process the plastic is heated, stretched into shape, and cooled. This process freezes the molecules in a stretched-out position.



When you heated the piece of polystyrene, the molecules returned to their original zigzag shape. Thus, the plastic shrank and became thicker but retained its original shape.




Plastic 1 came from a plastic cup. It was stretched in only one direction during manufacture, so it shrank only its length when you reheated it. Plastic 2 came from a deli container. It was stretched in two directions, so it shrank in both length and width.

## MATERIALS

*See Materials Prep for more details*

**(with amounts to have on hand)**

- One hot plate
- One small nonstick frying pan
- One bowl (cereal-bowl size)
- One metal spatula
- One 1000-ml plastic beaker
- Two 250-ml plastic beakers
- Two plastic petri dishes
- Sharpened pencils (keep four on hand)
- 100 sheets of scrap paper (8½ in. x 11 in.)
- Clear plastic cups with #6 recycle code (keep 20 on hand)
- Clear or black plastic rectangular deli containers with #6 recycle code (keep 20 on hand)
- Clock (from general storage)

### Setup/Takedown Procedures

## ORIGINAL SETUP

- ❑ Prepare sign about 5½ in. by 8 in.: **"CAUTION: Hot plate and pan are hot!"**
- ❑ Laminate the sign.
- ❑ Label the large plastic beaker "Used Paper."
- ❑ Label the two small plastic beakers "Paper and Pencils" and "Used Plastic."
- ❑ Label the two plastic petri dishes "Plastic 1" and "Plastic 2."

## WEEKLY SETUP

- ❑ Cut the needed paper and plastic. (See Materials Prep.)
- ❑ Sharpen the pencils.
- ❑ Place the hot plate on the counter, far back from the edge. Secure the hot plate in place by taping the cord to the counter. Using brightly colored tape, secure the laminated caution sign to the counter in front of the hot plate.
- ❑ Get the clock from general lab storage.

## DAILY SETUP


- ❑ Set out the visitor instructions in a Plexiglas holder.
- ❑ Plug in the hot plate and turn it to "3" to warm up **ten minutes before opening.**
- ❑ Place the frying pan on top of the hot plate's burner.
- ❑ Check to be sure that the sign, **"CAUTION: Hot plate and pan are hot!"** is secured to the counter in front of the hot plate.
- ❑ On a tray lined with a white mat, set out the following:
  - One spatula
  - One bowl
  - Three labeled plastic beakers
  - Two labeled petri dish bottoms
  - One clock
- ❑ Restock the paper, pencils, and plastic in the appropriate beakers and petri dishes as needed.
- ❑ Fill the bowl halfway with cold water.
- ❑ Sharpen the pencils if needed.
- ❑ Secure the tray to the counter with rolls of duct tape (so that the tray will not cover the caution sign).

## DAILY TAKEDOWN

- ❑ **UNPLUG and TURN OFF the hot plate.** Allow it to cool before storing it.
- ❑ Rinse and empty the bowl.
- ❑ Discard all used paper into the paper recycling box.
- ❑ Discard all the used plastic.
- ❑ Return all equipment to the experiment tub.

## WEEKLY TAKEDOWN

- ❑ Return all cooled and dried equipment to the tub.
- ❑ Return the clock to general lab storage.
- ❑ Clean the tray and leave it at the station.

## RUNNING SUGGESTIONS

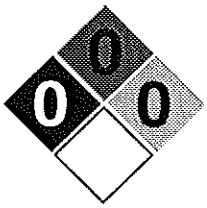
◊ Monitor the hot plate and frying pan frequently. Check that the heat setting has not been changed and that plastic has not been left in the pan.

◊ Encourage visitors to try the experiment again if they get ambiguous results.

## EXTENSIONS

This is the same material and process used in the toy "Shrinky Dinks™." Try other recycle-code 6 plastics and compare their behaviors.

## SAFETY & DISPOSAL




Use of a hot plate requires frequent monitoring; follow the safety precautions.

## MATERIALS PREP

To prepare paper:

❑ Cut scrap paper into small pieces about 2 in. by 2 in. (Keep 300 on hand.)

To prepare plastic:

❑ Cut approximately 3/4-in. square pieces from the sides (NOT from the bottom) of a #6 recycle-code clear plastic cup (keep 150 pieces on hand). Place the pieces in the "Plastic 1" petri dish.

❑ Cut pieces of plastic approximately 3/4-in. square from the BOTTOM of a #6 recycle code clear or black plastic rectangular deli container; if the plastic is clear, use a permanent marker to mark each piece with an "X." (Keep 150 pieces on hand.) Place the pieces in the "Plastic 2" petri dish.