

# Polymerization: Bakelite

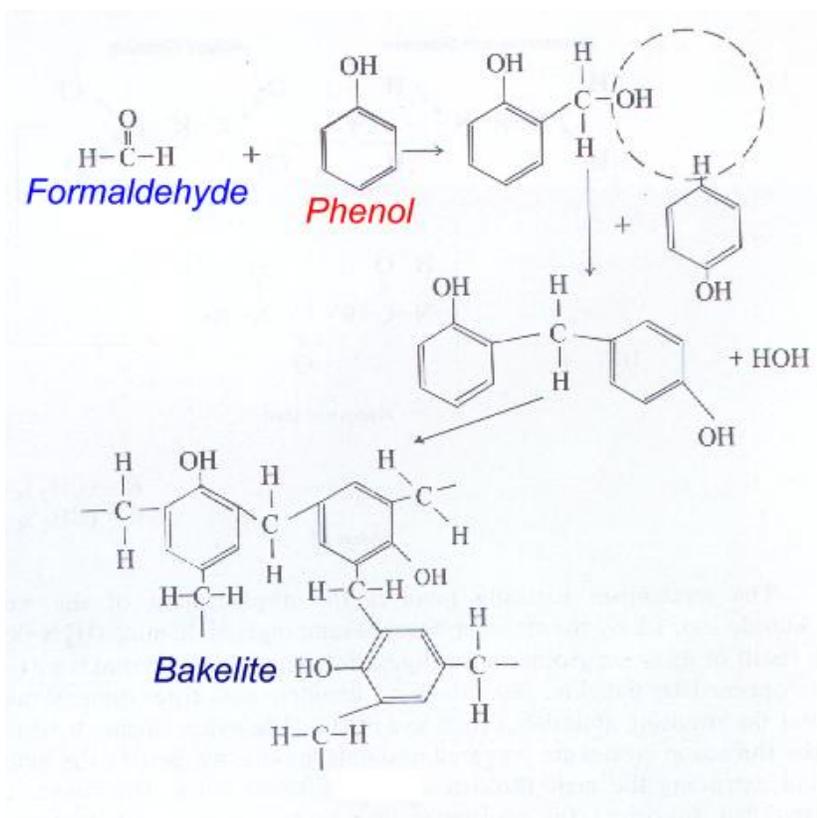
## Introduction

As the linked online lecture on polymerization precedes this experiment, there will be very limited introductory material to describe the process of polymerization. Instead, a brief description of the reaction of formaldehyde and phenol will follow prior to getting into the "cook-book" part of this experiment.

Bakelite (BAE kuh lite) has an interesting history. The links at the end of this experiment will bring you up to speed on that very rapidly.

Bakelite is a three-dimensional polymer of formaldehyde and phenol. The reaction in very broad terms is illustrated in the **graphic at right**:

Note that the structure of Bakelite depends on ortho-para substitution and on the fact that substituting units don't lie in the identical plane as other substituting units. All of this gives Bakelite its 3-D structure.



## Materials and Methods

Chemicals	Equipment
Melted phenol	Ring stand and 3-prong clamp
37% formaldehyde	Bunsen burner and striker and tubing
Concentrated sulfuric acid	Ignition tube
Disposable pipets	Hammer (if necessary)

## Methods

Place 3-3.5 mL melted phenol in the ignition tube -- clamp this in the 3-prong clamp after you have added the phenol. Pipet about 4.5 mL 37% formaldehyde on top of the phenol. Slowly and carefully add 3-4 drops of con sulfuric acid to the mixture, stirring carefully and constantly. Remember to face the ignition tube AWAY from yourself and your neighbors as you are doing this experiment.

Heat the mixture carefully with a LOW flame -- this is an exothermic reaction and too much heat will cause spattering and, potentially, could cause your tube to break. Once the mixture becomes very viscous, remove the flame and let the contents of the tube cool. After it has cooled, remove your Bakelite from the test tube -- by breaking the ignition tube with the hammer if necessary (this is done by wrapping the tube in 4-6 layers of paper towels and carefully hitting the tube -- this prevents glass shards from flying all over the place). Let your sample set for 30 minutes.

After it has cooled, hold it in your hand and rub it with your thumb until it warms up -- what is the odor you smell?

### Questions

Complete the Questions on separate paper and attach to the lab for turn-in.

1. Describe what the fat-soluble vitamins and natural rubber have in common.
2. What substituting group makes the difference between being poly-isoprene and gasoline/grease soluble and neoprene and gasoline/grease resistant?
3. Go to the library or online and look up the structures for 1,6-diaminohexane and adipoyl chloride. Draw them. Using what you know and what you can find, write the reaction necessary between these two compounds to form Nylon-66.

### Sources

1. D'Auria, Gilchrest and Johnstone: Chemistry and the Environment: A Laboratory Experience. (W.B. Saunders Co.: Philadelphia)© 1973.

### Links for Further Reading:

<http://www.deco-echoes.com/bakelite.html>

<http://www.worldint.com/science/bakelite.html>