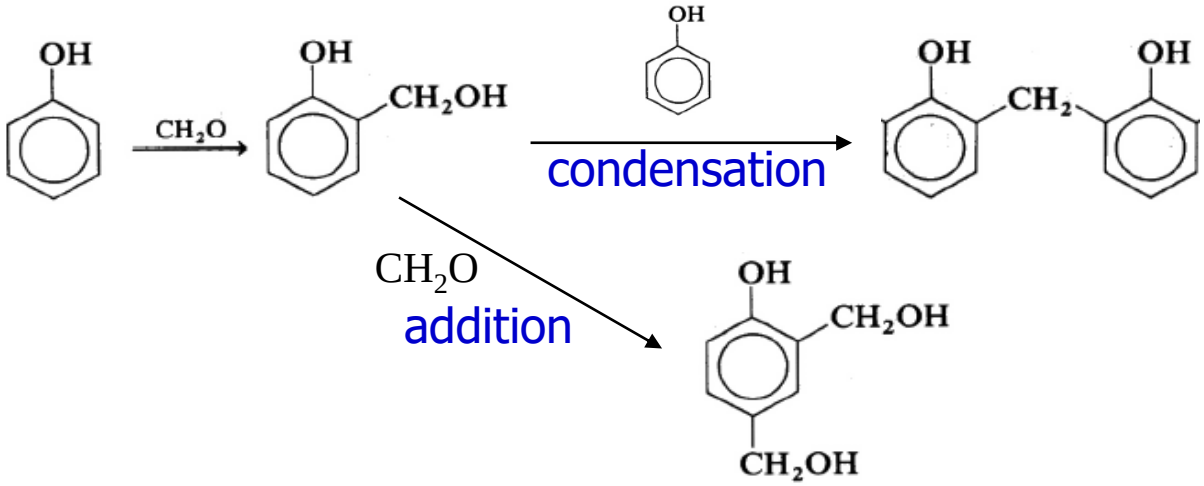
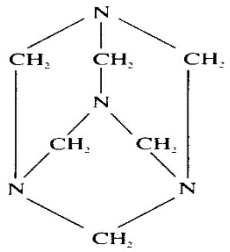
Formaldehyde resins

- PF or phenolic resin





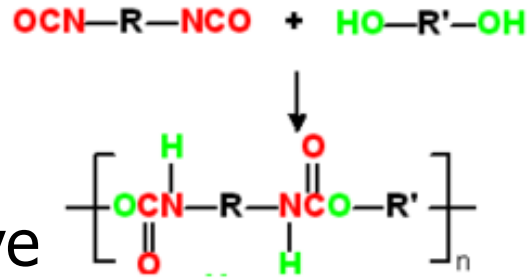
  - hard, heat- and chemical-resistant thermoset
  - prepolymers
    - resole [resol]: aldehyde xs, basic condition, polyalcohol, 3-4 rings, liq. or solid, cured by heat ~ one-stage resin ~ coating, laminate
    - novolac [novolak]: phenol xs, acidic condition, polynuclear phenol, 5-6 rings, solid, cured by amine (hexa) ~ two-stage resin ~ molding

- UF resin
  - H_2N-CO-NH_2 (f=4) + CH_2O
  - addition-condensation
  - superior to PF
    - colorable, electrical insulation, water-stability
  - adhesive for wood, molding
- MF resin
  - melamine ~ f=6
  - better than UF and expensive
    - hard, water-, heat-, staining-, electrical-resistance
    - houseware, tableware, tabletop

UF + MF = amino resins

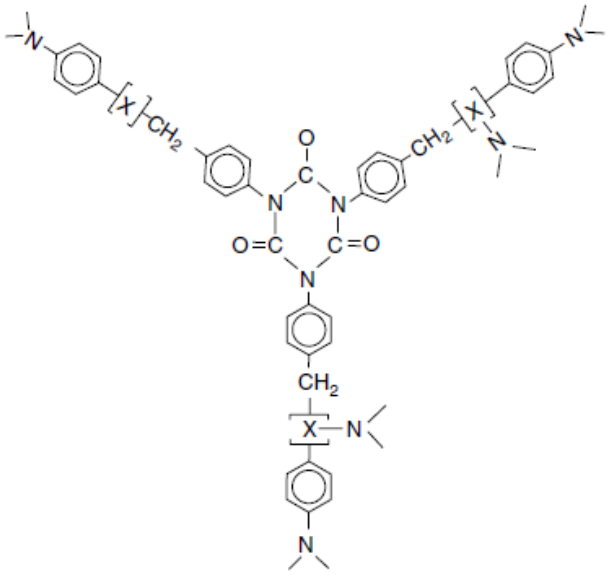
PU

- diisocyanate [DI] (Fig 4.28) + polyol (Fig 4.29)
- crosslinked rubber
  - Fig 4.30
  - high strength/stability rubber, expensive
  - roll mill or RIM ~ automotive and shoe industry



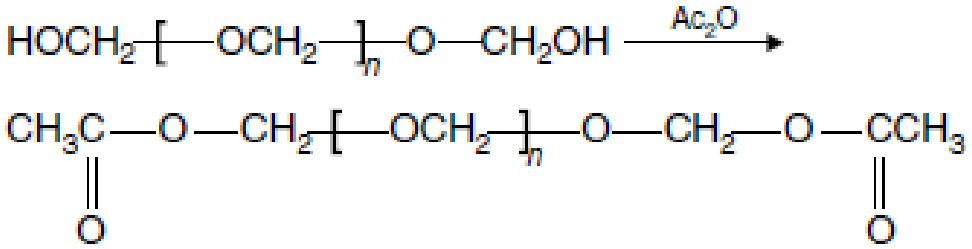
- TPU
  - soft segment ~ long-chain polyol
  - hard segment ~ urethane or urea block
  - molded for engineering rubber applications
- TPU fiber ~ Spandex, Lycra
  - dry-spun of amide solution

- foam
  - flexible ~ high M_c, foaming by water (+ HCFC)
    - cushion, cushioned packaging
  - (semi)rigid ~ low M_c, multifunctional DI
    - engineering foam, insulation
  - polyisocyanurate foam
    - better fire, thermal resistance
- coating
  - based on aliphatic DI
  - flexible, tough, yellowing-resistant



polyethers

- polyacetal [POM]
  - polym'n of formaldehyde or trioxane
  - low T_c → depolym'n
    - end-capping

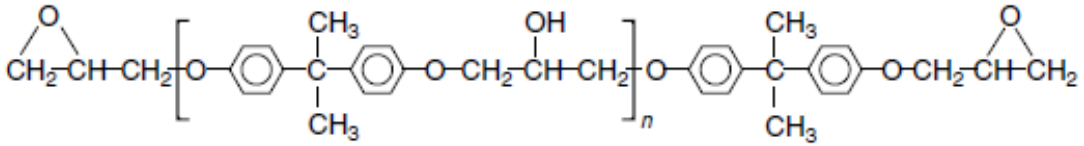


    - copolym'n w/ other ether like EO
  - engineering plastic with high X_c, T_m
  - applications ~ parts ~ compete with nylon
    - stiffer, better fatigue, water-resistant (than PA66)
    - worse impact

- PEO [POE]
  - water-soluble, biocompatible
  - PEG ~ low MW w/ OH end-group
    - MW < 600 ~ surfactants, lubricants
    - MW > 600 ~ base for cosmetics and phamaceuticals
      - cream, shampoo, ointment, ---
  - PEO ~ high MW (~10E5)
    - applications Table 4.24
    - water-soluble packaging and encapsulation
- PPG
  - polym'n of propylene oxide
  - polyol for PU foam
  - surfactant, lubricant (copolym'n with PEO)

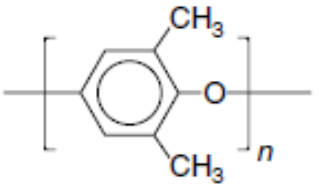
Epoxy

- DGEBA prepolymer (resin)
  - BPA + epichlorohydrin
  - epoxy [epoxide] equivalent
- curing



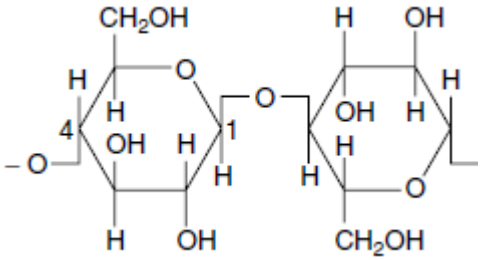
  - amine Table 4.27
    - tertiary (catalytic); primary or secondary
    - aliphatic (fast, adhesive); aromatic (slow, laminates)
  - anhydride Fig 4.35
    - opened and open epoxy
    - higher thermal stability than amine-cured epoxy
- variations ~ novolac, PPG, halogenated, alicyclic, acyclic
- coating > laminate (composite) > adhesive, ---

PPO



- oxidative coupling of 2,6-dimethyl phenol
- engineering plastic
  - high T_g, high strength
  - (dimensional and hydrolytic) stability
- blended with other polymers ~ mPPO
  - PS or HIPS ~ Noryl ~ compete with other EPs, cheaper
  - nylon ~ Noryl GTX ~ fender

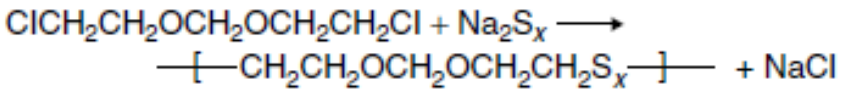
Cellulose polymers



- cellulose ~ from plants (pulp)
  - crystalline, H-bonding ~ intractable
- regenerated cellulose
  - xanthation ('viscose'), formed, and hydrolysis
  - viscose rayon (fiber), cellophane (film)
- cellulose nitrate
  - camphor-plasticised ~ Celluloid
  - table tennis ball, eyeglasses frame, knife handle
- cellulose acetate
  - acetylation then partial hydrolysis
  - acetate rayon fiber, photo film
- other esters and ethers

Sulfide polymers

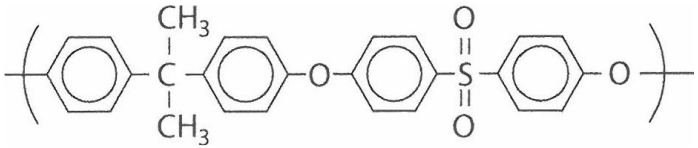
- polysulfide
  - linear or crosslinked ~ elastomeric
  - sealing, gasket



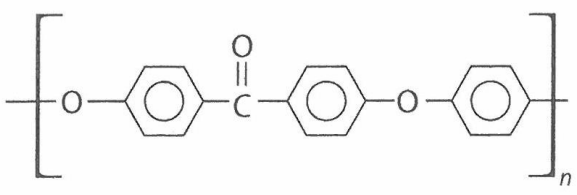
- PPS
  - EP ~ comparable to PPO
  - brittle, high heat resistant
  - high ESC resistance, arc-resistance
  - automotive parts

Aromatic polymers

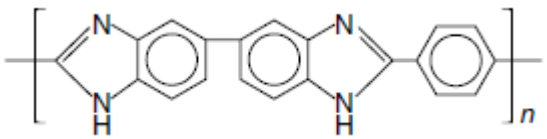
- Polysulphones
  - SO_2 containing ~ amorphous ~ transparent
  - (BPA-)PSF, PES, PAES Table 4.30
  - super EP ~ higher T_g Fig 4.36



- PEK, PEEK
  - semicrystalline, high T_m
  - high-end engineering applications

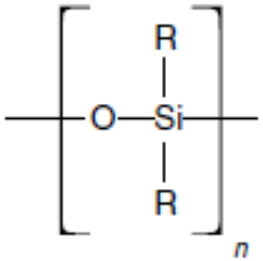


- PBI
  - higher use Temp than PI
  - fiber ~ flight suits



Silicones

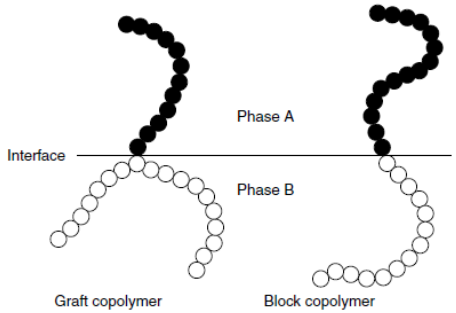
- hydrolysis/polym'n of SiR_xCl_{4-x} → PDMS (R=Me)
- silicone fluid (oil)
  - linear low MW PDMS
  - lubricant, water-repelling finish



- silicone resin
  - Xlinked PDMS ~ R/Si < 2
  - good thermal and electrical, bad mechanical
  - laminate for PCB
- silicone rubber
  - PDMS later crosslinked by RTV (Fig 4.38) or heat-cure
  - thermal, electrical, non-stick, biocompatible, ablative

Polymer blends

- polyblend, polymer alloy
- $\Delta S_{mix} \approx 0 \rightarrow \Delta H_{mix} < 0$ for miscibility
  - Most pairs are immiscible w/o specific interaction.
  - miscibility, compatibility, compatibilizer
- miscible blends ~ properties additive
  - PS/PPO
- immiscible blends
  - compatibilized ~ nylon/PPO
  - uncompatibilized ~ PC/PBT, PC/ABS
- nanoblends ~ domain < 100 nm
  - in-situ polym'n/compatibilization
  - PP/nylon ~ nylon polymerized w/ end-functionalized PP



IPN

- polym'n/Xlinking of polymer A and B
  - sequential (SIPN) or simultaneous (SIN)
  - full-IPN or semi-IPN
  - no or little phase separation
  - silicone/Kraton® SEBS
    - biocompatibility and mechanical strength