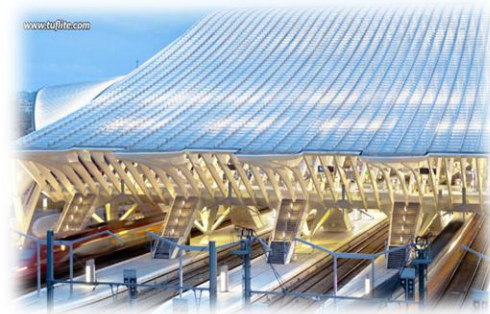


Materials Science (BMEGEMTAMM1)

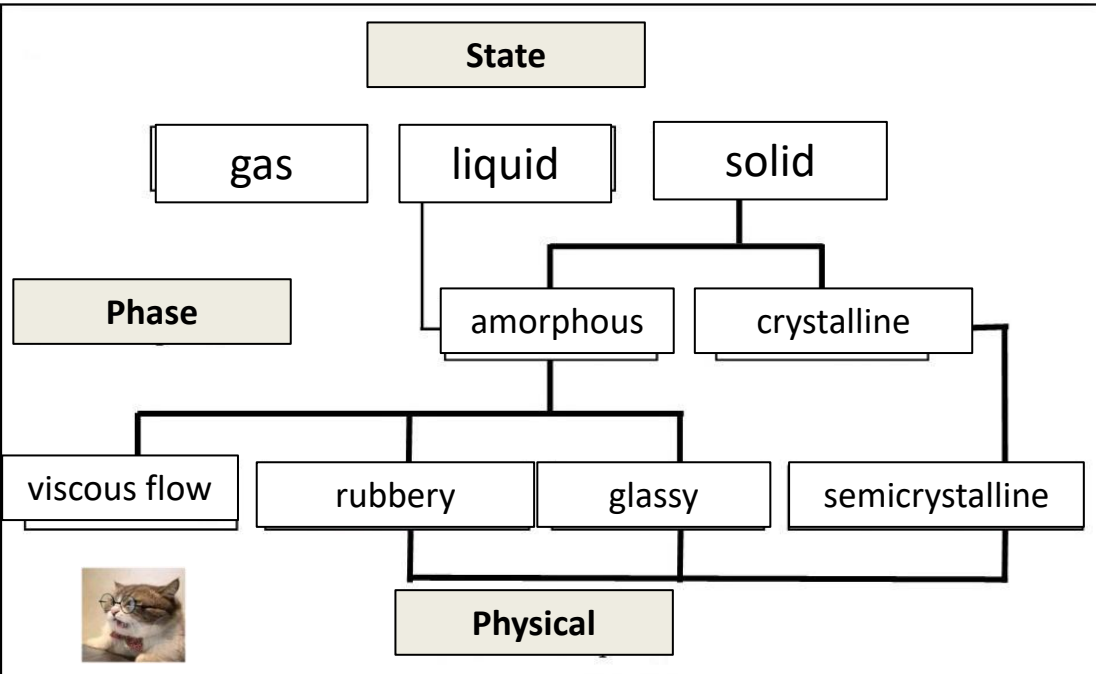
Lecturer: Dr. Ákos Pomázi
pomazi.akos@gpk.bme.hu



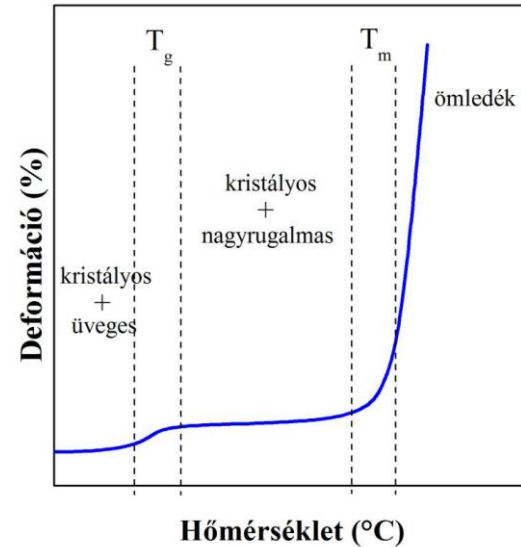
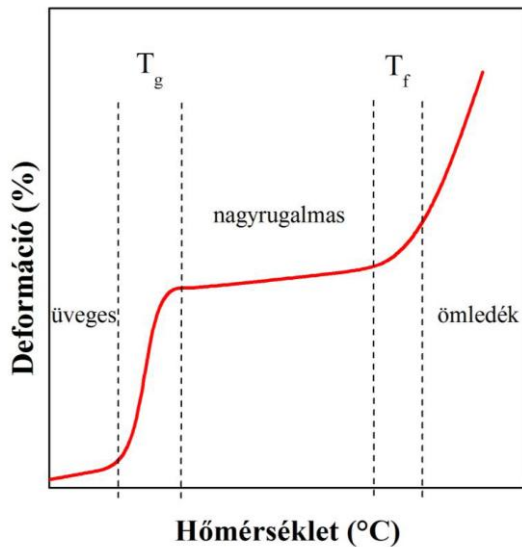
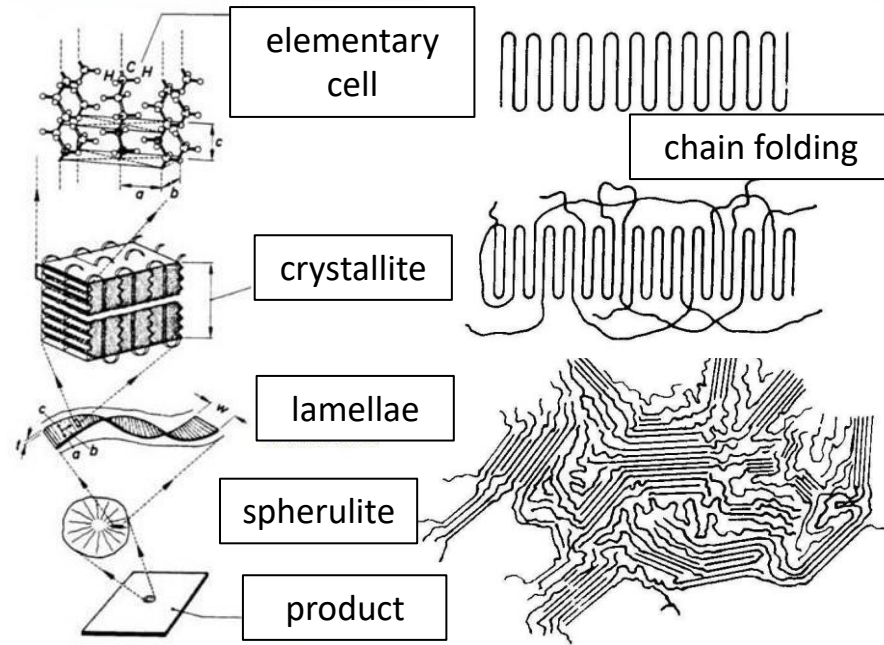
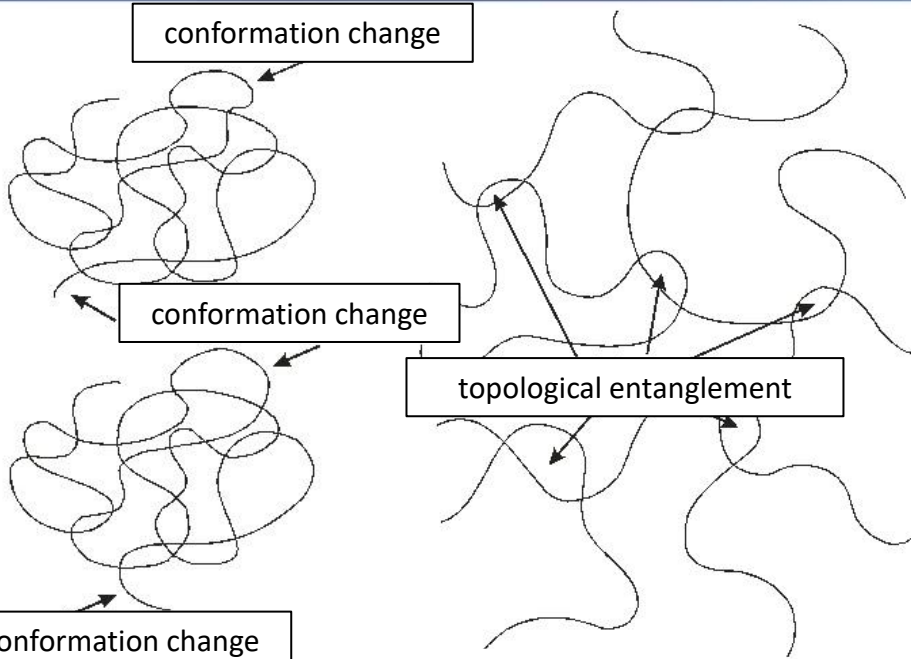
- **Amorphous**



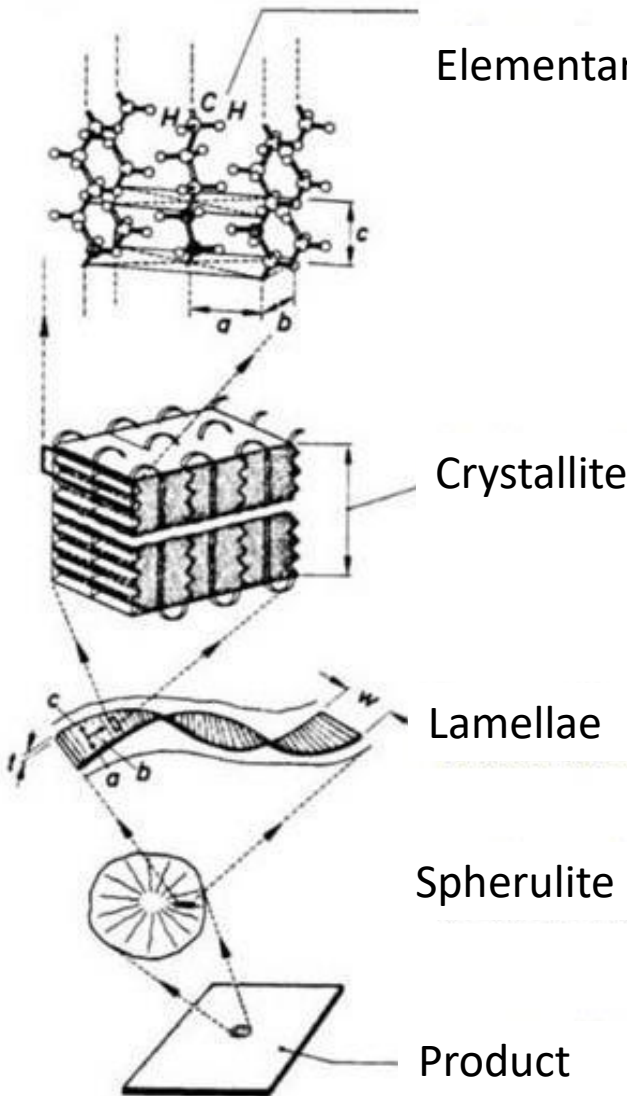
- **Semicrystalline**



Amorphous vs. Semicrystalline

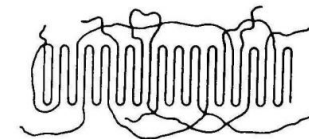
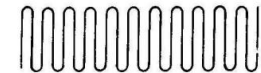
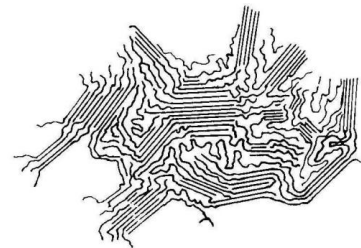


Structure of crystalline polymers



- Elementary cell: regardless of the polymer's origin and molecular characteristics; atomic groups in the grid points

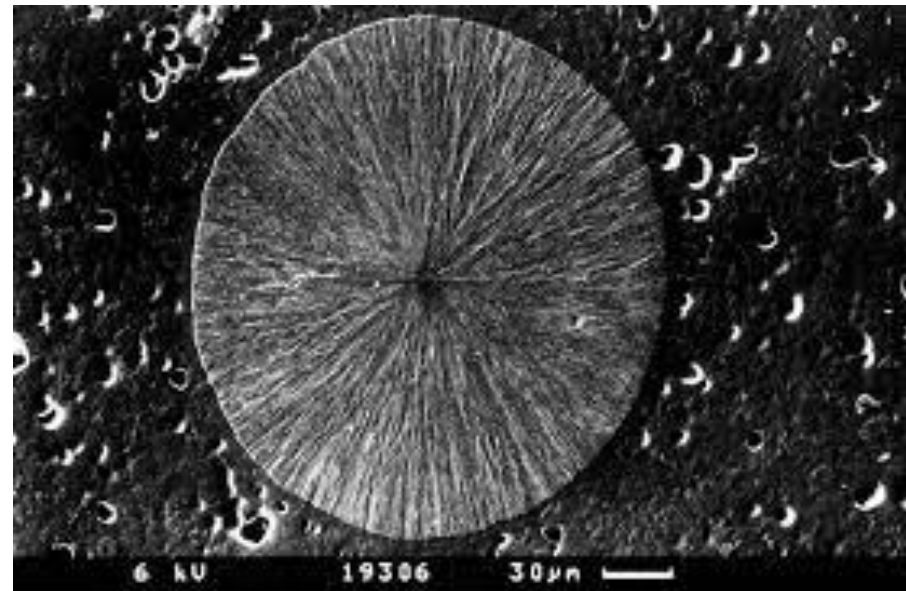
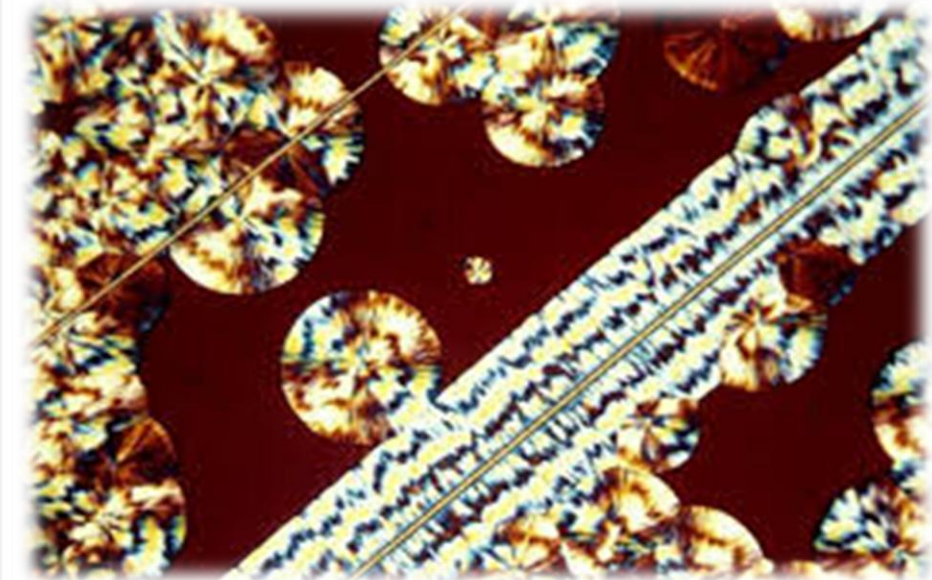
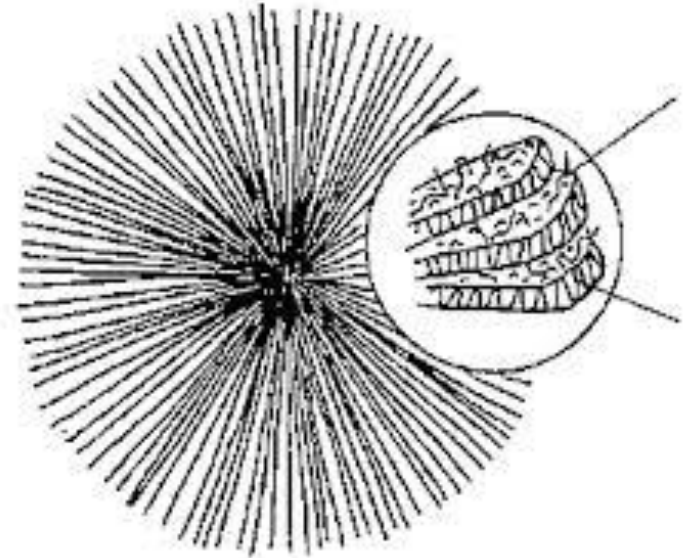
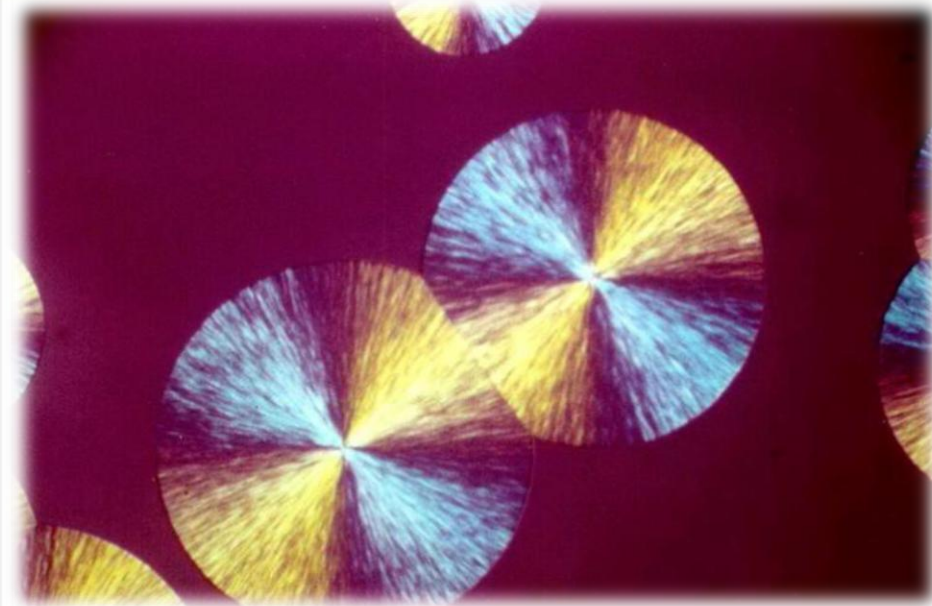
Crystallites: ordered molecules and amorphous chain segments



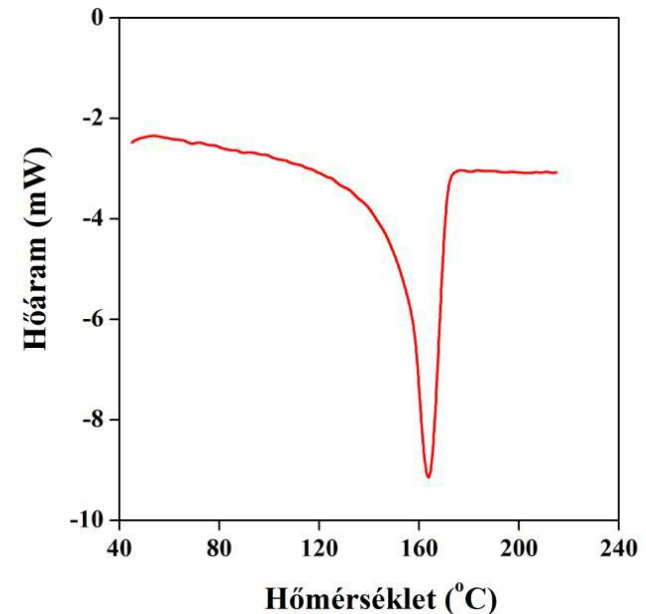
Lamellae/fibrillae: folded chain-like (fibrillar) or plate-like (lamellar) crystals

Spherulites: supermolecular structure; a spherical, symmetrical aggregate of lamellar crystallites radiating from a single point (nucleus)





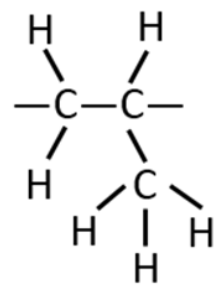
- Regular chain structure
- Thermodynamic condition: satisfied below the equilibrium melting temperature
- Kinetic condition: the mobility of molecular chains
- Factors influencing characteristics:
 - Type of crystal structure (α, β, γ)
 - Degree of crystallinity (crystalline fraction)
 - Lamella thickness, lamella thickness distribution
 - Nature and size of morphological formations (e.g., spherulite)
 - Number of binding molecules
- **The properties of a polymer are determined by its crystal structure**



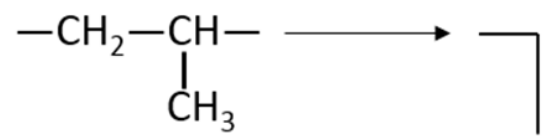


Stereoregularity, tacticity

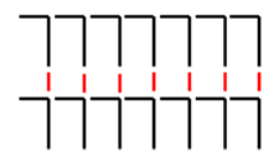
polypropylene repeating unit



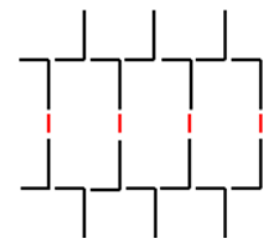
Simplified representation of a repeating unit



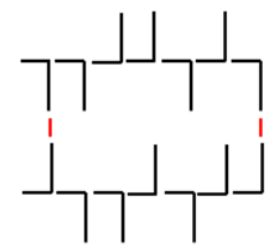
isotactic



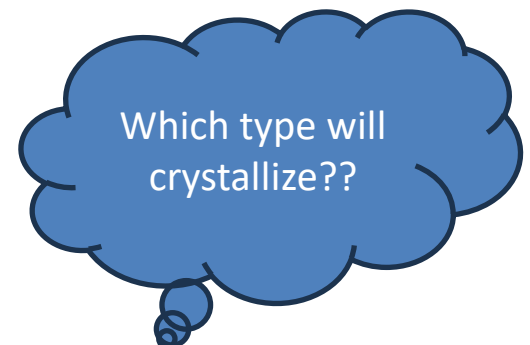
syndiotactic



atactic



← The secondary bonds formed between the side groups of the macromolecule link the molecules together



Homopolymer



PE, PP, PS, PET, PC etc.

Co-polymer

Statistical



SAN, ABS, EPDM etc.

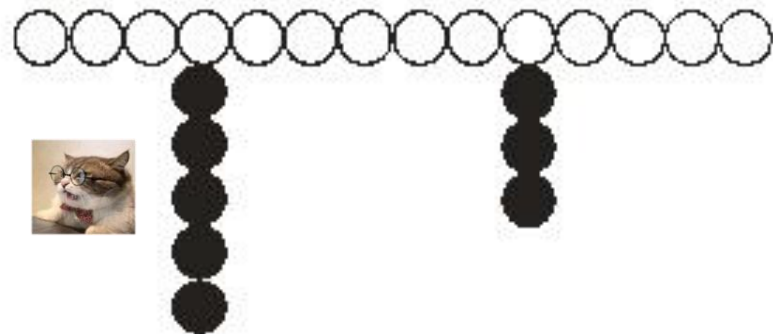
Alternating



Block



Stitched



- **Miscibility**

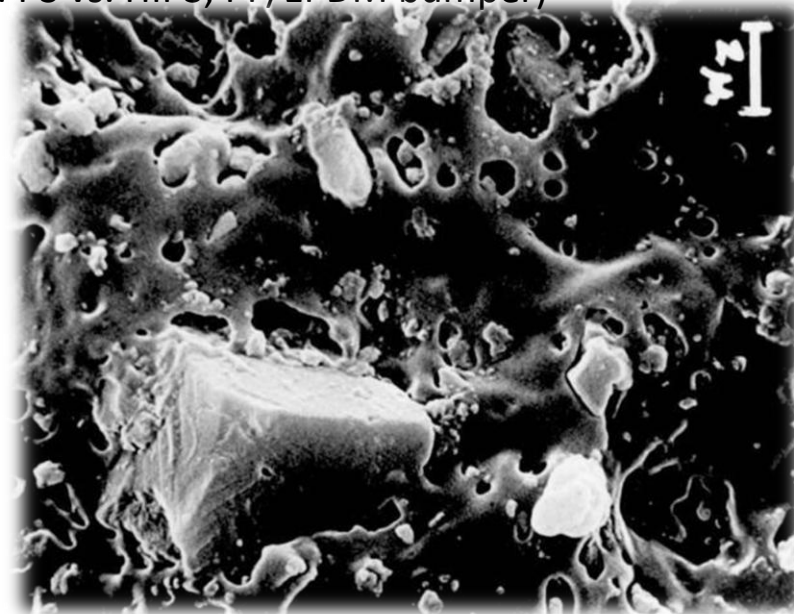
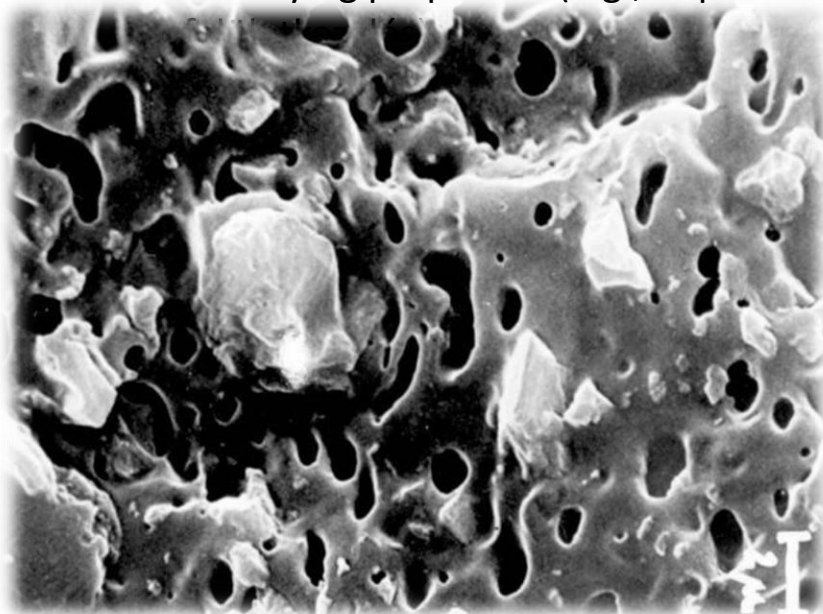


- $\Delta G < 0$, i.e., a spontaneous process \rightarrow a thermodynamic concept
- It depends on the temperature, the composition, and the interactions between the components
- Polymers are generally very difficult to blend (PPO/PS, PMMA/PVDF)

- **Compatibility**



- Practical feature
- Heterogeneous, multiphase systems \leftrightarrow polymer blends are often used to modify properties
- Modifying properties (e.g., impact resistance: PS vs. HIPS; PP/EPDM bumper)



- **Objective:** Modifying properties
- **Fillers (e.g., talc, CaCO_3 , carbon black, mica)**
- **Sliders: improve workability**
- **Plasticizers:** make hard plastics flexible (e.g., PVC)
- **Antistatic agents**
- **Flame retardants:** reduce flammability and smoke production
- **Stabilizers:** ensure that the polymer's properties are maintained under processing and application conditions
- **Dyes, pigments**
- **Odorants and fragrances**
- **Nucleating agents:** regulate crystallization and crystal structure



KEEP
CALM
AND
BE A
CSILLÁMPÓNI





Thank you for your attention!

Dr. Ákos Pomázi

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