

Chem 227 / Dr. Rusay

POLYMER CHEMISTRY
Nylon, Slime & Gak (Silly Putty)

Observe the preparation of nylon via a condensation reaction of a diamine with a dicarboxylic acid derivative. Then, you and a partner are to prepare *Slime* and *Silly Putty*; instructions follow (*Procedures A & B*).

The preparation of *Slime* and the *Silly Putty* involves a type of polymerization known as ***cross-linking***. Each of these two reactions applies a Borax soap solution as the cross-linking agent. Cross-linking agents bond together many lower molecular weight polymer chains to give a much larger molecular weight polymer. An analogy would be taking many strands of spaghetti and tying them together with several pieces of string. By doing this, the molecular weight of the polymer is increased, and the physical /material properties of the polymer developed. *Slime* is prepared by cross-linking polyvinyl alcohol with Borax. *Silly Putty* is prepared by cross-linking Elmer's glue with Borax. To visualize cross-linking, consider polyvinyl alcohol (PVA). A two-dimensional representation of small segments of two adjacent PVA chains are shown in figure #1 below:

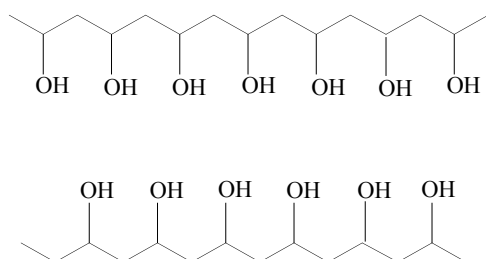


figure #1

When Borax is dissolved in water, the cross-linking agent $B(OH)_4^-$ is formed. The two-dimensional representation of this molecule is shown in figure #2:

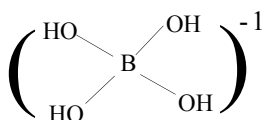


figure #2

Hydrogen bonds form between the Borax and the PVA molecule as shown in figure #3.

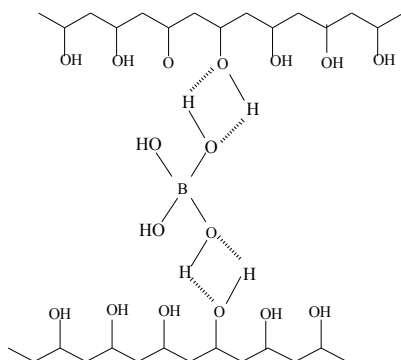


figure #3

Notice how the two polymer chains are connected. This occurs numerous times over the length of one polymer chain, and essentially bonds many polymer chains together, greatly increasing the molecular weight of each chain.

Procedures

A. PREPARATION OF SLIME:

1. Measure 50 mL of 4% polyvinyl alcohol (PVA) solution using a graduated cylinder and pour it into a Styrofoam cup.
2. Add 2 to 3 drops of the food dye/indicator of your choice and mix coloring throughout.
3. Measure 5 mL of the 4% (Borax) sodium tetraborate solution.
4. Using a spatula or stirring rod, stir the PVA solution quickly and constantly (like you are beating egg whites) while simultaneously adding the 4% Borax solution.
5. Continue to stir the solution vigorously for ~3 minutes until the slime gets to the perfect consistency.
6. If you wish to save your product wrap it in saran wrap in order to prevent the slime from drying out, otherwise, discard the product in the trash.

B. PREPARATION OF GAK/SILLY PUTTY:

1. Using your graduated cylinder, measure 20 mL of de-ionized H₂O into a Styrofoam cup. With a pen mark the water level on the cup.
2. Discard the water and add Elmer's glue up to the mark.
3. Add 20 mL of de-ionized H₂O to the glue and mix well.
4. Add 2 to 3 drops of the food dye/indicator, which may be combined to achieve a color of your choice, and mix well..
5. Obtain 10 mL of 4% Borax solution. Add 5 mL at first (more 4% Borax may be added as necessary) and stir vigorously for at least 2 minutes.
6. (Wearing gloves is recommended for this step.) When the mixture has stiffened such that you can no longer stir it, remove the silly putty from the cup and knead with your hands until the mixture is no longer sticky.
7. Press your Gak/Silly Putty on a piece of newspaper in the front of the classroom and see if the image is lifted onto it.

Show/Turn-in the samples of *Gak/Silly Putty* and *Slime* to Dr. R. before leaving lab.