Chem 664, Fall 2003
Handout

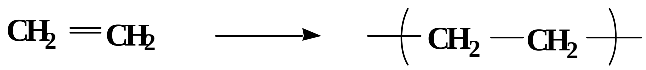
#3, 09/03/03

Chemical Structures of Polymers & Macromolecules:
Primary Structural Order & Chain Connectivity

A. Homo-atomic backbones; monomers & repeating units.

C-C backbones

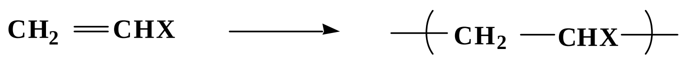
1. Primary vinyl structure without substituent:



monomer repeating unit

poly(ethylene)

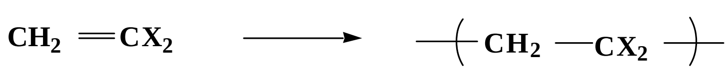
2. Single substitution: CH_2=CH- , vinyl group



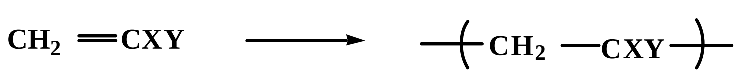
monomer	repeating unit
X= CH_3	poly(propylene), PP
X= Φ	poly(styrene), PS
X= Cl	poly(vinyl chloride), PVC
X= OH	poly(vinyl alcohol), PVA
X= $OCOCH_3$	poly(vinyl chloride), PVC
X= COOH	poly(acrylic acid), CH_2=CHCOOH acrylic acid
X= $COOCH_3$	poly(methyl acrylate)

•
•
•
etc.

3. Double substitution: CH_2=C<, vinylidene group

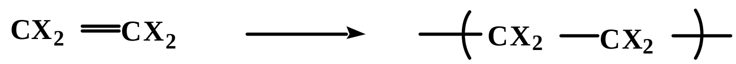


monomer	repeating unit
X=Cl	poly(vinylidene chloride), Saran®
X=F	poly(vinylidene fluoride)
X=CH_3	poly(isobutylene), CH_2=C$(CH_3)_2$ isobutylene



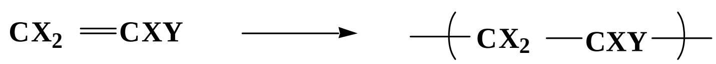
monomer	repeating unit
X=CH_3, Y=COOH	poly(methacrylic acid), CH_2=C(CH_3)COOH
X=CH_3, Y=$COOCH_3$	poly(methyl methacrylate), PMMA, Lucite®, Plexiglas®

4. Full Substituion



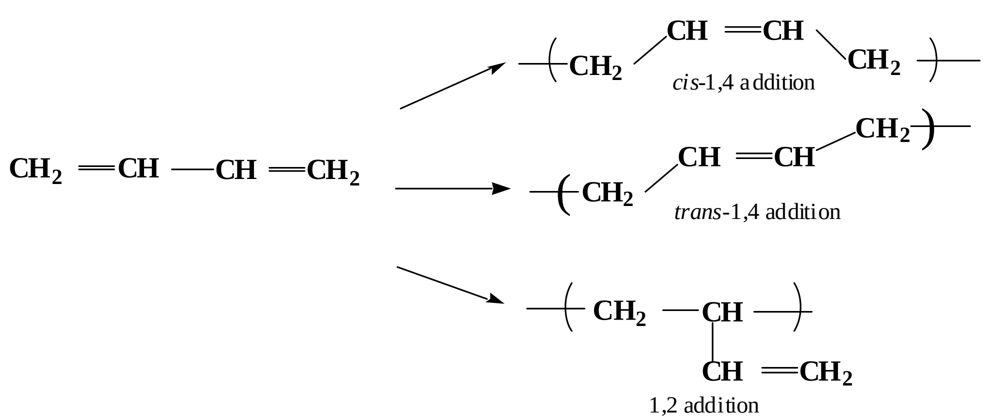
monomer

X=F poly(tetrafluoroethylene), Teflon®



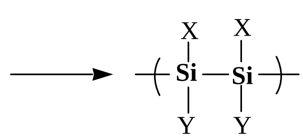
monomer repeating unit
X=F, Y=Cl poly(trifluorochloroethylene), Kel-F®

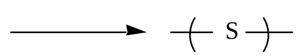
5. Dienes: CH_2=CX-CH=CH_2
   X=H poly(*cis*-1,4-butadiene), poly(*trans*-1,4-butadiene)
   poly(1,2-butadiene)=poly(vinyl ethylene)



X=CH_3 poly(*cis*-1,4-isoprene), poly(*trans*-1,4-isoprene)
Natural rubber (caoutchouc) is a mixture of the two.
poly(1,2-isoprene), poly(3,4-isoprene)
X=Cl poly(cis-1,4-chloroprene), Neoprene®

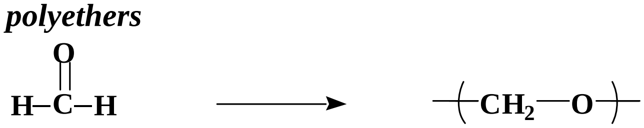
Other backbones: polysilanes and polysulfur

Wurtz reaction of dichlorosilane with Na 

Thermal polymerization of sulfur flour, S_8 

B. Hetero-atomic backbones:

1. Bi-atomic backbones
   polyethers



formaldehyde repeating unit, poly(methylene oxide)

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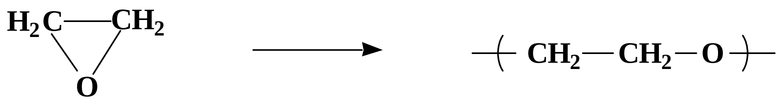
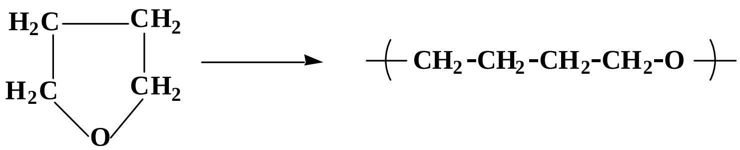


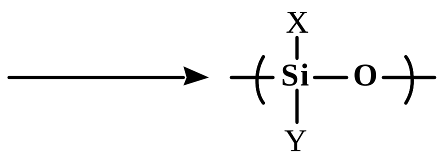
epoxide poly(ethylene oxide)



tetrahydrofuran poly(butylenes oxide)

polysiloxanes

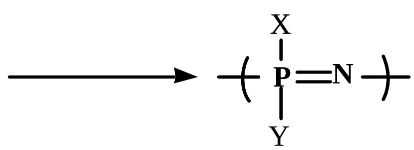
cyclic trimer or tetramer



X=Y= methyl, poly(dimethylsiloxane), Silicones
X= Y=ethyl, poly(diethylsiloxane)
X=methyl, Y=phenyl, poly(methylphenylsiloxane)

polyphosphazenes

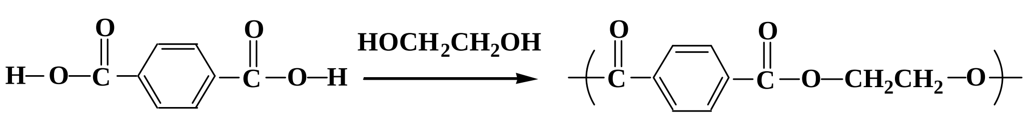
cyclic trimer



X=Y=Cl, poly(dichlorophosphazene)
X=Y=OCH_2CH_3, poly(diethoxyphosphazene)

3. Ter-atomic backbones

Polyesters

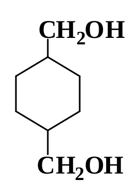


Polycondensation of dicarboxylic acid and diol
terephthalic acid + ethylene glycol poly(ethylene terephthalate), PET, Mylar®

other common diols;

$HOCH_2CH_2CH_2CH_2OH$

butanediol



cyclohexane 1,4-dimethanol

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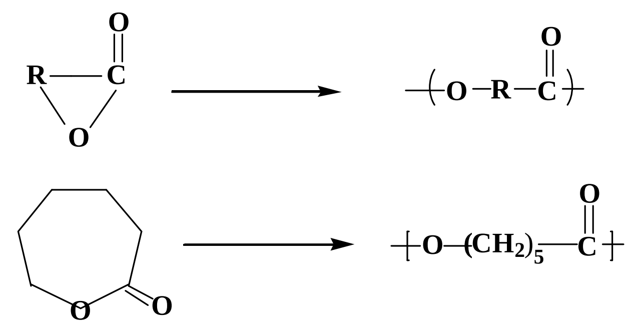
Ring-opening polymerization of lactones

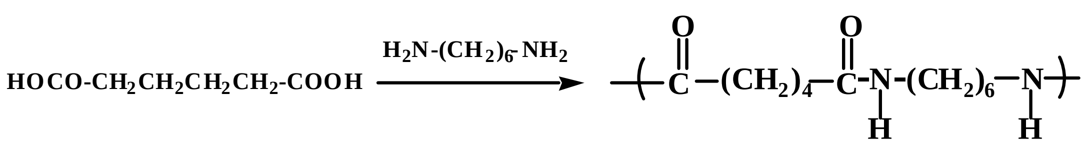


ε-caprolactone

Ring closure of a-hydroxycaproic acid (a-hydroxyhexanoic acid) results in e-caprolactone.

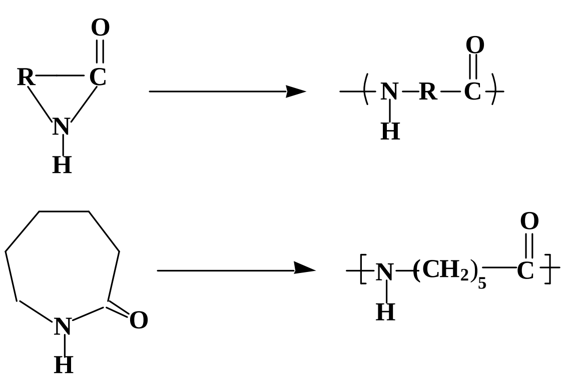
polyamides

Polycondensation of dicarboxylic acid and diamine



adipic acid + hexamethylene diamine   Nylon®-6,6

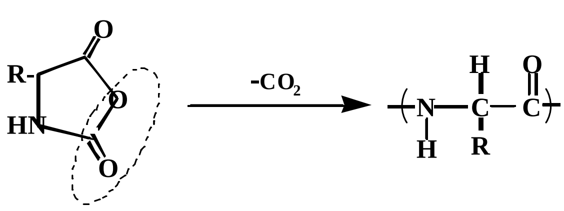
Ring-opening polymerization of lactams



ε-caprolactam

Nylon®-6

Leuchs reaction, decarboxylation of N-carboxy anhydride, for polypeptide



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Facts & Figures of Polymer Industries, C&E News, July 2, 2003

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