West Side Science Club – Event 18 – "Bioplastics"

Original Presentation (scheduled)

Date: 30 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 creation of solid plastics using vegetable oil as the polymer source, and the second is centered on the using of the casein in milk as the polymer source (cheese-making). In both cases students will learn how polymers can be made both of biological materials, and/or can be edible.

Big Questions

Words of the Day: polymers, proteins, and polymerization

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 made from edible and renewable sources. Not all plastics need to be petroleum based. Plants make molecules that can be polymerized just as well.

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.

Proteins

Definition: a chain of small monomers called amino acids linked together into a long string. Proteins are important molecules for plants and animals and exist in many foods.

Bioplastics

Plastics are formed from linked polymers, and these polymers can come from many sources. Synthetic polymer sources can be molecules like styrene, propylene and polyethylene. However, there are biological sources for polymers as well. When the monomer originates from a biological materials, the resulting polymer is referred to as a bioplastic. In these activities, vegetable oil and casein from milk will serve as the polymer sources.

Lesson Plan

Student Objectives

- Explore how to make polymers/plastics with edible materials
- Explain what a protein is and how proteins can also be used to make polymers
- Explain what a polymer is, and how the nature of chains of molecules gives plastics their unique properties.
- Explore how food materials can be used as a renewable source of plastics.

Schedule/Agenda

- Review: Event #16 – "Thermoplastics and scar stuff" and Event #17 "Recycling plastic" (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 recycling plastics activity is a good example of how materials can be reformed and repurposed through heat or chemical processes
- The day will be broken into two activities to be completed with a mentor at each table:
    - Activity #1: Use vegetable oil, water and cornstarch to make a solid plastic (45-50 min)
    - Activity #2: Use milk and vinegar to create a polymer from casesin (45-50 min)
- Wrap Up and Summarize Findings and Unusual Discoveries (10-15 min)

Materials

Shu

- Cookie cutters and cookie trays for working with melted plastic
- Measuring cup and Tablespoon
- Milk
- Vinegar
- 2 Large Pots
- Spoon, preferably plastic or metal
- Hotplate with which to simmer milk.
- Paper Towels, lots and lots of paper towels
- Wax Paper
- Aluminum Foil
- Rolling pin (optional)
- Canola oil
- Water
- Cornstarch
- Cups for mixing oil and cornstarch
- Latex gloves and thermal insulation gloves

Ben or Michelle

- Microwave
- Strainer, the finer the better

Safety

- Students must wear their eye protection and gloves to practice good safety habits for experimental work, especially in working with materials heated above 120C
- While these are food products, nothing should be eaten in these activities.
- We should have two Hot Plate Mentors who heat the milk and oil for each activity

Review of Previous Event: Thermoplastics and Recycling Plastics

- Reviews of sessions 16 and 17. How heat can break links between polymers as well as how materials can be reused, reshaped and reformed.

Making Bioplastic from Vegetable Oil, Water and Cornstarch

1. Have students mix one part cornstarch with one part water and add a small amount of vegetable oil (about 1 Tbsp. per cup of cornstarch). They can play with varying amounts for different textures
2. Be sure that the mixture is completely mixed and no chunks of cornstarch are left.
3. Pour the mixtures into cookie cutter molds taped to wax paper and microwave for about a minute to generate the plastic. Longer time in the microwave means dryer harder plastics.

Making Plastic from Casein in Milk

1. Simmer the milk at medium heat until a thick foam forms on top and it begins to steam. Stir constantly to avoid burning the milk on the bottom of the pot
2. At this point turn of the heat and add vinegar in a 16:1 milk to vinegar ratio (1 Tbsp. vinegar per cup of milk in the pot).
3. Casein chunks should begin to form immediately. Stir for at least another 30 seconds
4. Slowly port the hot casein milk mixture through a strainer over the second pot and collect the solid mass on a piece of wax paper (don't squish in the strainer to remove liquid. It will get stuck). Filter the remaining liquid once more to collect extra material.
5. Squeeze out the liquid on to the wax paper and sop it up with paper towels (lots of them) but don't over-dry or it will be difficult to mold
6. Roll out and mold the plastic. Set aside and let dry for several days. It may warp or shrink.

Possible Facilitation/Concept Questions

1. What is happening between the cornstarch, water and oil when heated that makes the polymer?
2. Why do the plastics get more rigid and/or change shape as they dry out?
3. How is the casein being formed from the milk?
4. Why does varying ratio of ingredients or microwave time change the plastic?
5. Why do the two bioplastics have different properties?

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: Making Bioplastics
http://www.instructables.com/id/Making-BioPlastics-Environmentally-Friendly-Plast/?ALLSTEPS
2. Instructables: Homemade Plastic

http://www.instructables.com/id/Homemade-Plastic/?ALLSTEPS