

Reminder: These notes are meant to supplement, not replace, the textbook and laboratory manual.

## Synthesis of Nylon 6.10

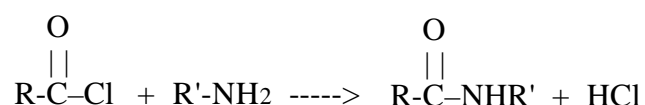
- Here is some terminology related to this experiment. More required terminology is found in notes for the preceding experiment (Transforming Polystyrene from a Foam to a Film).

An *interface* is the plane of contact between two immiscible liquid layers.

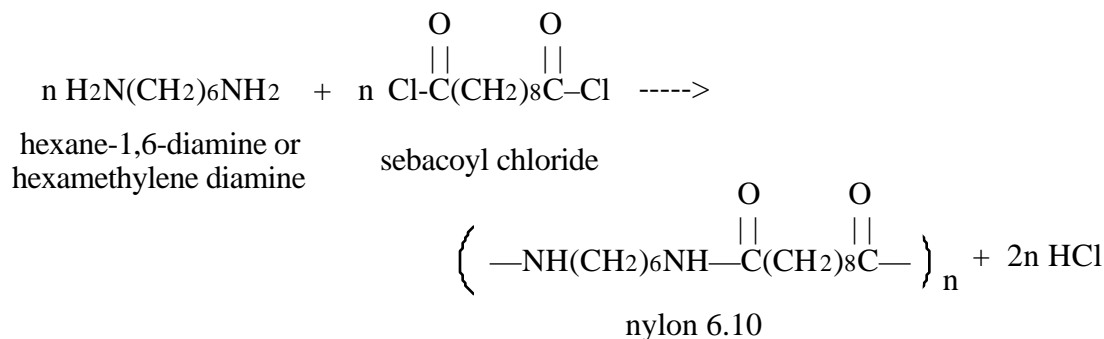
*Interfacial polymerization* is the reaction of monomers to form a very large molecule at the contact between two immiscible liquid layers. The monomers are dissolved in different layers, and only come into contact at the interface.

The main functional group present in nylon molecules is the amide functional group.

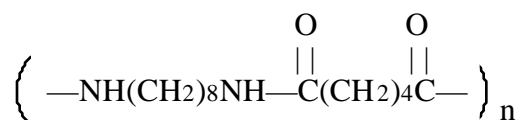
- This is the general reaction between a primary amine and an acid chloride to produce an amide plus HCl.



This is the equation for the preparation of nylon 6.10.

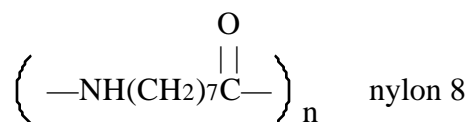


The numbers in the names of nylon molecules are, first, the number of carbons in the diamine portion of the starting material, followed by the number of carbons in the portion that contains two carbonyl groups. Here is a different nylon molecule. What is its name?



Answer: There are 8 carbons in the portion of the molecule that originated from a diamine, and 6 in the portion that originated from a dicarboxylic acid (and which contains the carbonyl groups). This is nylon 8.6.

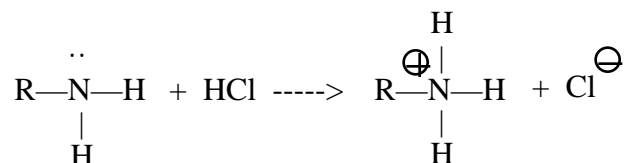
Note: some nylon molecules are made from compounds containing one carbonyl group and one amine group, and these have only one number. Here is an example:



3. Since this reaction gives a molecule of HCl as a product every time another monomer unit adds to the end of the chain, this is a condensation polymerization (not an addition polymerization). Other features of the reaction include:

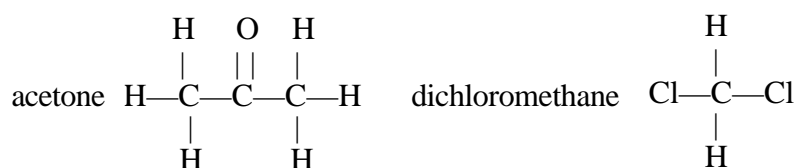
Water (the solvent for the diamine) is less dense than dichloromethane (the solvent for sebacyl chloride). The diamine solution floats on top of the sebacyl chloride solution, forming a good interface (if the pouring is done carefully).

If nothing were done about the HCl produced by the reaction, it would protonate unreacted hexane-1,6-diamine. Protonated diamine would not react with sebacyl chloride, because it has no unpaired electrons and cannot serve as a nucleophile.



This is the reason that the aqueous diamine solution contains NaOH. The NaOH reacts with the HCl as it forms, giving NaCl and water.

4. The structures of sebacyl chloride, hexane-1,6-diamine, and nylon 6.10 are shown above. The structures of dichloromethane (or methylene chloride) and acetone (wash solvent) are:



5. Safety considerations for this experiment include:

Sebacyl chloride is a lachrymator, and it reacts with water to give sebacic acid and HCl. Handle it in a fume hood, put the top back on the bottle when you're finished with it, and do not allow it to come in contact with your clothes or yourself.

The diamine is moderately basic, and the aqueous diamine solution contains the strong base NaOH. Do not allow this solution to come in contact with your clothes or yourself. If you notice that your hands are feeling slippery, as if there you have soap on them, wash them immediately with plenty of water. NaOH reacts with the compounds that make up cell walls to produce compounds that can be used as soap.

Dichloromethane (methylene chloride) is not good for you either. Dispense it in the hood, and do not allow the liquid to come in contact with your clothes or yourself.

Notes for topics that may be included in quizzes given after the experiment:

7. If your calculations give you a percent yield that is over 100%, you have an impurity in your product. The most likely impurity is water; the experimental procedure does not allow you enough time to dry your nylon thoroughly.
8. This experiment takes two starting materials (sebacyl chloride and hexane-1,6-diamine) and turns them into a different compound (nylon 6.10). Therefore, you must calculate a percent yield, not a percent recovery. For instructions and examples on how to do this, see the sample problems with solutions on this web site.

To calculate the percent yield of a polymer, cancel out the n's and read the equation this way: One molecule of sebacyl chloride plus one molecule of hexane-1,6-diamine gives one formula unit of nylon 6.10 and two molecules of hydrogen chloride.