

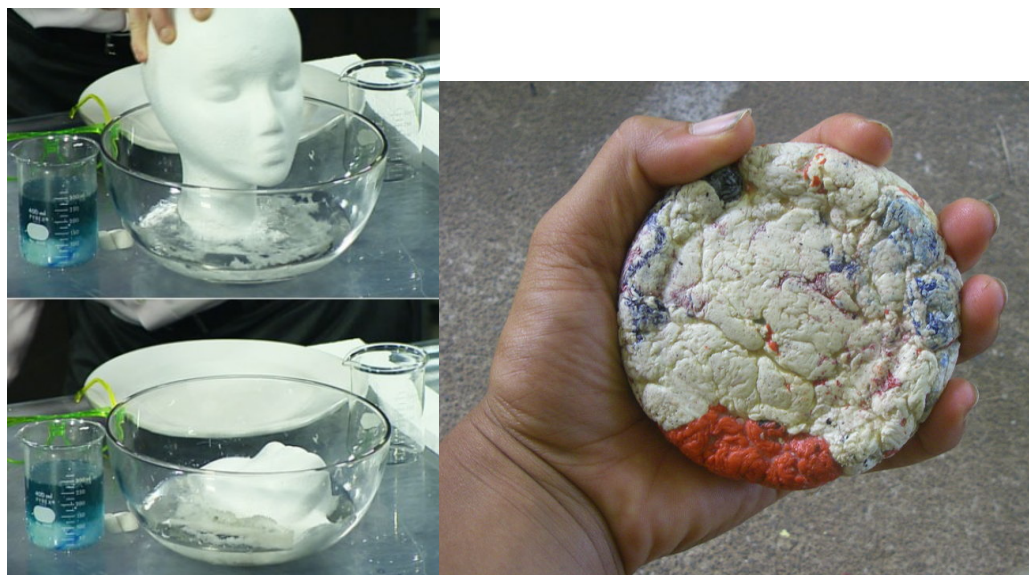
West Side Science Club – Event 17 – “Recycling Plastic”

Original Presentation (scheduled)

Date: 23 November 2013
Time: 10 am to 12 pm
Site: West Side Science Club

Brief Description

This lesson plan for the science club comes in two parts. The first is centered on the use of solvents for dissolving and repurposing low density Styrofoam, with acetone as the solvent, into solid polystyrene. The second part will focus on repurposing low density polyethylene (LDPE) plastic bags by melting down the bags using heated oil, allowing for the students to remold the material into other objects.



Big Questions

Words of the Day: polymers, bonds, and solvents

Concepts

Concepts to cover from the “Work of CCI Solar” Mind Map:

Level one (concepts): materials -> properties-> phase changes; materials->compounds; engineering -> fabrication;

Level two (skills): testing materials;

Motivation for this Activity

This activity is an introduction into how polymers can be recycled and repurposed via two methods. Plastics form a large component of modern materials, and it is important for students to understand how they can be reused through various chemical and physical processes.

Polymer materials

Definition: a large molecule composed of many repeated subunits of segmented molecules, known as monomers. A polymer is an organic material and the backbone of every organic material is a chain of carbon atoms. The carbon atom has four electrons in the outer shell. Each of these valence electrons can form a covalent bond to another carbon atom or to a foreign atom.

Solvents

Definition: typically a liquid capable of dissolving a solid. For this activity we will be using acetone to dissolve polystyrene in order to release all of the gas trapped in the Styrofoam. Using the common rule, "like dissolves like", this activity helps show how non-polar materials can mix into a common solution.

Polar and non-polar

Definition: Polar materials have easily separable charges, such as salt and water, and will mix as a result. Non-polar materials, such as oil and Styrofoam, do not have easily separable charges. They will still mix with one another, but a non-polar and a polar material will not dissolve one another (e.g. oil and water).

Recycling plastics

Plastics are formed from linked polymers, which in of themselves tend to be non-polar materials. As a result, they can be changed in form through the addition of a non-polar solvent. In the case of this activity it will be the addition of acetone to the polystyrene foam in Styrofoam. The action of such a solvent will cause the polystyrene to form a solution with the acetone, which will cause the air in the foam to outgas. The result will be a solution, which when the acetone evaporates away, will yield a solid form of the source plastic.

The other method by which plastics can be reformed is through the addition of heat. Heat will loosen the bonds between polymers, in this case the LDPE present in plastic bags, and allow for a solid to be physically reformed. The binding forces are the result of van der Waals forces between molecules and mechanical entanglement between the chains. When plastics are heated, there is more molecular movement and the bonds between molecules can be easily broken. This is why plastic materials can often be re-melted.

Lesson Plan

Student Objectives

- Explore how to recycle in individual or group projects
- Explain what is a polar and non-polar material, how to use this knowledge to chemically dissolve plastics.
- Explain what is a polymer, and how the nature of chains of molecules give plastics their unique properties.
- Explore how to use heat to melt and reform plastics.

Schedule/Agenda

- Review: Event #16 – “Thermoplastics and scar stuff” and Event #9 “Sugar and Salt” (5 min)
- Polymers, phase changes, and gels (Ben, 5 min)
 - The thermoplastics activity was a good example of what polymers are, and how heat can change their form.
 - The sugar and salt activity is a good example of how materials can be dissolved in one another. In that case polar salt dissolving in polar water.
- The day will be broken into two activities to be completed with a mentor at each table:
 - Activity #1: Use acetone to dissolve and reform Styrofoam (45-50 min)
 - Section #2: Use a heated oil bath to melt and reform LDPE plastic bags (45-50 min)
- Wrap Up and Summarize Findings and Unusual Discoveries (10-15 min)

Materials

General Items

Ben

- Cookie cutters and cookie trays for working with melted plastic
- Styrofoam

Shu

- 2 hot plates
- Canola oil
- 2 pyrex bowls to hold heated oil and LDPE plastic bags
- acetone
- LDPE plastic bags
- Latex gloves and thermal insulation gloves
- Thermometer

Safety

- Students must wear their eye protection and gloves to practice good safety habits for experimental work, especially in working with plastics heated above 120C as well as foam dissolving acetone.
- Work with acetone should be done outside in a well-ventilated area.
- We should have two Hot Plate Mentor who loads and unloads the molten plastic for various groups.

Review of Previous Event: Thermoplastics and Sugar and Salt

- Reviews of sessions 9 and 16. How heat can break links between polymers as well as how materials of common polarity can dissolve one another.

Dissolving styrofoam in acetone Procedure

Procedure- To be completed with a mentor at each table, outside, of students (3-5) leading the procedure

1. For each group give a container of acetone and piece of styrofoam. As the foam is added it will begin to dissolve. Student can add pieces of foam until it stops dissolving.
2. At this point the students, wearing gloves, can take the dissolved polystyrene out of the container. It will have a consistency similar to putty.

3. Students can add other materials to the plastic and set it to try in a particular shape.

Melting plastic bags Procedure

1. While the students are outside working with the polystyrene one of the adults will set up an oil bath to a temperature of approximately 120C. A few bags will be added to check for when the plastic begins to melt.
2. Students come back in and one of the mentors demonstrates how a single plastic bag will melt in the oil bath.
3. At this point student can choose different color plastic bags to melt down. The resulting material is hot an malleable.
4. The melted material will be placed on a cookie tray and cut using cookie cutters. The material can then be placed in a freezer for about five minutes to let it harden.

Possible Facilitation/Concept Questions

1. What happens in the plastic LDPE bags that causes them to fuse when heated?
2. Why does the plastic in the bag go from solid to liquid when heated up?
3. What is happening to the bonds of the plastic in the Styrofoam when the acetone is added?
4. Why will Styrofoam not dissolve in water?
5. Why is oil and not water used in heating up the plastic in the bags?

Additional Activity Variations and Testing

1. Can other materials, such as pigments and glitter, be easily mixed into the plastics?

Wrap Up

- Students should share their creations, both composed of recycled plastics.

References

1. Instructables: Plastic Smithing
<http://www.instructables.com/id/HomemadePlastic/>