

KID TECH PLASTICS AND RECYCLING PROJECT

INSTRUCTOR'S REFERENCE MATERIALS

Purpose

The purpose of this assignment is to give the student a background on plastics. In order to understand the basics of plastics, students must at least have a minimal background in chemistry. Additionally, the project will require students to recognize what everyday plastic articles are made of. It is recommended that the project be given to advanced students—teacher discretion should be used.

The subject of plastics is rather difficult to understand. Therefore, the focus of this project is to give the student a background on why plastics have the properties that they do. In addition, it is our goal to inform students of environmental concerns involved in plastic recycling efforts.

Material experimentation at any level requires advanced equipment and is usually quite expensive. Therefore, the more complicated and more “dangerous” experiments that are included are left as demonstration for the teacher to complete. The included student experimental portion allows the student to observe the varying properties of plastics. Observation and documentation skills should be emphasized when each child is performing the experiment.

Materials

- Pieces of plastic (brought in by the student) representing recycling codes 1, 2, 4, 5, and 6
- Scissors
- Aluminum foil pan (or aluminum foil made into a pan)
- Burner (or some other form of heat source) able to reach temperatures greater than 300°F
- Something to stir molten plastic (glass or metal rod)

Assembly

Other than preparing the materials for the teacher demonstration, no real assembly is required. The students should be given advance notice in obtaining the needed plastic articles. Using discretion, the teacher may assign this activity to individual students or assign groups of students to bring in plastic (groups pre-selected by the teacher). Specifically, the teacher should assign each student (or group) a recycling number to find. Before assigning the student a recycling number, the teacher should show the students where to look on plastics to find the code.

Experimentation

The student observation period should last no longer than 20-30 minutes. The plastic melting demonstration (included below) should last no longer than 30 minutes. The total length of the experiment should be approximately one hour.

Additional Resources

The following web addresses may be used in conjunction with the experiment to give the students a better understanding of plastics and plastics recycling. In addition, students will gain additional practice using the Internet.

- www.plastics.org.nz
- www.plastics.org
- www.polystyrene.org
- www.recycle.net
- www.plastics.com
- www.4spe.org
- www.plasticsresource.com
- www.ameriplas.com
- <http://www.ems.psu.edu/MATSE/polymers.html>
- **Also, using common search engines and searching under the keyword *plastic* or a related title may lead to additional information on the Internet.**

PLASTICS MELT DEMONSTRATION

The following is the procedure that should be followed when carrying out step 7 of the student's experiment. Please note that the experiment should be done in a well-ventilated area. It should be noted that some "smoke" will result.

PVC should not be included in the melting experiment! PVC when heated produces hazardous fumes, do not include in the melting experiment. The other plastics when melted do not produce hazardous vapors so there are no health concerns.

1. Bring the burner to temperature (if available, greater than 300°F).
2. Collect the pieces of plastic from each student. (Representing recycling codes 1, 2, 4, 5, and 6—**NOT 3!**).
3. Place all of the pieces of plastic in the aluminum foil pan.
4. Place the pan on the burner.
5. Apply pressure to the plastic pieces in order to speed up the melting process.
6. Once the plastic begins to melt (it will soften first), mix the pieces of plastic together with a stirrer (glass or metal).
7. After the plastic has melted, allow the students to see how the plastic was unable to mix completely and relate this phenomenon to the recycling process. (See students Plastic and Recycling Experiment Packet: Recycling Background)
8. After the "glob" of plastic has cooled, break apart the plastic and emphasize where it comes apart. The time for the melted glob to cool depends on the amount of plastic used in the experiment, more plastic, and more time to cool. Allow at least 15 minutes of cooling time. Each individual component of the glob should separate where the different plastics did not mix.
9. Emphasize to the students that ease of separation of the glob is directly related to the plastics not being able to uniformly mix. This is the primary reason that the plastics must be separated before recycling—so that maximum properties are retained when the recycled plastic is formed into a new article.

Trouble Shooting

If the plastic should ignite, immediately stop heating the plastic and move the burning plastic to a well-ventilated area. Safety issues, as far as the scissors and hot plate should be addressed.

Notes

Included are additional demonstrations that may be done in conjunction with this project for use at the teacher's discretion.

TEACHER DEMONSTRATION / ADVANCED LABS: MAKING NYLON

Introduction

This experiment can be done as either a demonstration or a lab for advanced chemistry students with lab experience. The purpose of the lab is to synthesize Nylon, a synthetic polymer widely used in the textiles and plastics industry. First discovered by accident in 1938, it is the result of a relatively simple reaction between two chemicals.

Background

Nylon is the commercial name given by the Dupont Company to a group of polymers called polyamides. Nylon is formed by the condensation reaction of hexamethylene diamine and adipoyl chloride.

A key component of the lab is the choice of solvents, hexane and water. The reason for this selection is that the two aren't miscible, that is, they don't mix with each other. This configuration is desirable because it allows for chemical reaction to occur only at the interface of the two solvents. It is at this liquid interface that the reaction occurs and the polymer is formed. A nylon string can then be pulled from this interface in much the same way it would be in commercial production.

Materials and Equipment

0.5 M hexamethylenediamine in 0.5 M NaOH
0.25 M adipoyl chloride
Acetone
Washbottle
50 ml beaker
2 10-ml graduated cylinders
Gloves
Lab apron
Goggles
Copper wire

Procedure

NOTE: The chemicals used in this experiment can be dangerous if handled improperly. Understand the safety issues related to each chemical used. Keep chemicals in a well-ventilated fume hood. Use care with all chemicals, especially acetone which is flammable.

1. Put on apron, gloves and goggles. Make sure all glassware is clean.
2. Using 10 mL graduated cylinder, measure 3 mL of the hexamethylenediamine solution and pour into the 50 mL beaker.

TEACHER DEMONSTRATION / ADVANCED LAB: MAKING NYLON (CONT)

3. Using the other 10 mL graduated cylinder, measure the 3 mL of the adipoyl chloride solution. Take the 50 mL beaker and tilt it very slightly. Carefully, pour the adipoyl chloride solution in the beaker allowing it to slowly run down the sidewall of the inside of the beaker as shown below. It is important to not let the two solutions mix. Carefully, place the beaker on a flat surface. The result should be two distinct layers of liquid. A reaction film should be evident at the interface.
4. Take the copper wire and bend it into a hook. Insert the hook into the beaker and grab the film with the hook.
5. Slowly pull the hook from the beaker, pulling a thread of nylon along with it. Observe the reaction at the interface as the thread is pulled. When the thread breaks, wash it with water, then wash it with acetone, and allow to dry before handling it. Examine the thread and note.

An alternative is to wind the thread around a glass rod. The amount of chemicals used is sufficient to produce many miles of nylon thread!

TEACHER DEMONSTRATION / ADVANCED LAB: CROSS-LINKING A POLYMER (MAKING SLIME)

Introduction

This experiment can be done as either a demonstration or a lab for advanced chemistry students with lab experience. The purpose of the lab is to create a cross-linked polymer. The polymer created is a “slime,” similar to the kind you see sold in toy stores. Both fun and educational, the experiment gives students something fun to take home with them.

Background

The experiment creates a cross-linked polymer slime composed of polyvinyl alcohol and borax. The polyvinyl alcohol is a water soluble polymer. When borax is added to a water solution of polyvinyl alcohol, the borax cross-links the polymer via hydrogen bonding. The borax reacts to form $B(OH)_4^-$ groups which cross-link the polymer chains via hydrogen bonding. Hydrogen bonding is a weak bonding that occurs between the hydrogen and oxygen atoms of the borax and the polyvinyl alcohol. The polymer chains are now cross-linked. Due to the cross-linking, polymer chain movement is restricted and a gel results. The weak hydrogen bonding allows for some polymer chains to break and flow past each other.

Materials and Equipment

4% aqueous solution of 99-100% hydrolyzed polyvinyl alcohol
4% solution of borax ($Na_2B_4O_7 \cdot 10H_2O$)
2 clear plastic cups
Wood splints or Popsicle sticks
Food coloring
Lab apron
Safety goggles

Procedure

1. Measure 3 mL of borax solution in a 10 mL graduated cylinder. Add two drops food coloring to the borax solution. Pour the borax solution into a clear plastic cup.
2. Measure 25 mL of polyvinyl alcohol in a 50 mL graduated cylinder. Observe how easily it flows. Add the polyvinyl alcohol to the plastic cup.
3. Use the wooden splint to stir the solution in the plastic cup. Continue stirring until the mixture becomes very thick.
4. Use a splint or your hands to remove the gel from the cup.
5. Experiment with the gel. Roll it in your hands. Set it on the table. Watch it flow. Jerk it quickly.