Introduction to Crystalline Morphology

Morphology — the organization of crystalline and amorphous components in a semicrystalline polymer.

• Size scale is usually nanometers to microns; the simplest morphological unit is the 'Single Crystal'.

• Morphology established during processing; may also be affected by storage.

• Concerned with the effects of process variables on morphology and therefore on material properties.
Assorted crystalline morphologies

• Single crystals
  Crystallize polymer from dilute solution (1%).

• Dendrites
  Crystallize using more concentrated solution.

• Spherulites
  Cool unoriented, unstressed melt below Tm (>Tg).

• Drawn Fibrillar
  Draw spherulites between Tg and Tm.

• Shish-kebab or Row nucleated
  Crystallize while flowing (melt or solution).

• Accordion structures
  Anneal shish-kebabs under tension.

• Extended Chain Crystals
  Crystallize a melt under high hydrostatic pressure.

• Oriented Extended Chain Crystals
  Crystallize with high hydrostatic pressure and flow.
General observations on polymer morphology.

- Wide variety of morphologies can be present, but there are several common features:

  1) Properties depend on percentage crystallinity.  
     ——> Need to measure HOW MUCH crystallinity.

  2) Properties are a function of morphology.  
     ——> Need SIZE and SHAPE of crystals.

  3) Properties depend on chain direction; anisotropy.  
     ——> Need to determine ORIENTATION of phases.

  4) Morphology is established at various rates.  
     ——> Need to measure the RATE of crystallization.

**Temperature and Time at Temperature**

**Fabrication Process**