West Side Science Club – Event 16 – "Halloween Science"

Original Presentation (scheduled)

Date: 26 October 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 low temperature thermoplastics, used in both the medical industry for casts as well as in makeup for creating custom body armor and fake body parts. The second part will focus on polymers with a high water content, gels, and how they can be used for special effects.

Big Questions

Words of the Day: polymers and phase changes

Concepts

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

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

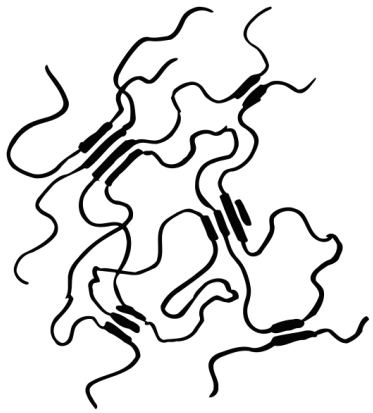
Level two (skills): testing materials;

Motivation for this Activity

This activity is an introduction into the nature of polymers, their uses, as well as their origins. The added motivation for the students is that it also ties in with Halloween and the use of different types of polymers in special effects and costumes.

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.

Macrostructure and microstructure
Polymer has interesting properties due to its ability to form long chains. The polymer chain is often shown in two dimensions, but it should be noted that they have a three dimensional structure. The carbon backbone extends through space like a twisted chain of TinkerToys. When stress is applied, these chains stretch and the elongation of polymers can be thousands of times greater than it is in crystalline structures.



Phase change: Glass/rubber transition

Glass-rubber transition refers to the reversible transition in the amorphous polymer (or in amorphous regions within semicrystalline polymer) from a hard and relatively brittle state into a molten or rubber-like state.

Thermoplastics and thermosets

Thermoplastic materials, such as polyethylene, can be pictured as a mass of intertwined worms randomly thrown into a pail. The binding forces are the result of van der Waals forces between molecules and mechanical entanglement between the chains. When thermoplastics are heated, there is more molecular movement and the bonds between molecules can be easily broken. This is why thermoplastic materials can be remelted.

There is another group of polymers in which a single large network, instead of many molecules is formed during polymerization. Since polymerization is initially accomplished by heating the raw materials and brining them together, this group is called thermosetting polymers or plastics. For this type of network structure to form, the mers must have more than two places for boning to occur; otherwise, only a linear structure is possible. These chains form jointed structures and rings, and may fold back and forth to take on a partially crystalline structure.

Since these materials are essentially comprised of one giant molecule, there is no movement between molecules once the mass has set. Thermosetting polymers are more rigid and generally have higher strength than thermoplastic polymers. Also, since there is no opportunity for motion between molecules in a thermosetting polymer, they will not become plastic when heated.

Lesson Plan

Student Objectives

- Explore how to use thermoplastics in individual or group projects
- Explain what is a phase change, and how it relates to the use of thermoplastics
- Explain what is a polymer, and how the nature of chains of molecules give plastics their unique properties.
- Explore how to use gel-based polymers for special effects and makeup.
- Explain how polymers with a high water content, such as gels, are useful for mimicking human tissue.

Schedule/Agenda

- Review: Event #9 – "The Hydrogel Challenge" and Event #10 – "Sugar and Salt" (5 min)
- Polymers, phase changes, and gels (Ben, 5 min)
    - The hydrogel challenge is a good example of how molecules can form long chains and trap in water to make various squishy materials.
    - The sugar and salt activity is a good example of how a polymer can be made, in this case with sugar being melted into caramel, as well as how heat can change the phase of the material.
- The day will be broken into two activities to be completed with a mentor at each table:
    - Activity #1: Use thermoplastic to make custom objects (45-50 min)
    - Section #2: Use various gels to make fake scar tissue and other Halloween makeup effects (45-50 min)
- Wrap Up and Summarize Findings and Unusual Discoveries (10-15 min)

Materials

General Items

Ben

- Scar stuff materials

Shu

- 2 hot plates
- 2 crystallization dishes for holding water and thermoplastic
- 6 lbs of thermoplastic pellets
- Latex gloves and thermal insulation gloves

Safety

- Students must wear their eye protection and gloves to practice good safety habits for experimental work, especially in working with plastics heated above 60C.
- We should have twos Hot Plate Mentor who loads and unloads the molten plastic for various groups.

Review of Previous Event: Hydrogel challenge and Sugar and Salt

- Reviews of sessions 9 and 10. How heat can both chain together molecules into polymers, as well as change their phases from solid to liquid.

Thermoplastic Procedure

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

1. For each hot plate place a crystallization dish filled halfway up with water. Heat the water to about 70C to melt down the thermoplastic pellets into a moldable form.

2. Student mentors, wearing thermal gloves, take molten plastic and give it to students to work with in building their projects. While this is going on other student mentors will be adding in fresh plastic to melt down.

Scar stuff Procedure

1. Mix the two parts of the scar material in a cup and apply to skin using a popsicle stick

2. While drying, pick at the material with tweezers and fingers to make texture.

3. Once dry, decorate with makeup and fake blood to complete the scary scar

Possible Facilitation/Concept Questions

1. What happens in the plastic pellets that causes them to fuse when heated?
2. Why does the thermoplastic go from solid to liquid when heated up?
3. What are other materials that will change form under a temperature change like thermoplastic?
4. Do all materials behave similarly to thermoplastic? That is, do they all melt as they're warmed up?
5. How are the makeup gels similar to other types of plastic?
6. How are the makeup gels different to other types of plastic?

Additional Activity Variations and Testing

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

Wrap Up

- Students should share their creations, both from the molded plastic as well as the makeup gels.

References

http://www.ndt-ed.org/EducationResources/CommunityCollege/Materials/Structure/polymer.htm
http://en.wikipedia.org/wiki/Glass_transition