

# Major Chemicals and Plastics We Use Every Day

F803

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# Topics

1. History of chemistry, and significant **discoveries** in the 19<sup>th</sup> century. Nitrogen fertiliser.
2. Plastics and rubber
3. Silicones
4. Chlorine containing chemicals and polymers.

# 2008 US Plastics and Fibers Production

(in 1000's of Metric Tons.)

Note: List is incomplete.

<b>Polyethylene</b>	<b>16,016</b>
Polypropylene	7,606
Polystyrene	2,368
Polyvinylchloride	5,801
Nylon fiber	728
Polyolefin fiber	1,109
Polyester fiber	1,240
Acetate fiber	27
<u>Total</u>	34,895

1 metric ton = 1000kg, so total = 34.9 billion kilos.

Ref: Chemical and Engineering News Online, July 6, 2009.

# Chemical Analysis of the Total Production

Carbon	77.0%
Hydrogen	11.8%
Chlorine	9.4%
Oxygen	1.5%
Nitrogen	0.3%

- Only 5 elements are involved out of 94!

# 1909 Again!

– Leo Baekeland

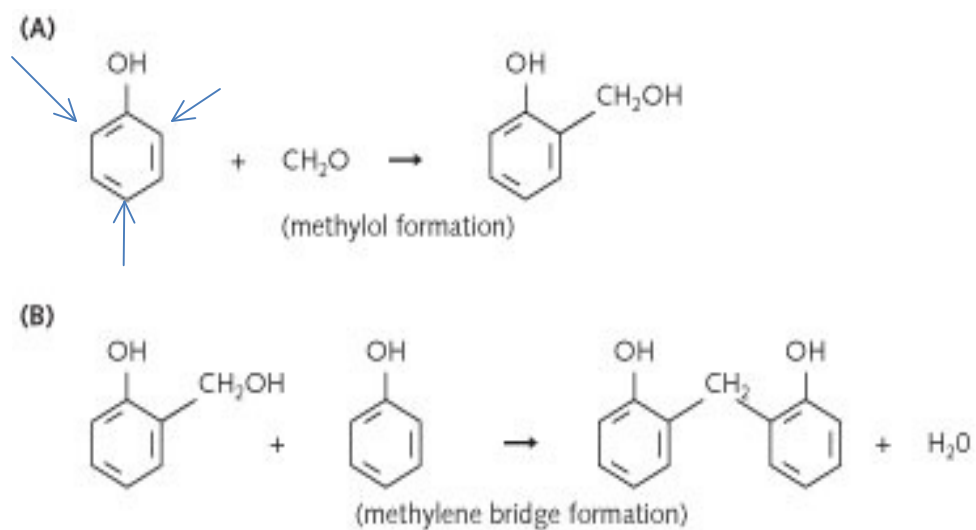
- Born in Belgium, immigrant in New Jersey
- Knew of a reaction between phenol and formaldehyde, discovered in 1870's, which made a hard solid.
- Was trying to make a substitute for shellac.



# Baekeland

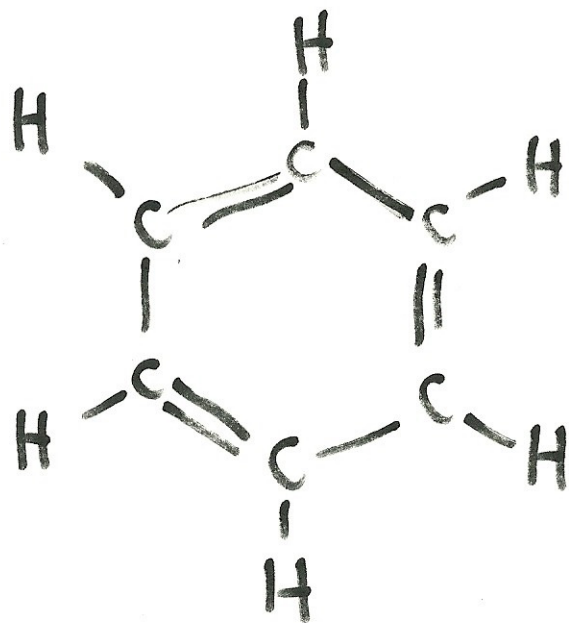
- Learned how to slow the reaction down and control it.
- Could stop the reaction at a gooey, amber colored viscous liquid stage.
- Separated it from the water
- Mixed it with filler to make a dough
- Molded it, heat cured -> hard infusible solid.

# Phenol-formaldehyde Reaction



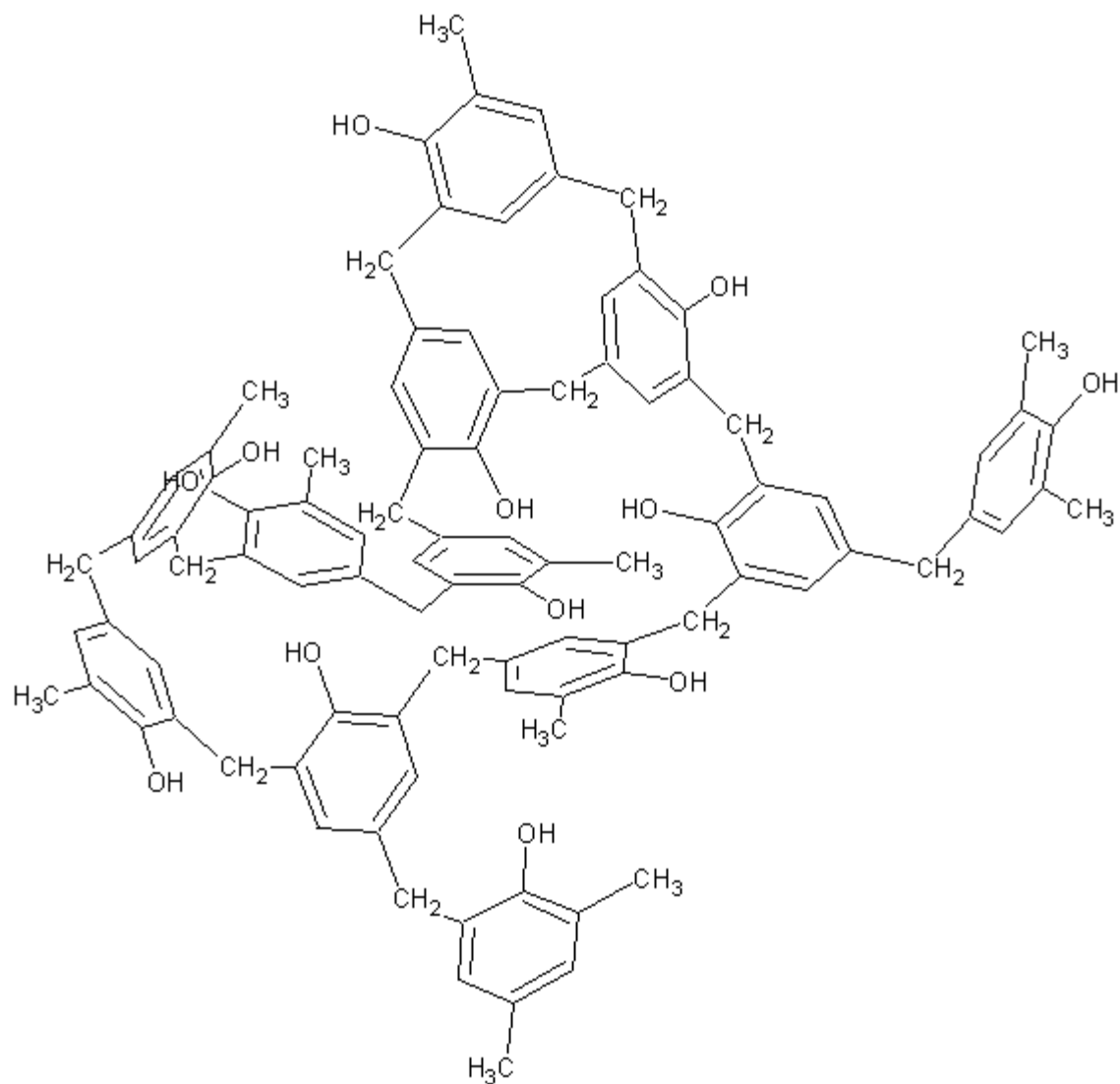


# Benzene Ring

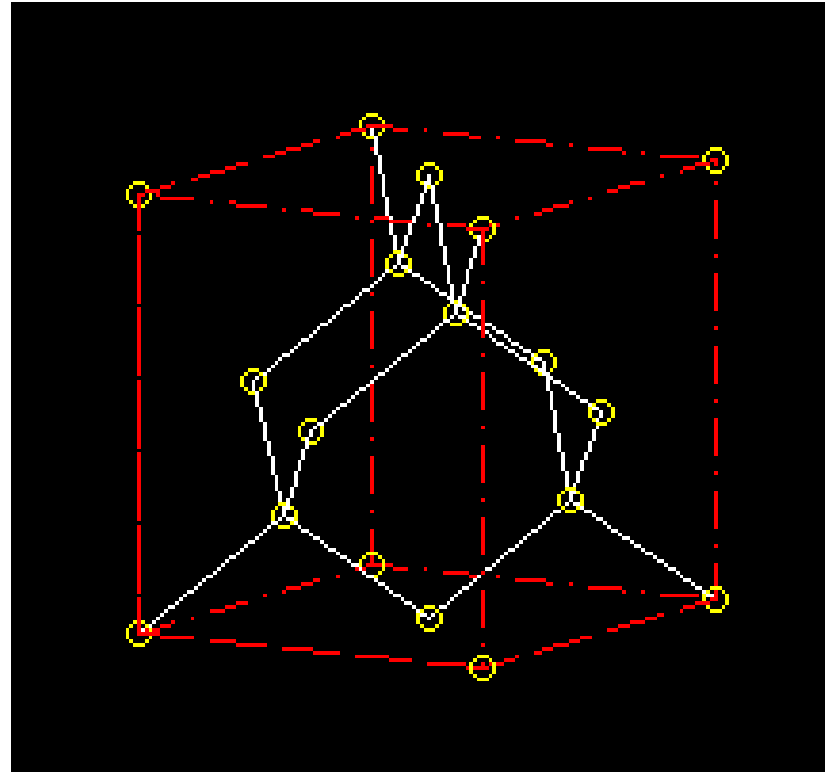


Short hand.

# Heat Cure, 350<sup>0</sup>F/15 minutes



# Diamond lattice structure



# Definitions

## Polymer

Meros (Greek) part or portion

Polymeres (Greek) having many parts.

Monomer      One part

## Thermoset polymer

One that sets on heating and cannot be remolded.

Webster

## Thermoplastic polymer

One that is not thermoset, and can be remelted repeatedly.

# Properties

- The first synthetic material which could be molded into complex shapes
- Hard and strong
- Brown colored
- Electrically insulating, heat resistant and fire retardant
- Ideal material for electrical components, rapidly developing industry in 1909.
- Regarded as the first polymer.



# **BAKELITE**

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Trade Mark for the  
Phenol Resin Products  
manufactured under  
patents owned by

**BAKELITE CORPORATION**

**THE MATERIAL OF A THOUSAND USES**



Bakelite letter opener, probably around 1920, from Germany

This is a file from the [Wikimedia Commons](#). Author [Sarefo](#)

# Uses

- Used for light switches, plugs and sockets, insulating varnish for wire, encapsulant for coils, radio housings, circuit boards. (Health hazards for production workers.)
- Laminating adhesive for plywood
- Fiberglass insulation
- Metal primer,
- Heat shield for spacecraft and missiles



# Developments in 1920-1940

- Phenol was substituted by urea for light color, but polymer is unstable to sunlight and moisture; used today as slow release fertiliser for lawns.
- Light colored articles could be made by substituting phenol with melamine; useful for dinnerware and countertops (Formica).
- Over the last 30 years many applications of thermoset polymers have converted to thermoplastics, for lower cost of manufacture.