Chemical Engineering 160/260
Polymer Science and Engineering

Lecture 11 - Polymer Blends

February 9, 2001

Objectives

- To provide some design guidelines for the development of polymer blends
- To illustrate the commercial significance of polymer blends.

Definitions

- ***Polymer blend*** - mixture of at least two polymers or copolymers
- ***Homologous polymer blend*** - mixture of narrow molecular weight distribution fractions of the same polymer
- ***Miscible polymer blend*** - homogeneous to the molecular level
  - $\Delta G_m \approx \Delta H_m \leq 0$
- ***Immiscible polymer blend*** - phase separated
  - $\Delta G_m \approx \Delta H_m \geq 0$
- ***Compatible polymer blend*** - "utilitarian" term denoting commercially attractive polymer mixture
- ***Polymer alloy*** - immiscible polymer blend with modified interface

Methods of Blending

- Mechanical mixing - cheapest
- Dissolution in co-solvent, then film casting, freeze or spray drying
- Latex blending
- Fine powders mixing
- Use of monomer(s) as solvent for another component, then polymerization (interpenetrating network)

Reasons for Blending

- Dilute high-cost engineering resin with low-cost polymer
- Develop broad property range materials
- Form high performance blend from synergistically interacting polymers
- Adjust composition to suit customer
- Recycle industrial/municipal plastics scrap

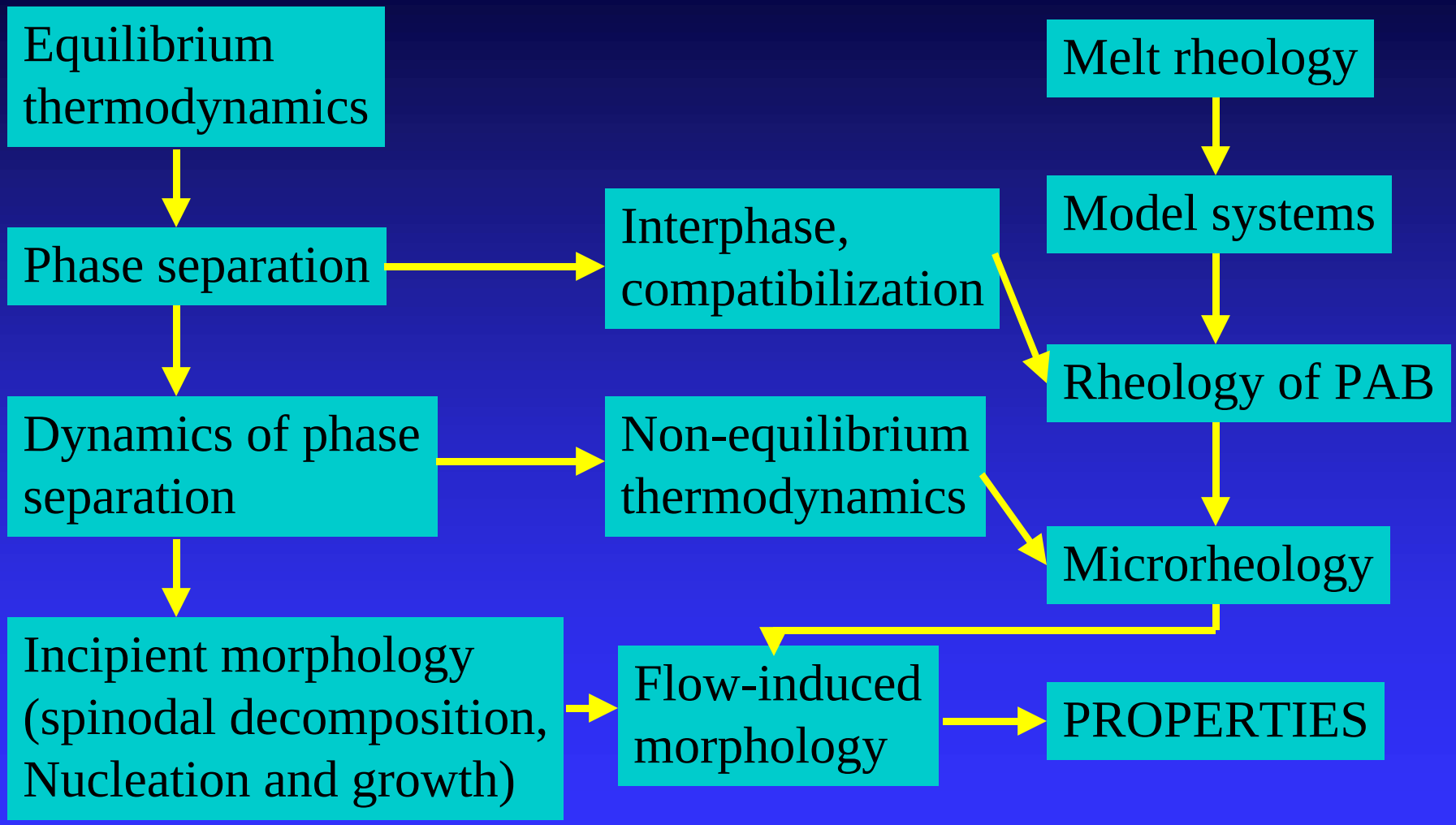
Design Criteria for a Polymer Blend

- Define physical/chemical properties needed
- Select possible resins with some of the needed properties
- Evaluate advantages/disadvantages
- Select test set of resins
- Determine miscibility and/or method of compatibilizing
- Examine economics (cost of resin, compatibilization, compounding) and effect on forming and maintenance of longevity
- Define ideal morphology
- Select rheological properties (molecular weights, compounding parameters), concentration of ingredients, amount of compatibilizer, type of deformation and intensity
- Determine method of stabilization of morphology (controlled cooling rate, crystallization, chemical reaction, irradiation)
- Select optimum fabrication method to yield desired morphology

Technological Development is Needed for:

- Test methods, especially for cyclic loading
- Long-term performance, weatherability
- Recycling

Polymer Blend Development Matrix



Principal Properties Claimed in PAB Patents

High impact strength	38%
Processability (including weld line)	18
Tensile strength	11
Rigidity/modulus	8
Heat deflection temperature	8
Flammability	4
Solvent resistance	4
Thermal stability	3
Dimensional stability	3
Elongation	2
Gloss	2

Advantages and Disadvantages of Some Engineering Polymers and Modifiers

Polymer	Advantages	Disadvantages
Polyamide	processability, impact strength, crystallinity	water absorption, heat distortion temperature
Polycarbonate	low temperature toughness, HDT	stress-crack sensitivity, solvent and chemical resistance
Polyoxymethylene	tensile strength, modulus	stress-crack sensitivity, impact strength
Polyphenylene ether	HDT, rigidity, flame retardancy	processability, impact strength

Specific Interactions that Promote Miscibiliy

Hydrogen bonding

Ionic interactions

Electron donor-acceptor complexes