Synthesis of Schweizers Reagent then Precipitation of Rayon by Acidification
by Disulfideprotein

The synthesis of Schweizers reagent is interesting. To synthesize it you must be able to synthesize cupric hydroxide. Cupric hydroxide is usually formed by dissolving copper sulfate in water and then adding sodium hydroxide. The problem with this method is that it is quite sloppy and you must rinse and wash the cupric hydroxide because a black product also forms along with other contaminates. I found a different method of synthesizing Schweizers reagent using only copper sulfate and ammonium hydroxide. The use for this process/synthesis is a less time consuming, easier method of making Schweizers reagent. Why? Schweizers reagent is used in the process of making rayon (artificial fiber). Many home chemists could use the 3 step technique for synthesizing Schwiezers reagent but it is less time consuming and messy to just use the 2 step process. Schwiezer reagent is: $[Cu(NH_3)_4(H_2O)_2](OH)_2$ **(Shown Below).** The equation for this reaction is as follows: $CuSO_4 + 2\ NH_4OH = Cu(OH)_2 + (NH_4)_2SO_4$ then: $Cu(OH)_2 + 4\ NH_4OH = [Cu(NH_3)_4(H_2O)_2](OH)_2 + 2\ H_2O$ the great part about this reaction is that the ammonium sulfate does not interfere with the rest of the chemical reactions in making rayon or other fibers.

The reaction can reversed back to products and a new insoluble complex making it prime to precipitation of the solute when acidified (specifically hydrochloric acid). When hydrochloric acid is added to the ammonia complex it converts back to cupric hydroxide and makes a new compound: Ammonium chloride. When sulfuric acid is added to the ammonia complex it makes makes cupric hydroxide and ammonium sulfate. Though after the rayon precipitates out it is destroyed and broken down by the sulfuric acid which is this is not used for this process because of this reason. When HCl is added to the Schweizers reagent with the cellulose dissolved in it the reaction reverses and becomes ammonium chloride and cupric hydroxide. When it is acidified by a weak acid such as acetic acid (from observations) barely any rayon is formed.

This precipitates out because of the simple fact that when the acid is added it converts the complex to a different complex that the solute is not soluble in.

Please note that this reaction is reversible when the ammonia is evaporated. When it is evaporated you should be left with cupric hydroxide.

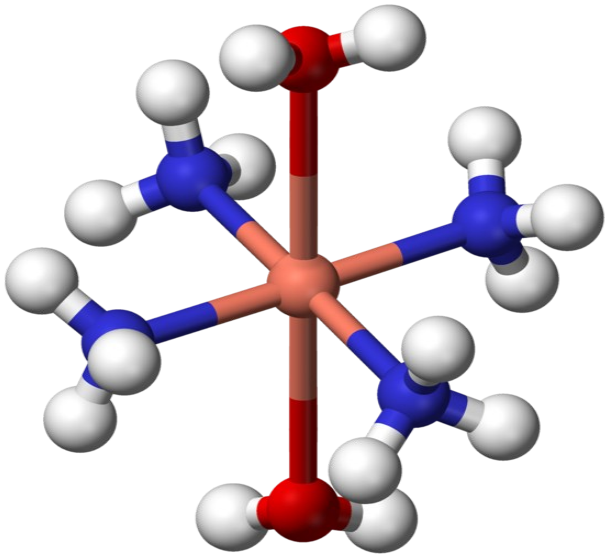

Illustration 1: Schweizers Reagent:
tetraamminediaquacopper dihydroxide

This is great for making rayon, because cellulose is soluble in Schweizers reagent but can be regenerated by acidification of the solution. Cellulose is a sugar and has the chemical formula: $C_6H_{10}O_5$. It is a polysaccharide made of Beta D-Glucose molecules linked together. We are incapable of metabolizing cellulose and derivatives of it such as rayon but we do produce it for clothing. It (rayon) is a rearrangement of cellulose. They are chemically identical to each other but are structurally different.

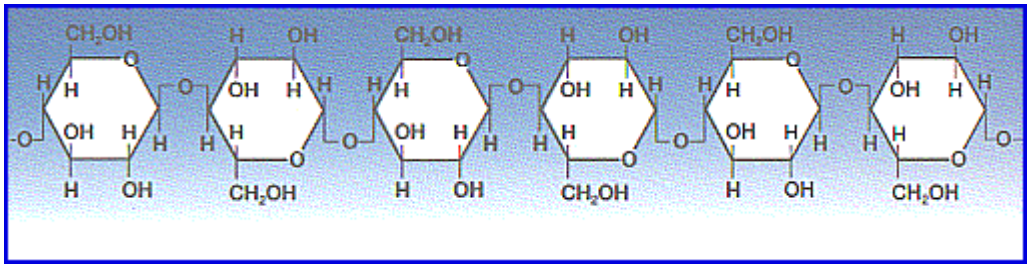

Illustration 2: Cellulose Molecule

Rayon: The only difference is the structure of the cellulose and in such we are not altering the chemical formula of the cellulose.

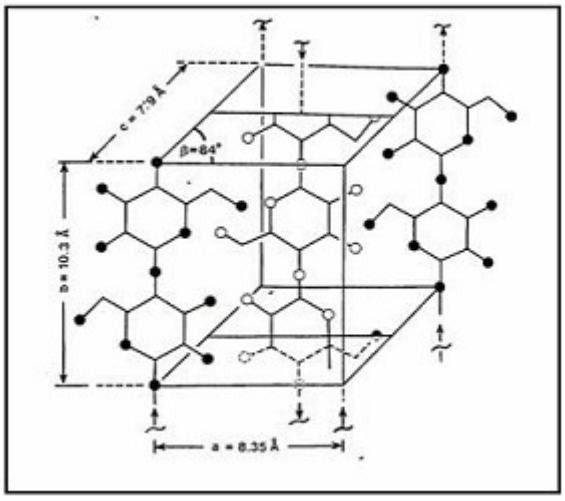

Illustration 3: Rayon Molecule

Equipment:

- Needed equipment: 2 beakers, a syringe or a pipet.
- Chemicals needed: Copper sulfate, ammonium hydroxide, hydrochloric acid.
- Stoichiometric amounts (first reaction): CuSO4: 159.610 g NH4OH: 70.0918g = Cu(OH)2: 97.5611 (NH4)2SO4: 132.1402 g
- Stoichiometric amounts (second reaction): Cu(OH)2: 97.5611 NH4OH: 140.1836g = [Cu(NH3)4(H2O)2](OH)2: 201.7139 g
- That in turn gives the theoretical yield for Schweizers reagent.
- **The amounts that were used in the experiment where .1 mole amounts, this is much more plausible for general experimental use. The amounts shown in the pictures were not measured out but an average was used because I do not have pictures from the original experiment and are for illustrative purposes.**

Steps:

1. Measure out the stoichiometric amounts of each chemical needed for the first reaction.
2. Put the copper sulfate in one beaker and then add the NH4OH to the other.
3. Pour the ammonium hydroxide into the copper sulfate. There should be a precipitation of cupric hydroxide and in the process some Schweizers reagent should be formed. (After stirring as long as there is an excess of copper sulfate there should be no Schweizers reagent that was formed in excess.)

Illustration 4: Cuperic Hydroxide

4. Stir vigorously for 2-5 minutes.
5. After that pour the stoichiometric amount of ammonium hydroxide needed for the second reaction in the beaker with the Cu(OH)2.
6. Stir if necessary.
7. There should be a very noticeable change in color. This is the Schweizers reagent. It should be a deep blue.

Illustration 5: Schweizers Reagent

Now onto the rayon:

1. Get toilet paper or another source of cellulose and dissolve it into the solution (until no more can disolve and take excess out of the solution.)
2. Take a syringe and fill it up with hydrochloric acid.
3. Put it into the cellulose solution
4. Keep adding until no more rayon precipitates.
5. Please note that there will be ammonium chloride gas coming out of the beaker, it is not incredibly toxic but not be ingested/inhaled because of the minor lung irritation. Please see the link for the MSDS down below.

Conclusion: Rayon precipitated out of the solution when it was acidified. It made fiber strands in the solution that could be gathered by filtration. Rayon precipitated out of the solution because when the solution was acidified it change the complex to a different one in which the solute was insoluble in. Please note that I use .1 mol or less than that quantities of chemicals. But what ever you do in the 3rd step keep the cupric sulfate in excess.

Notes on Storage: Schweizers reagent should be stored in an air tight container. It should NOT be stored in a way that the ammonia can evaporate and reverse back to cupric hydroxide. Store at room temperature in a dry area.

Sources:

- http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/C/Carbohydrates.html (for the second picture)
- Wikipedia.org (for the first picture)
- http://web.utk.edu/~mse/Textiles/Rayon%20fibers.htm (for the third picture)

MSDS:

- HCl: www.inchem.com.ph/productpages/**hcl_msds**.pdf

- Ammonium Hydroxide: http://www.sciencestuff.com/msds/C1225.html
- Ammonium Chloride: http://mubychem.com/MSDS/ammonium_chloride%20MSDS.htm