Polyamide (Nylon)

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\begin{align*}
\text{SOCl}_2 & + \text{Sebacic acid} & \rightarrow & \text{Sebacoyl chloride} \\
\text{bp} = 79^\circ C & \text{mp} 137^\circ C & \text{bp} 168^\circ C/12 \text{ mm Hg} \\
\end{align*}
\]

\[
\begin{align*}
\text{SOCl}_2 + \text{Sebacoyl chloride} & \rightarrow \text{HCl} + \text{SO}_2 \\
\text{Hexane-1,6-diamine} & \text{mp 45 - 46}^\circ C \\
\text{Nylon 6.10} & + \text{HCl}
\end{align*}
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Discussion:
This experiment is an example of an $S_N2$ reaction that forms a film of polyamide. Diamine dissolved in water is floated on a solution of diacid chloride dissolved in an organic solvent. The reaction stops on the surface unless the nylon layer that forms on the surface is removed. The solubility of diamine in water and dichloromethane is the key for the success in this reaction. This is an easy and fun reaction.

Procedure:

a. Set 15-mL reaction tube fitted with a condenser and gas trap.
b. Add 2 g sebacic acid (1,8-octane dicarboxylic acid), 2 mL thionyl chloride, and 0.1 mL N,N-dimethylformamide.
c. Heat tube to 60-70°C in water bath in the hood.
d. As the reaction proceeds, the product forms a liquid layer on the bottom of the tube. Use this liquid to wash unreacted acid later as the reaction proceeds.
e. When the reaction is complete (about 10-15 min), transfer the product to a 250 mL beaker using 50 mL dichloromethane.
f. On top of the dichloromethane pour a solution of 2 g hexane-1,6-diamine dissolved in 50 mL water containing 1.0 g of sodium hydroxide.
g. Pick up the polymer layer at the center, using a copper wire. Remove as much polymer as possible, wash it with water, and press it dry.
h. After drying weigh the polymer and calculate its percent yield.

Cleaning up: Add cotton from the trap to the used reaction mixture, and stir to cause nylon to precipitate. Decant water and dichloromethane. Squeeze the solid as much as possible and place the solid in the non-hazardous waste container. Place the dichloromethane in the halogenated organic solvent container. The aqueous layer should be neutralized, diluted with water and flushed down the drain.