Lecture 16

Polymer Processing

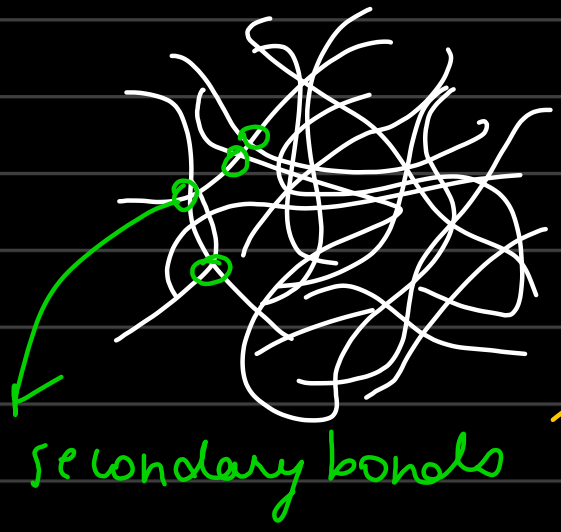
Common processing methods:

- Injection molding
- Compression molding
- 3D printing
- Blow moulding
- Thermoforming

Based on behaviour with temperature:

- Thermoplast & Thermosets

Thermoplastics:



easily melt under heat, allows easy movement of chains.

→ In thermosets: inter-chain cross links are covalent bonds → do not break

Glass-Transition Temperature:

$T > T_g$: viscous flow : secondary bonds break

$T < T_g$: rigid solid : secondary bonds intact.

Eg of Thermoplasts; PVC, PP, PMMA, PTFE

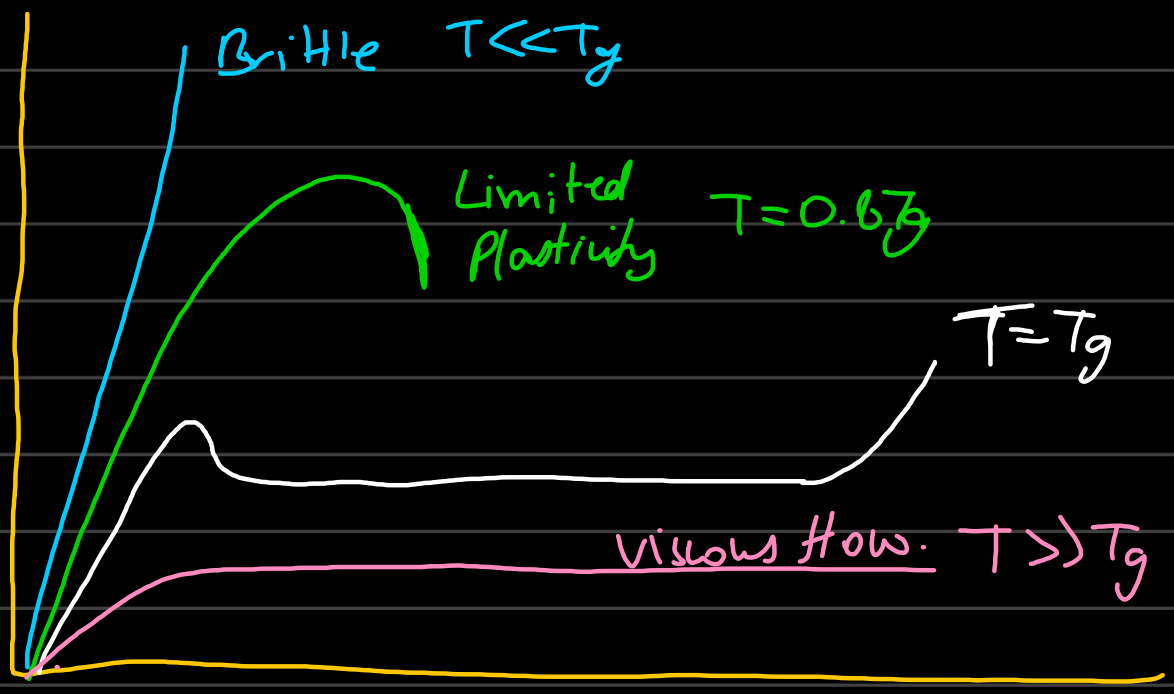
Thermosets:

↳ raw material bought in partial polymerized state, upon eventual processing to attain final product shape, complete polymerization takes place. (total cross-linking):

Mechanical Properties:

↳ subject to glass-Transition temp.

Case 1: $T_{(RT)} >> T_g$



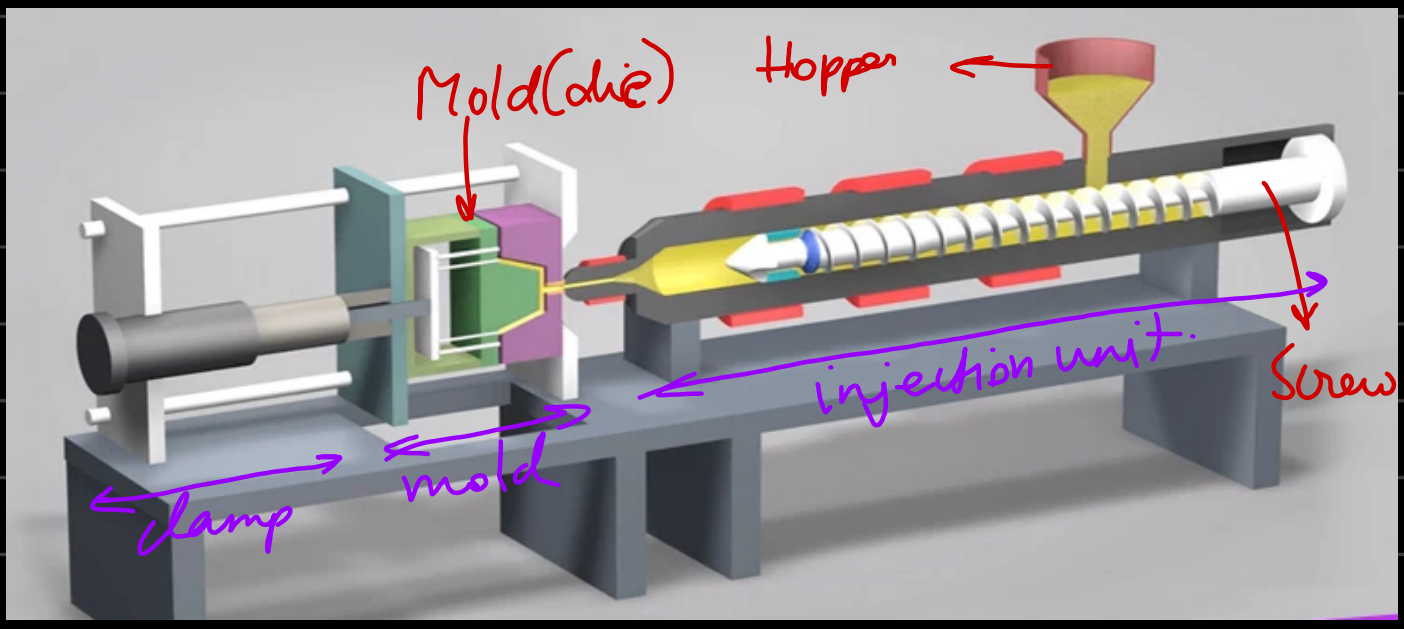
Injection Moulding:

↳ most common method to process polymers.

↳ Heating → forming → cooling.

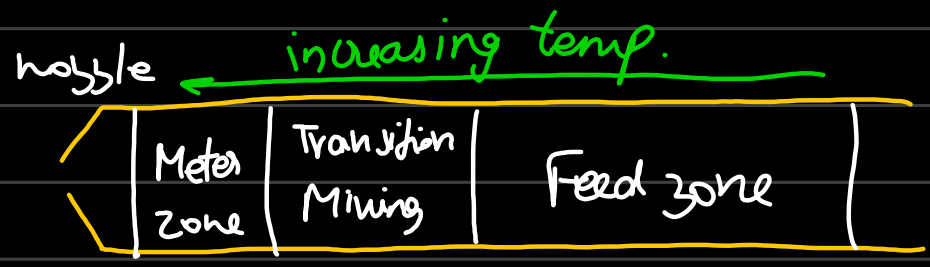
"Billiards balls were made of ivory harvested from husk of elephants."

→ celluloid ball →



Injection Molding.

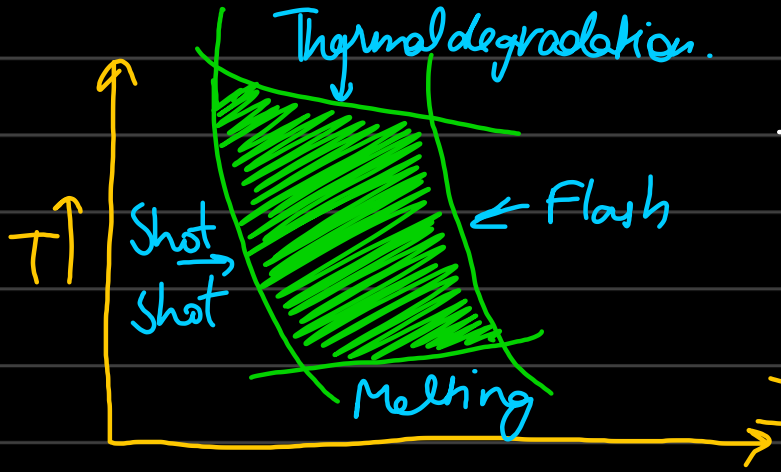
→ only for thermoplastics:



→ Optimal $\frac{L}{D}$ ratio: 20:1

The effect of changing L/D ratio:

↳ the larger the L/D ratio longer the flighted length.



The injection molding window.

Defects in Injection Molding:

1) Flash:
   - ↳ excess molding material appearing as a protrusion over components.
   - ↳ due to low viscosity of melt, injection pressure is too high, clamping force is weak.

2) Weldline defect:
   - ↳ molten polymer entering the same region from two gates.
   - ↳ basically a crack.
   - ↳ lines visible by naked eye in final product.
   - ↳ low temperature of mold causes incomplete dissolution of the molten plastics.

3) Warping: ⌐ appears when part is removed from mould and pressure is removed.
   - ↳ distortion in product.
   - ↳ due to stored residual stresses.
   - ↳ soln is to keep a longer cooling time, lower the ejection speed