



Bouncing Glue Balls

Subject Area(s): Chemistry, Chemical Engineering, Materials Engineering, Materials Science

Activity Title: Bouncing Glue Balls

Grade Level: 6 (5-8)

Time Required: 30-45 minutes

Group Size: 3

Expendable Cost per Group: \$4

Summary

Different types of Elmer's glue are used to make polymer glue balls, each ball has distinct material properties. The students can see and feel the differences in the material properties by playing with the glue balls and seeing how high each of them bounces when you bounce them on the ground.

Engineering Connection

Polymer are used in various engineering applications, crosslinking is used to tailor the properties of the polymer for the desired application.

Keywords: chemistry, polymers, crosslinking

Educational Standards

- Science: 3.4.7
- Math: none

Learning Objectives

After this lesson, students should be able to:

- Explain what a polymer is.
- Explain the relationship between mechanical properties and crosslinking.

Materials List

Each group needs:

- Borax
- Cornstarch (found in the baking section of the store)
- Elmer's glue school glue (makes an opaque ball) or blue or clear school glue (makes a translucent ball)
- Warm water
- Measuring spoons
- Plastic spoon or craft stick to stir the mixture
- 2 small plastic cups for mixing
- Marking pen
- Watch with a second hand
- Metric ruler
- Zip-lock plastic baggie
- Plastic to cover the work area
- Bouncing Glue Balls Worksheet

Introduction / Motivation

In this activity we are going to look at how just changing the Elmer's glue used can significantly affect its mechanical properties.

Vocabulary / Definitions

Word	Definition
Cross-linking	bonds that link one polymer chain to another
Young's Modulus	tendency of an object to deform along an axis when opposing forces are applied along that axis
Polymer	a large molecule composed of repeating structural units

Procedure

Background

These polymer glue balls are a type of polymer called an elastomer, which has elastic properties, they can recover their original size and shape after being deformed. Other elastomers are rubber and silicone rubber. The Elmer's glue is crosslinked using the sodium borate which forms very weak intermolecular bonds which hold together the glue balls. These crosslinks provide flexibility to the cross-linked polymer.

Before the Activity

- Cover the area the students will be working with plastic, the Borax Solution tends to be spilled before it is all used.

With the Students

1. Label one cup 'Borax Solution' and the other cup 'Ball Mixture'.
2. Pour 2 tablespoons warm water and 1/2 teaspoon borax powder into the cup labeled 'Borax Solution'. Stir the mixture to dissolve the borax.
3. Pour 1 tablespoon of glue into the cup labeled 'Ball Mixture'. Add 1/2 teaspoon of the **borax solution** you just made and 1 tablespoon of cornstarch. Do not stir. Allow the ingredients to interact on their own for 10-15 seconds and then stir them together to fully mix. Once the mixture becomes impossible to stir, take it out of the cup and start molding the ball with your hands.
4. The ball will start out sticky and messy, but will solidify as you knead it.
5. Once the ball is less sticky, go ahead and bounce it!
6. You can store your plastic ball in a sealed ziploc bag when you are finished playing with it.

Safety Issues

- Do not let the students eat the glue balls.

Assessment

Activity Embedded Assessment

Title: Bouncing Glue Balls Worksheet

References

- American Chemical Society's "Meg A. Mole's Bouncing Ball", a featured project for National Chemistry Week 2005.
- <http://chemistry.about.com/od/demonstrationsexperiments/ss/bounceball.htm>

Owner

Drexel University GK-12 Program

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Name _____

Procedure

1. Label one cup 'Borax Solution' and the other cup 'Ball Mixture'.
2. Pour 6 teaspoons warm water and 1/2 teaspoon borax powder into the cup labeled 'Borax Solution'. Stir the mixture to dissolve the borax.
3. Pour 3 teaspoons of glue (pick either Elmers white glue, transparent glue or blue gel) into the cup labeled 'Ball Mixture'. Add 1/2 teaspoon of the borax solution you just made and 3 teaspoons of cornstarch. Do not stir. Allow the ingredients to interact on their own for 10-15 seconds and then stir them together to fully mix. Once the mixture becomes impossible to stir, take it out of the cup and start molding the ball with your hands.
4. The ball will start out sticky and messy, but will solidify as you knead it.
5. Repeat Steps 1-4 with the other 2 glues. In total you will do steps 1-4 three times: once with white glue, once with transparent glue and once with blue gel glue.
6. Once the balls are less sticky, go ahead and bounce it!
7. Fill out the property table on the next page, fill out the properties that I have listed, then fill in other properties that you think describe the balls in the blank spaces.
8. Bounce the balls on the floor and measure how high it bounces using measuring tape, do this after you first make it, then after you play with the balls for awhile (~20 minutes). Does the distance change?

Material Property	Elmer’s White Glue	Elmer’s Transparent Glue	Elmer’s Blue Gel Glue
Stickiness			
Hardness			
How high ball bounces after first made?			
How high ball bounces after 20 or more minutes?			