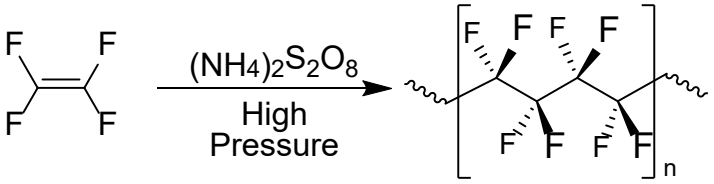
Experiment #3 - Polymers

Introduction

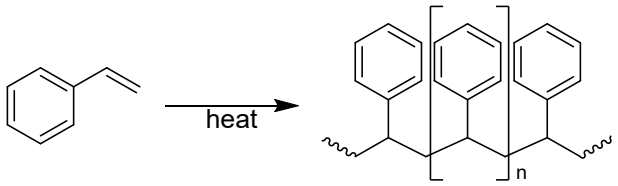
The process by which plastics/polymers are formed is known as polymerization. Today our culture is inundated with polymers ranging from Ziploc® baggies to space age technologies. It would be hard to imagine life without synthetic polymers. The reason that polymers are so widely used is simple variations can provide many different properties. A polymer can be rigid, flexible, transparent, opaque, hard, soft, elastic, stiff and resistant to chemicals. A polymer is a gigantic chainlike molecule made by connecting small molecules (usually called monomers) together. Scientists are able to manipulate the properties of a polymer by choosing which monomers are used and how these monomers are chemically connected. For example, tetrafluoroethylene can be polymerized to form the polymer known as Teflon® as shown below. The chemistry building at the University of Idaho, Renfrew Hall, is named after Prof. Malcolm Renfrew, who was one of the pioneering Teflon scientists.



tetrafluoroethylene — polytetrafluoroethylene (Teflon)

Tetrafluoroethylene is virtually resistant to all chemicals and forms a surface which is non-stick. Tetrafluoroethylene also maintains these properties over a temperature range of -270 to 385 Celsius.

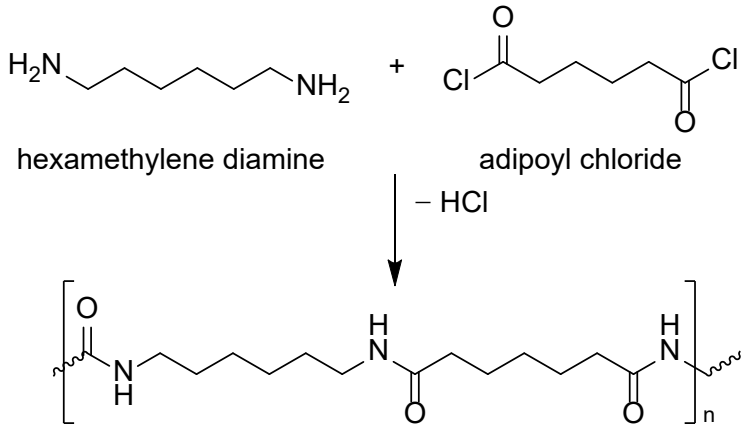
Another example is the polymerization of styrene to form the polymer known as polystyrene as shown below.



styrene — polystyrene

Both of these types of polymerizations shown go through an addition reaction because two molecule (two tetrafluoroethylene or two styrene) monomers are added together resulting in the removal of the double bond. However, to make these polymers, an initiator is required. The initiator, tert-butyl benzoyl peroxide, and heat are needed to start the reaction. Polystyrene is a hard and transparent polymer which is ideal for food containers. Polystyrene can also be readily foamed to create packing material or thermal insulators. Styrofoam is the trade name given to foamed polystyrene.

A second type of polymerization reaction is known as a condensation reaction. In a condensation reaction two monomers react to form a polymer with the removal of a small molecule. Nylon 6-6 is synthesized using a condensation polymerization reaction. The monomers adipoyl chloride and hexamethylene diamine react to form the polymer with the removal of HCl as shown below.



nylon 6,6

Procedure:

Nylon 6-6

1) Into a 50 mL beaker add 2 mL of 20% NaOH and 10 mL of a 5% aqueous solution of hexamethylene diamine and mix.
2) Measure 10 mL of a 5% adipoyl chloride solution in cyclohexane.
3) Being careful not to mix, slowly pipet the 5% adipoyl chloride solution on top of the aqueous solution in the 50 mL beaker.
4) You should see two different liquid layers with nylon 6-6 being formed at the interface.
5) Using forceps grasp the nylon at the interface at its center and slowly lift the solid from the solution. **Lifting up to fast will cause the nylon to break.**
6) As the polymer is lifted begin to roll the nylon around a stir rod. New nylon will continue to form at the interface.
7) Wash the nylon with cold water and dry with paper towels.
8) Note the physical properties of the polymer and polymer length.

HOW LONG IS YOUR NYLON? _____ cm or _____ m

NAME _____ High School _____