CRISP Kit Teacher Module

Title of Module:

Gak/Silly Putty

Subject(s) or Unit of Study:

Polymers

Grade Level(s):

5+

Est. Length of Activity:

1 Class Period

Student Objectives:

- Students will be introduced to the concept of polymers, their structures and properties.
- Students will understand:
  - What a polymer is
  - What is means to be a cross-linked polymer
  - What elasticity is, and what it means for a material to have elastic properties

Vocabulary:

Polymer, Monomer, Cross-link, Molecule

Materials:

All-purpose white glue
Saturated solution of sodium tetraborate (Borax detergent in water) in 10mL test tubes
Food coloring
Small cups
Stirring sticks
Eye droppers

Learner Background:

Polymers are composed of a large number of repeating units. The word is derived from the Greek words *poly* (meaning "many") and *mer* (meaning "part"). There are both naturally occurring and synthetic polymers. Some examples of naturally occurring polymers are proteins, starches, cellulose, and latex. Synthetic polymers are mad-made, on a large scale and have a wide range of properties and applications. A good example of a synthetic polymer is plastics – water bottles, sand buckets, plastic sunglasses and so many more types are produced every day.

Polymers are formed by chemical reactions in which a large number of molecules called **monomers** are joined together to form a chain. In many polymers, only one type of monomer is used but sometimes two or three different monomers may be combined.

CRISP Kit Teacher Module

Polymers are classified by the characteristics of the reactions by which they are formed. If all atoms in the monomers are combined into the polymer, the polymer is called an *addition polymer*. If some of the atoms of the monomers are released into small molecules, (like in the form of water), the polymer is called a *condensation polymer*.

Most addition polymers are made from monomers containing a double bond between carbon atoms. Such monomers are called olefins, and most commercial addition polymers are polyolefin (many olefin). Condensation polymers are made from monomers that have two different groups of atoms which can join together to form, for example, ester or amide links. Polyesters (used in clothing) are an important class of commercial polymers, as are polyamides (nylon).

Learning Activity or Procedure:

1. Look closely at the sodium tetraborate solution and the glue. Write down any properties that you notice
2. Fill the cup about 1/4 with glue (not more than 25mL)
    a. **You may also mix equal parts of water and glue – this will give it more of a gak feel rather silly putty (not as solid)
3. Add a drop of food coloring and stir in well (optional)
4. Slowly add the sodium tetraborate (Borax solution) using the dropper. Pay close attention to what is happening as you add and stir.
5. Continue slowly adding the Borax solution, one dropper at a time, constantly stirring, until you have a putty-like solution (you will need to stir for about 2 minutes)
6. Remove the putty ball and roll around your hands to help dry it off (it might be sticky for a minute)

Assessment:

Please see last page

Additional Resources:

Apply any links or additional information for students or teacher including videos, websites, etc.

Teacher Notes:

Try to split up the class. Have each group use a set amount of the Borax solution (1 dropper full, 2 droppers full, 3 droppers etc.) and let them compare their results. Ask students how they can make the Gak/Silly Putty slimier, or more solid. What's going on at the nanoscale that is making the solution like that?

CRISP Kit Teacher Module

Safety:

Do not ingest the sodium tetraborate (Borax) solution or Glue. Materials can be disposed of in regular trash

STEM Careers:

Materials Scientist
Researcher
Research and Development
Bioengineer
Engineer
Manufacturing Technician

Standards:

Next Generation Science Standards:

NGSS Performance Tasks	**5-PS1-1** • Develop a model to describe that matter is made of particles too small to be seen. **MS-PS1-2 Matter and its Interactions** • Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred. **HS-PS2-6** • Communicate scientific and technical information about why the molecular-level structure is important in the functioning of designed materials.
NGSS - (DCI) Disciplinary Core Ideas	**MS- PS1.A: Structure and Properties of Matter** • Each pure substance has characteristic physical and chemical properties (for any bulk quantity under given conditions) that can be used to identify it.
NGSS - (CC) CrossCutting Concepts	**CC-3 Scale, Proportion, and Quantity** • Natural objects exist from the very small to the immensely large. **MS - Patterns** • Macroscopic patterns are related to the nature of microscopic and atomic-level structure
NGSS - (SEP) Science and Engineering Practices	**SEP 2- Developing and Using Models** • Use models to describe phenomena. **SEP 4 – Analyzing and Interpreting Data** • Analyze and interpret data to determine similarities and differences in findings. **SEP 6 – Constructing conclusions and designing solutions** • Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future.

CRISP Kit Teacher Module

Standards:

Common Core Standards:

CC ELA/Literacy Standards	**RI.5.7** • Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.(5-PS1-1) **SL.8.5** • Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest. (MS-LS1-2)
CC Math	**5.MD.C.3** • Recognize volume as an attribute of solid figures and understand concepts of volume measurement. (5-PS1-1) **6.EE.C.9** • Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable. Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. (MS-LS1-2)

CRISP Kit Teacher Module

Student Worksheet:

1. What are some of the properties of the Glue? What about the sodium tetraborate (Borax)?
   Glue:

   Borax:

2. What properties did you see when they were combined?

3. What happened on the nanoscale when you mixed the Borax and the glue? (*Hint: what's the definition of a polymer?*)

4. How do we use polymers in everyday life? List 5 examples of products that are made of polymers
   1.

   2.

   3.

   4.

   5.

5. What might make the putty you just made different from some of the items on your list?