

Making Slime and Bouncy Balls Using Household Polymer Materials

NATURE Sunday Academy 2022-2023

Name of faculty, department, and university/tribal colleges:

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1. Description of topic:

Plastics are made of long chain-like molecules called polymers. They are produced in large quantities worldwide and used in various everyday items. Typically, a number surrounded by a triangular shape consisting of three recycling arrows is stamped on the plastic object which tells its component. The so called "big six" plastics earlier are often applied in their "pure" form, while in many applications a combination of plastics and other reagents are required to achieve desired properties. A common strategy to reinforce certain properties is through cross-linking, i.e., making connections, or bonds, between different polymer chains. The result is an interconnected polymer matrix that can have wide range of properties. The extent of cross-linking can vary greatly based on the requirement of applications. A classic example is the so-called vulcanization process, in which natural rubber or related polymers are converted into more durable materials by the addition of sulfur.

In this project we will produce cross-linked polymers from common household items such as glue, borax and cornstarch. The glue contains polyvinyl acetate, which form polyvinyl alcohol upon reaction with water. Borax contains primarily sodium tetraborate that has a ring structure, and cornstarch is a natural polysaccharide that contains many hydroxyl groups. When mixed they form extensive hydrogen bonding, leading to a 3-D structure that allows water to hide in holes in the network. By modifying the compositions and their ratios, the polymeric materials can be obtained with different properties such as elastic (stretch without breaking) and cohesive (the fibers tend to attract to each other).

2. Learning goals and outcomes:

- The students will learn the basics of plastics and polymers.
- The students will learn the importance of polymer materials in everyday life.
- · The students will learn the impact of crosslinking on polymer properties
- The students will understand how the materials properties can be manipulated.

3. Session Organization:

11:00-11:15 Cultural connection and general organization 11:15-11:30 Introduction to the Making Bouncy Balls Using Household Polymer Matter



11:30-12:00 Activity 1 Activity 2 12:00-12:45 Lunch

01:00-01:45 Activity 3 Activity 4

01:45-02:30 Discussion

02:30-03:00 Wrap up and clean up

4. ND State Science Standards:

9-10.2.2 Use appropriate safety equipment and precautions during investigations9-10.2.6. Design and conduct a guided investigation

9-10.5.4 Identify the short-term and long-term effects of physical processes

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9-10.6.1 Use appropriate technologies and techniques to solve a problem9-10.8.3 Explain how individuals and groups, from different disciplines in and

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outside of science, contribute to science at different levels of complexity

11-12.1.1 Explain how scientists create and use models to address scientific knowledge

11-12.2.1. Understandings about Scientific Inquiry: Explain how new knowledge and methods emerge from different types of investigations and public communication among scientists

11-12.2.2. Abilities Necessary to Do Scientific Inquiry: Select and use appropriate instruments, measuring tools, and units of measure to improve scientific investigations 11-12.6.2. Technological Design: Identify examples of how new technologies advance science

5. Materials needed Provided by tribal colleges

- 1. small beakers,
- 2. rulers
- 3. heating plates

Provided by UND

- **1.** Elmer's glue,
- 2. Borax powder
- 3. Cornstarch
- 4. Food coloring
- 5. Paper clips
- 6. plastic spoons,
- 7. glass stirring rods,
- 8. mixing bowls
- 9. measuring cups/spoons set



6. Description of the hands-on activities

Activity 1: Modeling Polymers with Paperclips:

- 1. Take a set of 12 paperclips of the silver color. Join them together to form a long chain. This shows how the same monomer can be linked together to form a polymer chain.
- 2. Take two sets of 6 paperclips of different colors (e.g., 6 silver, and 6 blue). Join one color into a chain first, and then the other color. Now you have a block co-polymer with two different segments.
- 3. Take another two sets of 6 paperclips of different colors (e.g., 6 silver, and 6 blue). Join them in an alternating fashion (e.g. -silver-blue-silver-blue-). Now you get an alternating co-polymer.
- 4. Now you have three polymer chains (you can make more if you want). Place them together in parallel. Use another different colored paperclip with regular placement to connect these separate polymer chains together. Now you get a sheet of paperclip chains, or crosslinked polymer network.

Activity 2: Making Slime:

- 1. Mix 1 teaspoon of Borax into a cup of warm water. Stir until it's fully dissolved, and the solution appears clear. Set it aside.
- 2. In a medium mixing bowl, add 4 ounces of glue and a few drops of your favorite food coloring. Stir gently to mix them.
- 3. Add small amount of your Borax solution into the glue mixture **very slowly** while stirring thoroughly. Add some more while stirring, until the slime isn't sticky anymore. You probably won't need it all.
- 4. Now you can knead and squish the slime with your hands to finish mixing.

Activity 3: Making Polymer Bouncy Balls:

You will make three balls with different compositions. As before, you can add a drop of your favorite food coloring. For better visual differentiation, use different color for different ball.

Activity 3a: Ball A

- 1. In a mixing bowl, add:
 - 3 tablespoons of glue
 - A few drops of food coloring, mixing
 - 1 teaspoon of distilled water
 - 1 tablespoon of borax powder
- 2. DO NOT STIR. Allow the ingredients to interact for 10-15 seconds. Then use stirring rod to mix. Once the mixture becomes impossible to stir, take it out of the beaker and mold the ball with your hands. The ball will start out sticky and messy but will solidify as it is kneaded.



3. Record physical observations about the ball in the worksheet: is the ball stretchy? gooey? slimy?

Activity 3b: Ball B

- 1. In a mixing bowl, add:
 - 3 tablespoons of glue
 - A few drops of food coloring, mixing
 - 1 teaspoon of distilled water
 - 1 tablespoon of cornstarch
 - 1 tablespoon of borax
- 2. Repeat steps 2-3 from previous session for Ball A.

Activity 3c: Ball C

- 1. In a mixing bowl, add:
 - 3 tablespoons of glue
 - A few drops of food coloring, mixing
 - 1 tablespoon of cornstarch
 - 1 tablespoon of borax
- 2. Repeat steps 2-3 from previous session for Ball A.

Activity 4: Measuring Bounciness of Balls

- 1. Use the ruler and hold the ball at a height of 30 cm (=12 in) above the bench. Drop the ball and record how high it bounces.
- 2. Repeat this three times and record the heights in the worksheet.

In the table, record your observations of each ball: Is it stretchy? gooey? slimy? For the bounciness test, record the heights of three bounces for each ball.

Bouncy Ball	Physical	Height of	Height of	Height of
	observation	bounce #1	bounce #2	bounce #3
Ball A				
Ball B				
Ball C				

Discussions

- 1. Based on your observations, which ball is the bounciest?
- 2. Can you think of any way that can make the ball even bouncier? Try it out! Record your "recipe" here and test its bounciness as you did earlier.