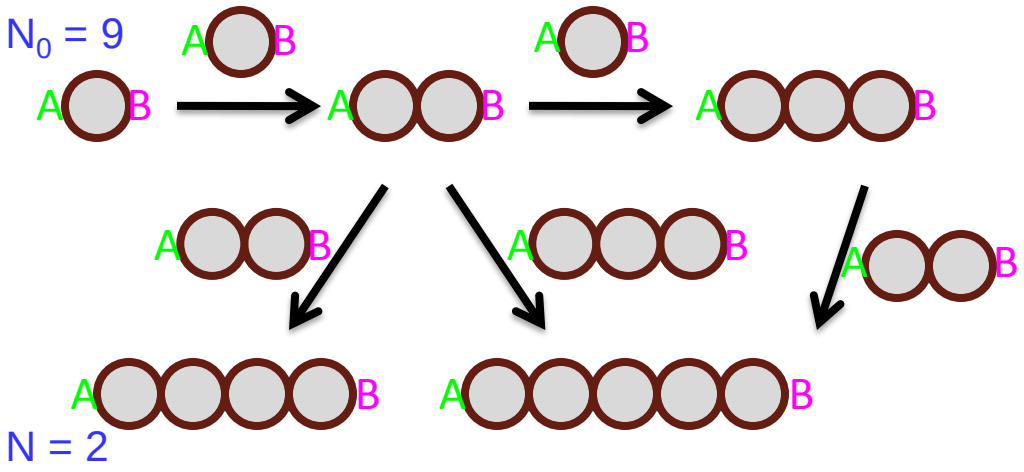
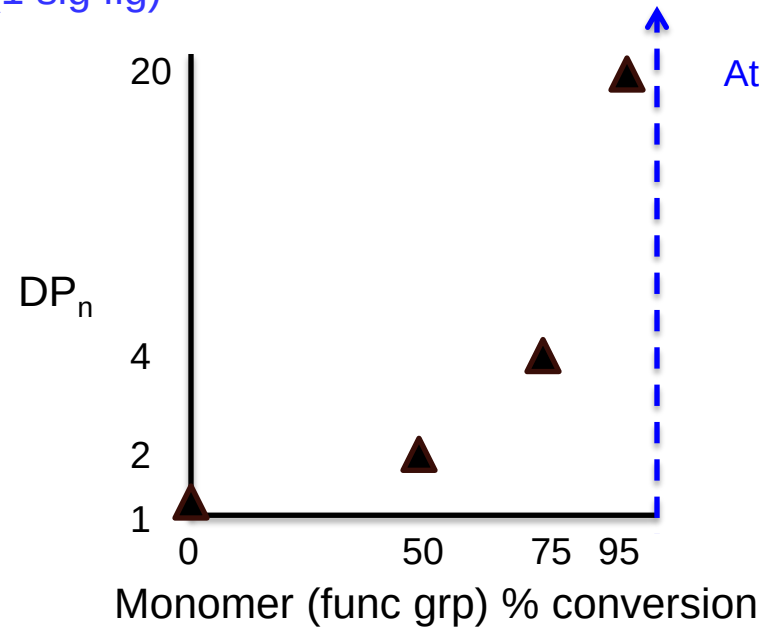
Condensation, Step-Growth Polymerizations



DP_n = 5 (1 sig fig)
c = 0.8



- Polymers build-up stepwise; high degrees of polymerization only at high degrees of monomer conversion
- Non-living (non-chain-growth), except in a few cases (T. Yokozawa)

At 100% conversion, either infinite chain length or entirely cyclic structures

Stoichiometric equivalence of functional groups is critical to achieve high conversions

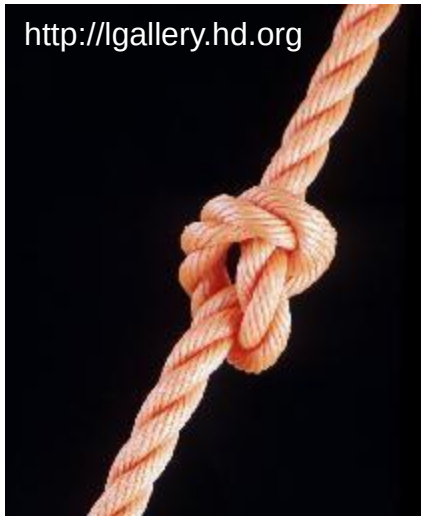
$$DP_n = \frac{N_0}{N} = \frac{\text{Number of molecules at t = 0}}{\text{Number of molecules at t = x}}$$

$$\text{Conversion*} = c = \frac{N_0 - N}{N_0}$$

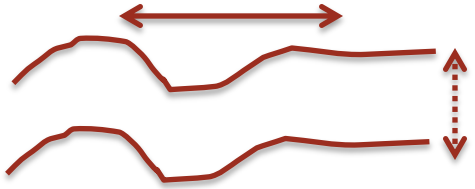
$$DP_n = \frac{1}{1 - c}$$

* For an AB monomer system, where # molecules = # A or B groups

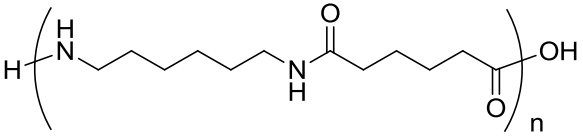
Achieving Stoichiometric Equivalence—Carothers



Strong Intramolecular Bonding

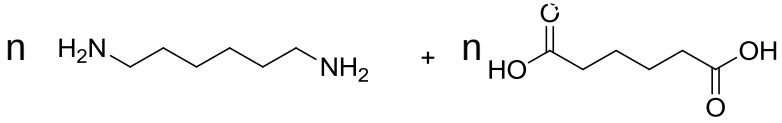


Strong Intermolecular Interactions

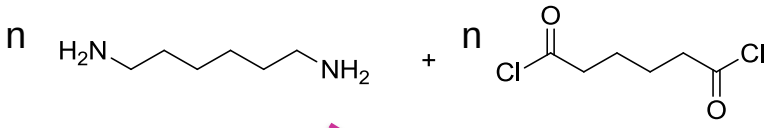


Nylon 6,6

Always show chain ends—they are diagnostic of the synthesis



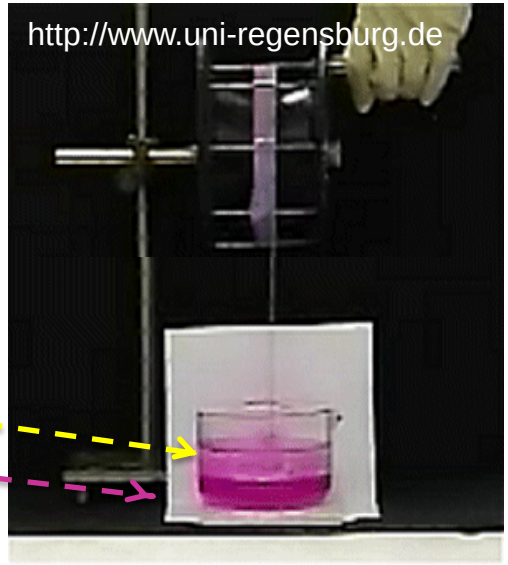
or



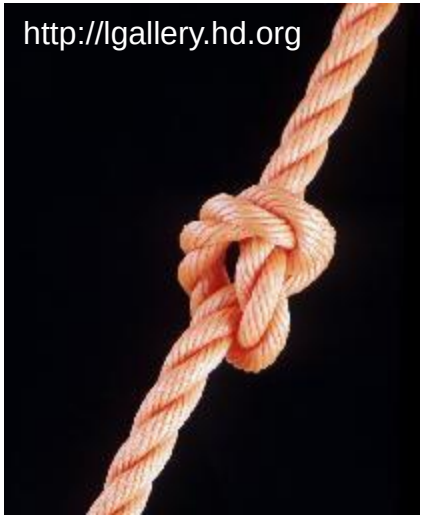
Interfacial Polymerization to Achieve Polymerization with Stoichiometric Equivalence at the Interface

In 50% $NaOH/H_2O$

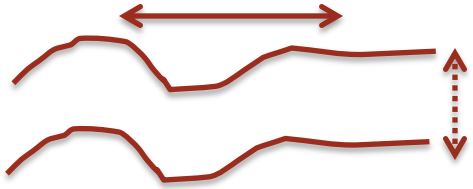
In toluene



Achieving Stoichiometric Equivalence—Carothers



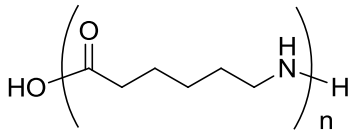
Strong Intramolecular Bonding



Strong Intermolecular Interactions

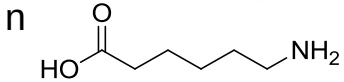
Also, the placement and type of brackets indicate important information about the synthesis and structure

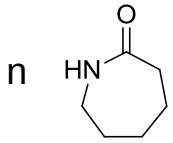
Nylon 6



Δ, - n-1 H_2O

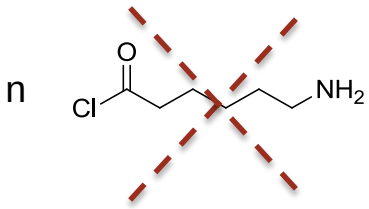
1) HO^-, Δ
2) H^+/H_2O





Ring-opening Polymerization

A Chain Polymerization Mechanism



Incompatible (Reactive) Functional Groups