Glue Slime

Preparation of Polymers

Introduction

Glue is a solution of a polymer in water. Adding sodium borate to glue produces a new type of polymer, which has been called *Gluep* (pronounced ′glü•ep). Gluep is relatively easy to prepare and has some unique properties. It is a gel-like substance with properties that are intermediate between those of a liquid and a solid. Thus, the polymer gel may flow and take the shape of its container, but it can also be molded into shapes and may be elastic, like -rubber.

Concepts

- Cross-linking
- Polymers
- Polymer gel

Materials

Borax (sodium borate), 1 g
Elmer's™ glue, 20 mL
Water, 35 mL
Bag, zipper seal, sandwich size
Drinking straw
Scissors
Scoop
Soda bottle, plastic 2-L
Support stand with ring clamp
Stirring rod
Vials, Snap-Seal™, 45-mL, 2

Safety Precautions

Although the materials used in this demonstration are considered nonhazardous, please follow all laboratory safety guidelines. The Gluep polymer may be harmful by ingestion and may leave stains on wood, carpeting or upholstery. Set the polymer samples in paper cups or plastic bags when not in use, and do not allow students to take the Gluep home. Wear chemical splash goggle or safety glasses. Be careful adding food coloring to the slime—it will stain hands, clothing, and upholstery. Wash hands thoroughly with soap and water before leaving the laboratory. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Measure 15 mL of water into one vial.
2. Add approximately 1 g (a healthy scoop) of sodium borate, snap the cap shut and shake for 15 seconds.
3. Set aside and allow the undissolved particles to settle.
4. In a second vial, add 20 mL of water.
5. Add 20 mL of glue to the second vial (along with food coloring if desired).
6. Stir the water and glue thoroughly until uniform (if food coloring was added, no white should be seen).
7. Pour the glue solution into a resealable plastic bag.
8. Decant the sodium borate solution into the bag, leaving behind in the vial any undissolved granules.
9. Pressing the air out, seal the bag and knead the mixture until the "gluep" comes clean from the inside of the bag. *Note:* Once the Gluep begins to come clean from the bag, opening the bag and allowing air to enter, then resealing the bag and continuing to knead may help finish the process.
10. Remove a small piece of the Gluep "slime" from the bag and demonstrate some of the following properties.

    a. Stretchability: Show what happens when the slime is pulled apart quickly (it shears), and when it is pulled apart slowly (it stretches).

    b. Viscosity: Cut off the top half of a 2-L soda bottle, and set it upside-down to use as a funnel in the ring stand. Place

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the slime in the funnel (see Figure 1), and wait. Time how long it takes for the first "drip" to reach the table.

c. Resilience: Shape the slime into a ball and demonstrate its ability to bounce.

d. Inflatability(!): Form the slime into a pancake and wrap it around the end of a straw (see Figure 2). Hold the slime ball in the palm of one hand and inflate it by gently and slowly blowing into the other end of the straw (you might need to pinch the slime together around the straw to prevent the air from leaking out the sides).

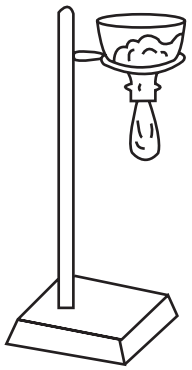

Figure 1.

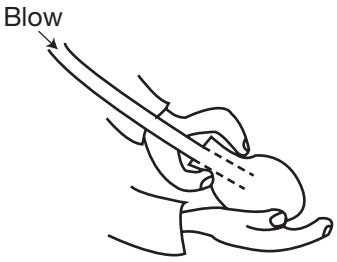

Figure 2.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. Gluep may be disposed of in the trash according to Flinn Suggested Disposal Method #26a. Excess sodium borate solution and glue may be saved for other activities or disposed of down the drain with excess water according to Flinn Suggested Disposal Method #26b.

Tips

- This activity naturally leads into a discussion on the differences between solids and liquids . . . and on how some substances seem to defy this kind of categorizing.
- Although this has been written as a demonstration, this activity works quite well as a lab. (If you plan to make a lot of slime, buy your glue by the liter from Flinn Scientific!)
- A large mound of slime (3–4 L or more) is especially impressive! It seems to have a mind of its own, and just trying to hold it all together in your hands proves quite challenging.
- The 50/50 glue water dilution must be done rather precisely; even slight deviations seem to affect the product's consistency (see *Discussion* section below). You may wish to show what happens if the glue is not diluted, or if it is diluted too much. This can serve as a good quantitative exploration of the subject—systematically varying the recipe, and observing the affect on the viscosity of the product (by measuring, for instance, the time it takes to flow through the funnel and reach the table 50 cm below), on the stretchabililty or on the resilience by measuring the height of the bounce of a Gluep ball.

Discussion

A typical polymer may contain thousands of monomer "units" that have been joined together by a chemical reaction. The properties of a polymer depend on the chemical nature of the monomer, how the monomers are joined together, and the length of the polymer "chain." In some cases, individual polymer molecules may be tied together into a network structure by adding a cross-linking agent.

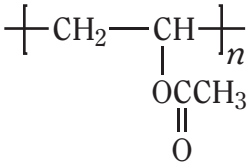

Figure 3.

The main polymer ingredient in white glue is polyvinyl acetate or PVAC (see Figure 3). PVAC is a simple addition polymer consisting of a long chain of carbon atoms with a polar acetate group ($-OCOCH_3$) on every other carbon atom. Adding a solution of sodium borate (borax) to glue leads to hydrogen bonding between the –OH groups in borate ions $[B(OH)_4^-]$ and the acetate groups in PVAC (see Figure 4). Each borate ion may bind to as many as four oxygen atoms in the same or neighboring PVAC molecules. The result is the creation of a large, fluid, three-dimensional network of polymer molecules (see Figure 5). The process by which borate ions "tie-together" neighboring polymer molecules is called *cross-linking*, and the resulting network of polymer molecules forms a gel that traps water molecules. (Although a hammock is often used as an analogy for this type of networking, a hammock is very systematic and orderly; most cross-linked polymers are much more randomly networked.)

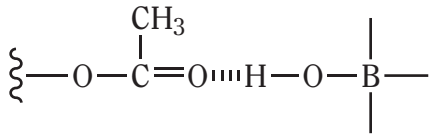

Figure 4.

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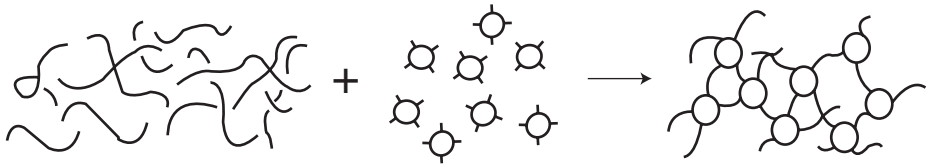

Figure 5.

The properties of Gluep will depend on the ratio of PVAC molecules and borate ions in the polymer network, and also on the amount of water trapped inside the gel. The 50% dilution of the glue is necessary to spread apart the polyvinyl acetate chains prior to cross-linking, otherwise, the cross-linking would occur too extensively and the fluid nature of the product would be lost. In general, cross-linking will tend to make the Gluep polymer more elastic, but too much cross-linking may make it brittle. If the dilution were too great, however, and the chains were too spread apart, little or no cross-linking would occur and the product would be too runny.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Form and function
Content Standards: Grades 5–8
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standard E: Science and Technology
Content Standard G: History and Nature of Science, nature of science
Content Standards: Grades 9–12
Content Standard A: Science as Inquiry
Content Standard B: Physical Science, structure and properties of matter, chemical reactions
Content Standard E: Science and Technology
Content Standard G: History and Nature of Science, nature of scientific knowledge

Acknowledgments

This lab was adapted from an activity by Marie Sherman of Ursuline Academy, St. Louis, MO.

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Glue Slime* activity, presented by Bob Becker, is available in *Preparation of Polymer* and in *Properties of Liquids*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Glue Slime* are available from Flinn Scientific, Inc.

Materials required to perform this activity are available in the *Gluep Production Lab—Student Laboratory Kit* available from Flinn Scientific. Materials may also be purchased separately.

Catalog No.	Description
AP5937	Gluep Production Lab—Student Laboratory Kit
G0049	Glue, White, 1 L
S0335	Sodium Borate, 500 g
FB0015	Snap-Seal™ Vials, 45-mL
AB1003	Bags, Zipper-Lock, 4" × 9", Pkg/50

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.

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