POLYMER STATIONS SHRINK TO FIT

GOALS/PURPOSE

• Demonstrate polymer memory and thermoplastics

MATERIALS/EQUIPMENT

- Scissors
- Rulers
- Balance
- Permanent markers
- Polystyrene (PS; recyclable #6) plastic: salad trays, bakery boxes
- Tray covered with aluminum foil
- Spatula
- Toaster oven
- Pot holder
- Hole punch
- 2 ceramic tiles (optional)

PROCEDURE

- 1. This is a two-day lab. The first day, the students experiment in groups with percent reduction of PS using different geometric shapes. Next they design individual projects and calculate what the preheated dimensions need to be, using what they learned the first day.
- 2. Collect enough items made of recyclable plastic #6 for each student to have one.



Fig. 4.15 Original polystyrene object before shrinking



Fig. 4.16 Shrinking a polystyrene object in a toaster oven

- 3. Preheat the toaster oven to approximately 300° F.
- 4. Draw the following geometric shapes on the board: circle, square, rectangle, triangle, and a rhombus. Have the students provide the formulas for calculating the area of each. Divide the students into five teams and assign each one a shape.
- 5. Each team is to cut out the largest shape possible from their piece of plastic. They measure the dimensions, calculate the area, and find the mass of their geometric shape and record all data.
- 6. Shrink each shape using the preheated toaster oven. Place the piece of PS on an aluminum foil covered tray and place it in the oven. It should take about one minute and will sometimes curl up as it heats. Once it has uncurled, it can be removed from the oven. Watch it carefully. Sometimes it will curl up and "stick" to itself. You can usually undo it by manipulating it with forks if it doesn't harden too quickly. Use the spatula to flatten it while it is still hot if still slightly curled. Pressing the piece between two ceramic tiles works very well.
- 7. Students measure the dimensions, calculate the area, and measure the mass of their geometric shapes again. They should record the "after-heating" data on the board for all students to copy into their journals. Once again, have them make observations about the plastic in their journals.



- 8. Have students calculate the percent reduction and the percentage of plastic area remaining.
- 9. On the second day, the students design individual projects (key chains, pendants, earrings, Christmas ornaments, luggage tags, etc.). They draw the design in their journals showing the dimensions they wish their final project to have. Using the information gathered in the team activity, they determine what the original dimensions of their plastic will need to be. Have them make the object and compare the size of the completed project with their original drawing. Permanent markers may be used to add color and create designs. A hole punch can be used to make key chains luggage tags. (Demonstrate this for them. One punch shrinks too much to fit most key rings, so usually multiple over-lapping punches are needed. Be sure to punch the holes before the shrinking process.)

INSTRUCTOR NOTES

- The plastic used in this activity (PS) is easy to work with when heated. While hot, PS can be stretched into any shape required. Normally, the polymer chains in a piece of PS are jumbled together in an almost random way (think of wet spaghetti noodles dumped on a plate). When heated, the strands can be stretched into a more ordered pattern and "frozen" in place. If the PS is reheated, it returns to its original shape (a type of "memory polymer"). A plastic that softens upon heating and can be reshaped is known as a thermoplastic. Thermoplastics can be melted or softened to make new products and thus are recyclable. They include polyethylene, polypropylene, polyvinyl chloride (PVC), and polystyrene. Products and packaging made from one of these thermoplastics are stamped with the recycling symbol —a triangle of arrows with a number (1-7) inside.
- Students may also measure thickness (both before and after heating) with calipers. This will allow them to calculate the percent change in thickness and also compare volumes.
- Have plenty of PS because the students will likely end up wanting to make more than one project.
- On the average, between 70% and 90% reduction in area occurs.
- Websites where sheets of polystyrene can be purchased:
 - o https://www.dickblick.com/products/grafix-shrink-films/?ig_id=6829
 - o http://www.misterart.com/store/view/003/group_id/7371/GRAFIX-Shrink-Film.htm

