Experiment 23 Polymer Synthesis and Properties

Introduction:
Polymers are everywhere. Right now, the clothes you’re wearing are made of polymers and the food you just ate is composed of polymers. Life in America would be much different if it wasn’t for polymers. For example, plastics are polymers and are everywhere. Plastics’ versatility allows it to be used in everything from car parts to soft drink bottles.

The word Polymer comes from the Greek: “poly” meaning many and “meros” meaning parts or units. A polymer is a chain like molecule made up of the same repeating units. Polymers are made by a process called polymerization, which is just the joining of single units called monomers into a long chain. The example below illustrates the monomer ethylene, and its polymer chain which is made by opening up the double bond.

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\begin{align*}
\text{H}_2\text{C} & \equiv \text{CH}_2 \\
\text{ethylene} & \quad \cdots \quad \text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\cdots \\
\text{polyethylene}
\end{align*}
\]

Polymers can be synthesized from lots of different monomers using lots of different reactions. This means by changing the monomer used in the synthesis, you can alter the properties of the long chain. For example if you had lots of groups in the polymer that likes to dissolve in water (these groups are called hydrophilic groups), then the polymer will dissolve in water. Also the interaction between one long polymer chain and the ones around it will also affect its properties. For example if the long chains are attracted to each other, or are linked to one another in some way, then it will be harder to break apart the long chains. So the properties of a polymer depend on both the molecules that react to form the long chains and also the interaction between the chains.

Experimental:
This experiment basically consists of three parts:

1. In the first part of the experiment, we will investigate certain properties of different polymers. Specifically, we will test the properties of the two polymers: Teflon® and high-density polyethylene film (HDPE). These tests will help you determine the interaction between polymer chains, and the bonding between the chains.

2. In the second part, we will synthesize different polymers, specifically nylon, polyurethane foam and polyvinyl alcohol gel, which are common polymers that are found extensively in the real world. After synthesizing these polymers, we will investigate their properties.

3. The final part of the experiment deals with sodium borate solution being added to polyvinyl alcohol gel. The function of sodium borate is to hold the long chains of the polymer together by forming bonds between the polymer chains. This phenomenon is called cross linking and this part of the experiment is meant to find out what happens as more sodium borate solution is added.

Remember to record all observations and properties in your lab book. Wear gloves when doing the synthesis work as some of the solutions are dangerous, and some of the byproducts are acidic. Safety goggles and aprons must be worn at all times in the lab.