

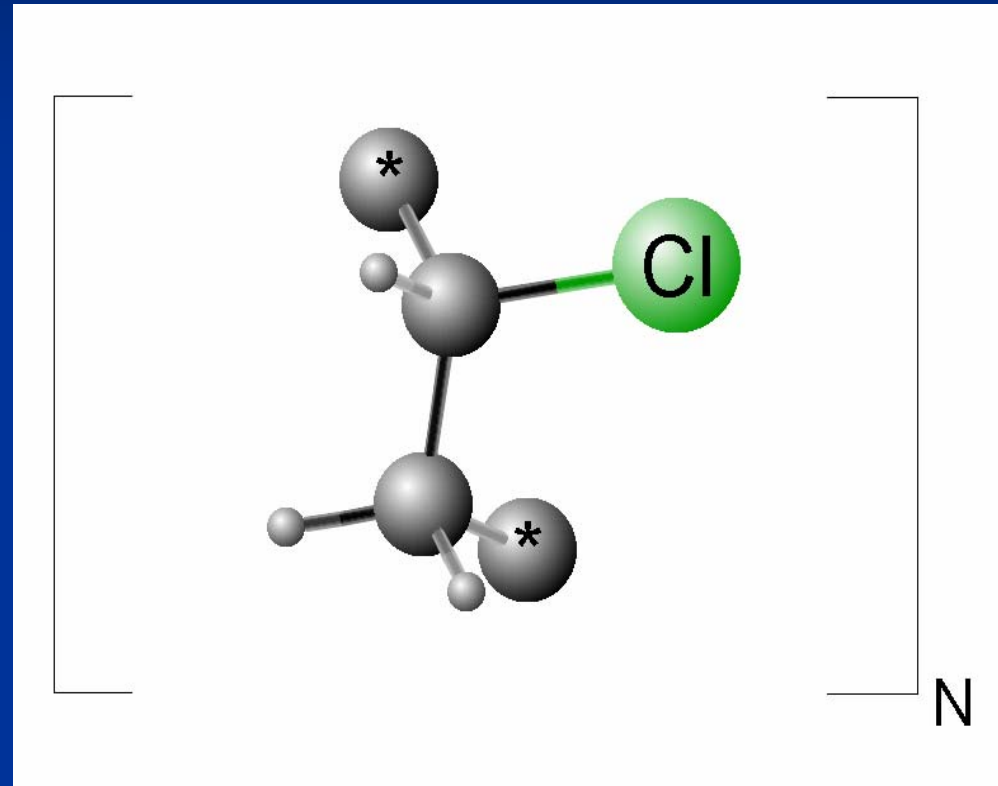
PVC

poly (vinyl chloride)

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Introduction to Polymers
CE435

Presentation Outline

- Molecule
- Properties
- Manufacturing
- Products
- Q&A



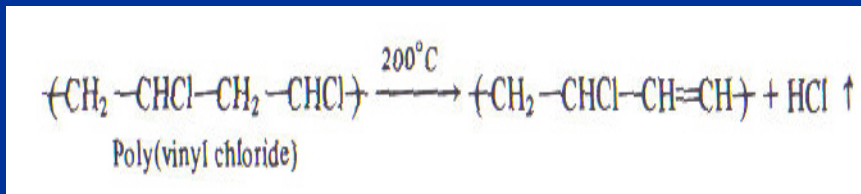
3-D view of PVC monomer

Molecule Synthesis

- Synthesized by free radical polymerization
- Common initiator –
Lauroyl Peroxide (soluble in monomer)



Free radical polymerization of PVC



Example of a degradation reaction

- To protect against dehydrohalogenation (degradation), chemical stabilization is required
 - Absorb or neutralize HCl
 - Displace “active” chlorine atoms such as those on tertiary carbons
 - React with double bonds
 - React with free radicals
 - Neutralize other species that may accelerate degradation
- Examples
 - Metal soaps of Ba, Cd, Zn, Ca
 - Organo- tin compounds
 - Epoxy compounds
 - Phosphites
 - Phenols

Properties

External Plasticizer Addition

“External Plasticization”: non-permanent or physically bound

Examples: tritoyl phosphate, dioctyl phthalate, dibutyl phthalate, dioctyl sebacate

No Added Plasticizer

- Rigid, but not very tough
- Slight branching
- ~55% syndiotactic structure
 - The rest largely atactic; (related to polymerization temp)

Added Plasticizer

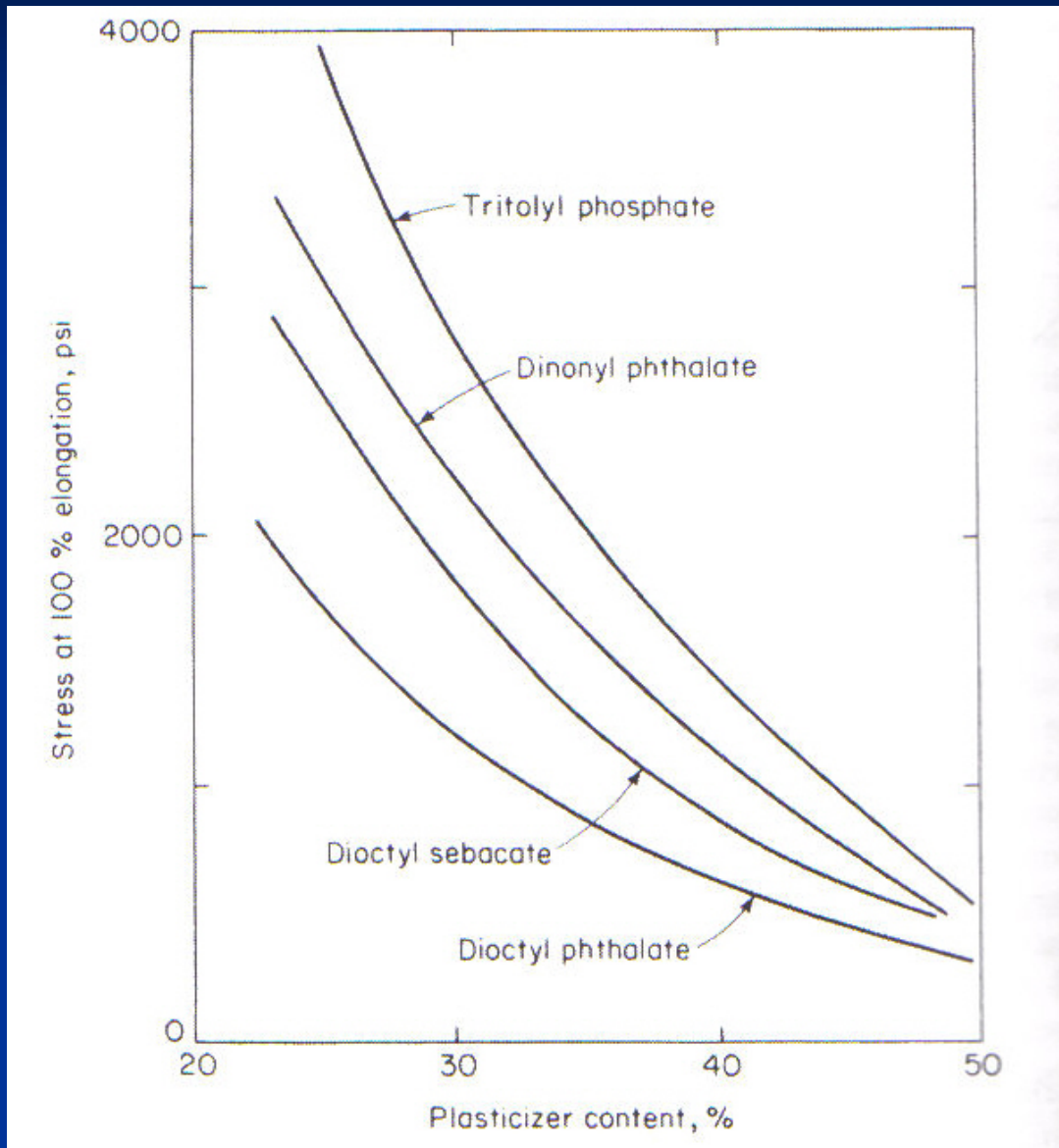
- Flexible and soft
- Branching has been observed to decrease with decreasing polymerization temp
- Syndiotacticity increases with decreasing polymerization temp

Independent of Plasticizer Addition

- Thermoplastic
- Resistant to oxidizing agents, reducing agents, detergents, oils, fats, etc....
- Fire resistant
- Water resistant

Properties

External Plasticizer Addition



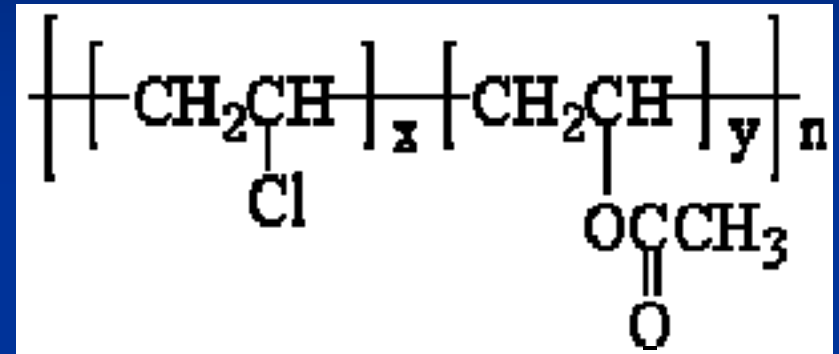
Properties

Internal Plasticization - Copolymerization

“Internal Plasticization”: permanent or chemically bound

Examples- PVC-PVAc, Poly(vinyl chloride-vinyl acetate-(2-hydroxypropyl propenoate))

- Popular copolymer is PVC-PVAc
- Crystalline domains will decrease with increasing PVAc addition
 - At high PVAc concentrations, (~17%) domains are shown to be almost completely amorphous, even upon physical stretching.
- Similar to “externally” plasticized PVC, “internally” plasticized PVC is resistant to fire/ water/ chemicals.



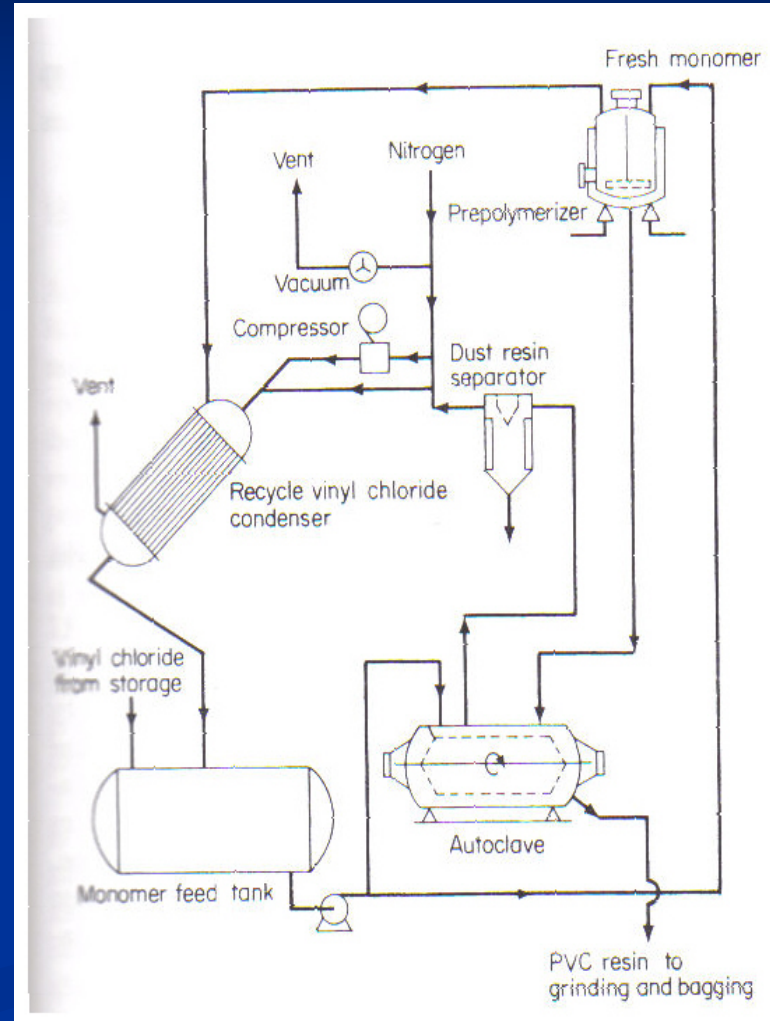
PVC-PVAc Copolymer

- The variation of PVC-PVAc composition gives the ability to tune properties such as tensile strength, elongation, impact strength, and solubility.

Product Manufacturing

Methods of Polymerization

- Batch wise suspension
 - Suspension - stabilizer {poly(vinyl alcohol)}
 - Un-reacted monomer can be blown off to reveal a porous material that is very susceptible to plasticizer
- Dispersion
 - Emulsification - dispersion of insoluble PVC in plasticizer
 - Plasticizing is helped by residual emulsifier on surface of dried particles
- Bulk Polymerization
 - No residual emulsifier or stabilizer to deal with
- Copolymerization
 - Emulsion polymerization used successfully



Schematic of Continuous Bulk Polymerization

Products

No Added Plasticizer

- pipe fittings, housings for electrical equipment, electrical conduit fittings; bottles, junction boxes, door handles, telephone handsets, chair backs and seats, water filtration pressure tanks, ventilation grilles, corrugated roofing, general chemical engineering applications



Externally Added Plasticizer

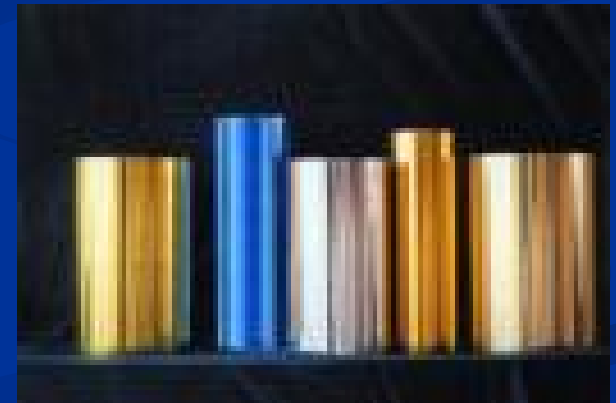
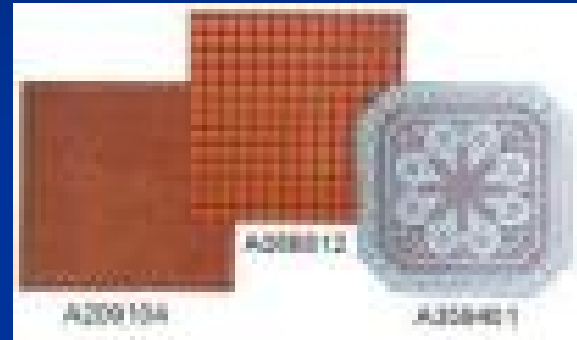
- leather cloth, cable coating, packaging, clothing, household goods, toys, watch straps, cable grommets/ends; gaskets, washers, handle coverings, footwear (beach shoes, sandals), heel tags, electrical shields, plugs and other electrical components



Products

Internally Plasticized

- Flooring, records, sheet, film, packaging, pipes, fittings, coatings and films



Q&A

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