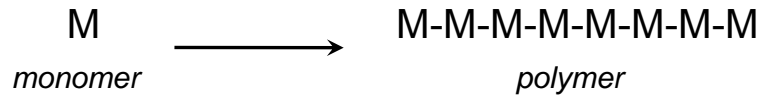
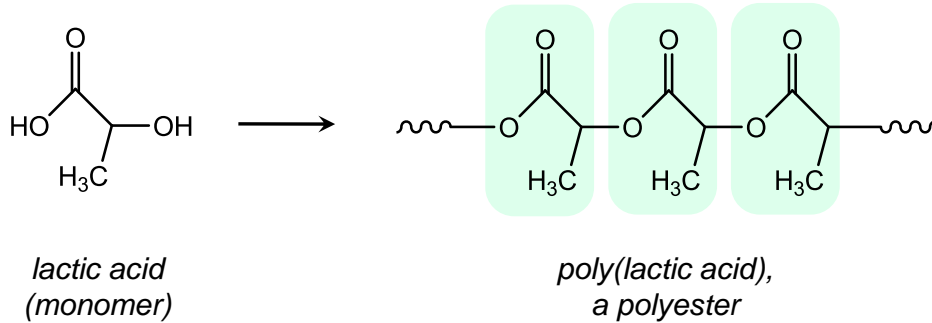


# Polymers

- Polymers are linear chains of monomers.



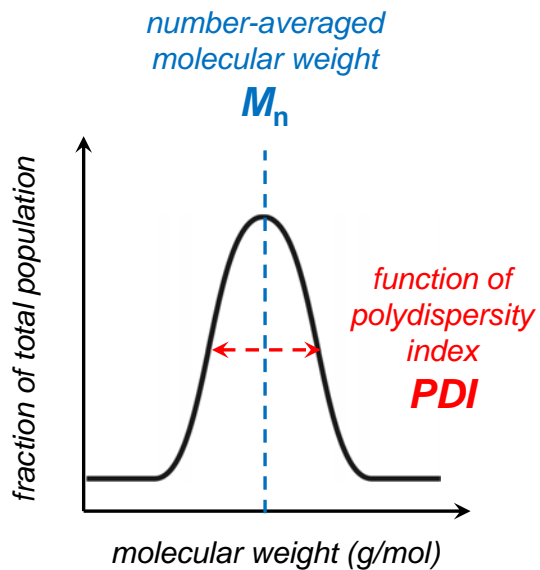
Example:



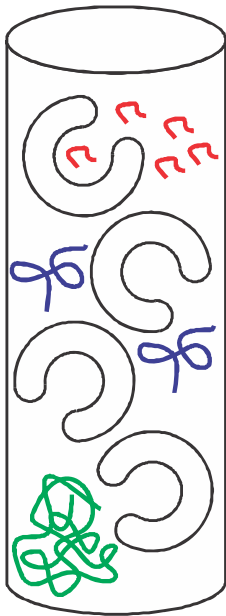
## Characteristic Properties of Polymers

- Polymers are *polydisperse*.

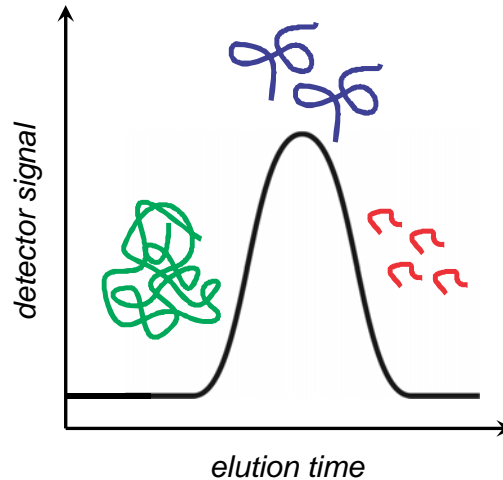
Polymer materials are composed of a collection of chains with a distribution of lengths/masses (and are typically characterized by the average mass and the breadth of the distribution).



# Molecular Weight Characterization by Gel Permeation Chromatography



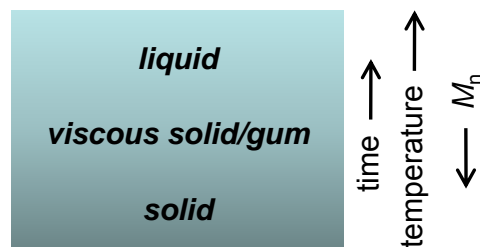
- Polymer chains flow through a column of porous beads.



- Smaller polymers experience more volume in column than larger ones.
- As a result, smaller polymers elute later.

## Characteristic Properties of Polymers

- Polymers often exhibit a continuous range of phase behavior. (Are “viscoelastic”.)
- Polymers deform and flow throughout this range, but with different timescales.



*So, polymer materials are processable and forgiving.*

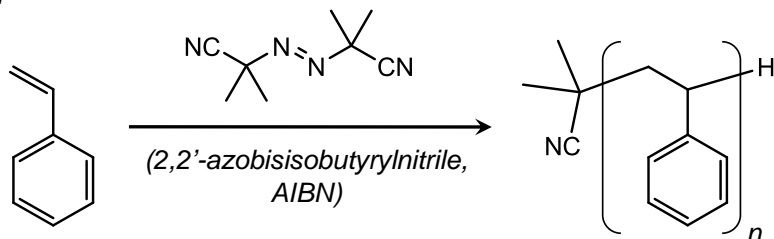
- Polymer properties are dictated almost entirely by
  - Monomer structure;
  - Average molecular weight; and
  - Degree of crosslinking (to a lesser extent).





## Radical Polymerization of Vinyl Monomers

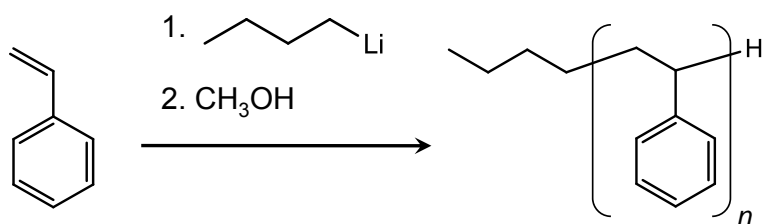
Example:



- Because propagation is faster than initiation, chains grow rapidly and at different times, to generate broad distribution of polymer lengths (polydispersity).

## Anionic Polymerization of Vinyl Monomers

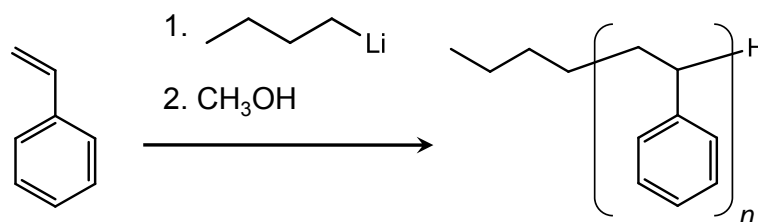
Example:



- Involves same three mechanistic steps:
  - 1 Initiation
  - 2 Propagation
  - 3 Termination

# Anionic Polymerization of Vinyl Monomers

Example:



- Because initiation is faster than propagation, chains all start immediately and grow for the same amount of time, to produce low polydispersity.
- No spontaneous termination, so chains are always “living”.