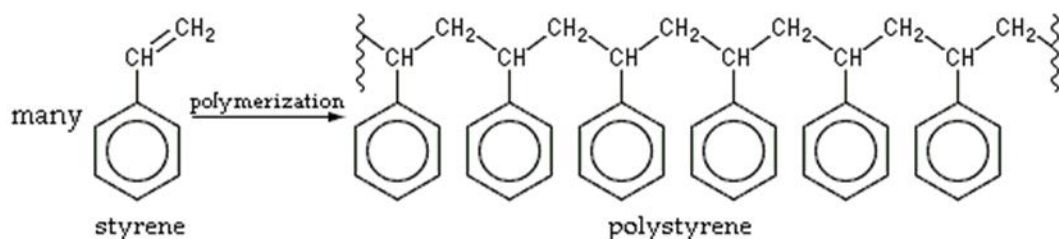


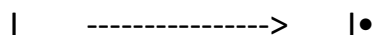
# Polystyrene Synthesis

## Background

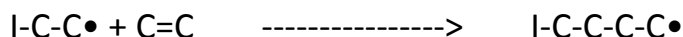
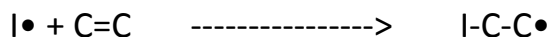


In this lab, the polystyrene is made by chain-growth polymerization. Chain-growth polymerization involves the polymer growing by adding monomers on to the ends of the chain of the polymer. The monomer is present throughout the polymerization but it decreases gradually. The molecular weight increases at a constant rate. Also a longer reaction time will produce more a longer chain during polymerization. The four most common types of polymerization are free radical, anionic, cationic, and coordination. Chain-growth polymerization has three steps: initiation, propagation, and termination. The initiation step is when the two radicals separate from the initiator. Then a monomer is added to a radical. The propagation step is when more monomers are added to form the chain. The termination step is when the polymer chain end of two chains join together or the polymer chain disproportionation, or the free radical's extra electron is given to another free radical, ending both chains.

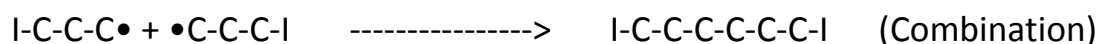
➤ Initiation:



➤ Propagation:



➤ Termination:



## **Procedure**

### **Materials**

We used Styrene monomer manufactured by Aldrich for the polystyrene polymerization. The boiling point of the styrene monomer is around 145°C. As an initiator we used benzoyl peroxide, also manufactured by Aldrich. Benzoyl peroxide (BPO) decomposes with the cleavage of its oxygen-oxygen bond at a temperature between 80 and 90°C.

### **Synthesis**

Working with chemicals involves many hazards, so we had our goggles, gloves and apron on the whole time. When working with organic materials we used the fume hood to avoid inhalation hazards.

1. First, we weighed out 2 different amounts of the BPO initiator (100mg and 400mg) on a piece of weigh paper. Then we transferred each amount to a separate 50 mL glass beaker, each labeled polymer 1, and polymer 2.

2. We poured 15 mL of styrene and poured each into a different labeled beaker. Each mixture was gently stirred with a glass rod until all of the BPO was dissolved.
3. The beakers were placed on a hotplate which was heated to roughly between 80°C and 90°C. The mixture was stirred continuously while heating.

After few minutes, we noticed that the beaker with the highest amount of BPO (Polymer 2) started bubbling and white smoke was released. The same thing was observed later with the Polymer 1 beaker. We also observed that the volume in the tow beakers decreased over time and the viscosity of each solution increased significantly. In order to determine when the reaction reached completeness, we extracted a small amount of the solution using a glass rod which then formed a fibrous string. We let the string cool for few seconds and then we checked it for brittleness. A brittle fiber was the sign of the end of polymerization, and we then removed the beaker from the hot plate and quickly poured the viscous mixture into a petri dish to cool down and solidify. However, much of the polystyrene solidified in the beaker while pouring and was difficult to remove. We used a spatula to break the solidified polystyrene and placed the fractured pieces into separate labeled vials for future characterization.



**Styrene Polymerization**



**Final Polystyrene**



**Brittle Fiber Formation**

### **Results & Discussion**

During the polymerization of styrene, we observed that as the reaction took place, bubbles started to appear. The more initiator that was used, the sooner the reaction started. When the reaction took place, we observed a decrease in total volume of each solution. This can be seen in the image below, the black mark on the beaker marks the original volume line. After they started to bubble, the viscosity of each solution significantly increased while they were being stirred. The viscosity continued to increase until each solution completely solidified. The polymer with the least amount of initiator seemed to be the most viscous when transferring the solution into the dish.