Rayon from Dryer Lint

Description: Dryer lint (mostly cotton) is dissolved in $[\text{Cu(NH}_3\text{)}_4(\text{OH})_2]$ and injected into 3 M $\text{H}_2\text{SO}_4$. After a period of time, a thread of Rayon is produced.

Materials:

- Dryer lint or cotton ball
- 3 M $\text{H}_2\text{SO}_4$
- $\text{CuCO}_3$
- $\text{NH}_4\text{OH}$

- Crystallizing dish
- Medicine dropper or pipet
- Spatula
- Beaker

Procedure:

This demonstration is best performed on an overhead projector.

1. In a fume hood, dissolve 2.27 g $\text{CuCO}_3$ in 50 mL $\text{NH}_4\text{OH}$. Stir this mixture for 5 minutes and add 0.7 g of dryer lint. Stir this mixture until the lint has dissolved. Remove any insoluble material (usually hair) with tweezers.

2. Fill a large crystallizing dish with enough 3 M $\text{H}_2\text{SO}_4$ to submerge the tip of a thin stemmed pipet or medicine dropper. Draw up a pipet full of the Cu/lint mixture and place the tip below the surface of the $\text{H}_2\text{SO}_4$. Inject a small amount of lint solution into the acid and pin that material against the side of the dish with a spatula. Inject the remainder of the Cu/lint mixture into the acid while slowly pulling the pipet away from the side of the dish, creating a thread. A visible blue thread will result and over time will lose its color as the $\text{Cu}^{2+}$ diffuses into $\text{H}_2\text{SO}_4$. The thread can be rinsed thoroughly with water and handled gently.

Discussion: Rayon is a fiber composed of regenerated cellulose. This demonstration involves dissolving cellulose (dryer lint) with $\text{Cu(NH}_3\text{)}_4^{2+}$, known as Schweitzer’s reagent, and precipitating rayon as a thread. It has long been reported that copper carbonate in $\text{NH}_4\text{OH}$ would dissolve highly crystalline cellulose, normally insoluble in water. The cellulose is held in solution by complexing with $\text{Cu}^{2+}$ upon deprotonation of the $-\text{OH}$ cellulose groups, hence the basic conditions:

$$n \text{Cu}^{2+} + (\text{C}_6\text{H}_{10}\text{O}_5)_n + 2n \text{OH}^- \leftrightarrow (\text{CuC}_6\text{H}_8\text{O}_5)_n + 2n \text{H}_2\text{O}$$
Upon reprotonating in H$_2$SO$_4$, the cellulose is regenerated as the less crystalline fibers observed in this demonstration. The chemical structure of the product is suggested to be:

\[
\begin{array}{c}
  \text{OH} \\
  \text{O} \\
  \text{HO} \\
  \text{OH} \\
\end{array}
\]

**Safety:** Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration. Prepare copper solution in a fume hood as concentrated NH$_4$OH gives off NH$_3$ gas. Concentrated NH$_4$OH and H$_2$SO$_4$ can cause burns and should be handled with caution. Copper compounds are hazardous if inhaled or ingested.

**Disposal:** Place materials in a fume hood to dry. Solutions should be neutralized properly (copper solution with 1 M HCl; H$_2$SO$_4$ with NaHCO$_3$) and disposed of in an appropriate waste container. Dry thread can be disposed of in a normal waste container.

**References:**
