Lecture 2

Materials Processing

→ Significance of processing.

↳ Sn (Tin) very good for casting due to low melting point.

↳ However Sn undergoes ductile-to-brittle transformation at low temperatures.

↳ Sn very important material for solder.

Classification of Manufacturing:

↳ Forming, Casting, Moulding, Joining, Machining & Additive.

→ Process Selection:

↳ material ↳ object geometry ↳ no. of parts

↳ tool and material costs ↳ required levels of automation.

* Compatibility of Material and process:

Casting

→ involves pouring molten metal into moulds.

Casting → Machining → Final product

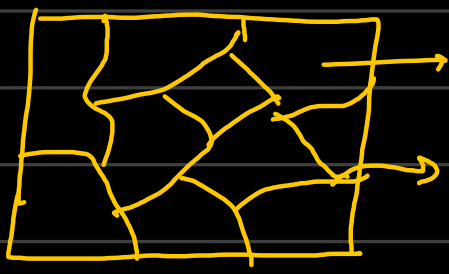
Casting: primary shaping

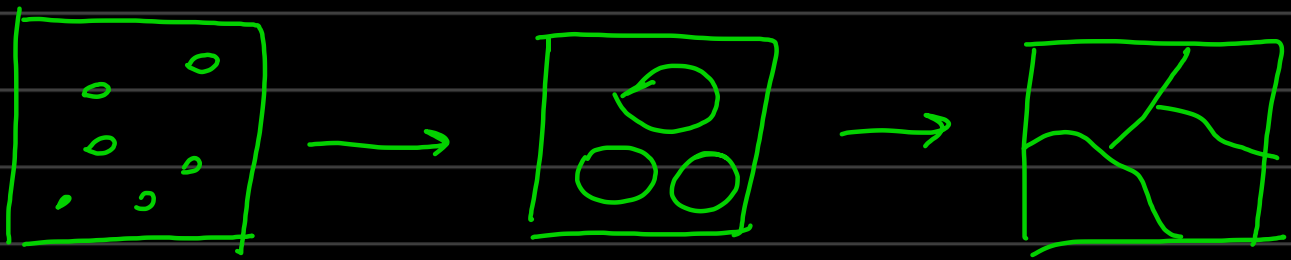
Machining: secondary shaping.

→ Casting means solidification of molten metal

→ Solidification Microstructure.

↳ Microstructure: structure at micron scale.





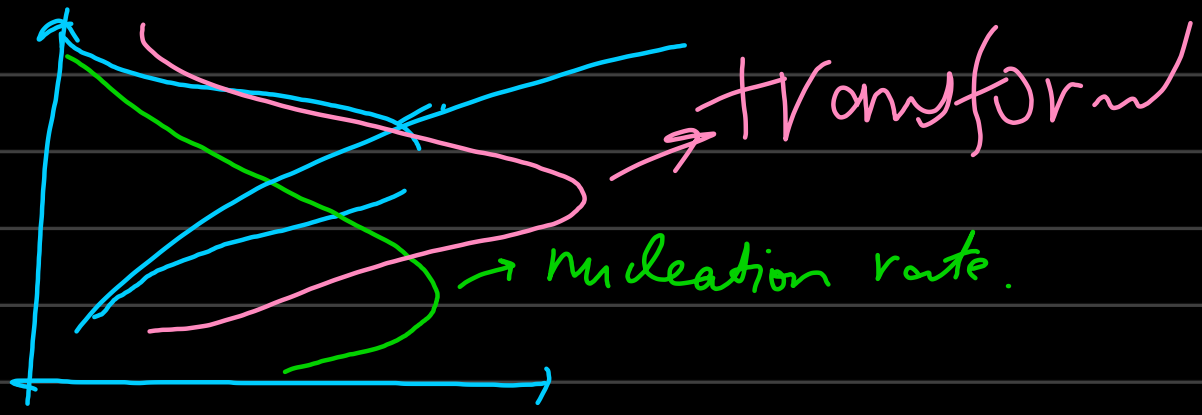
Nucleation & growth

(homogenous & heterogenous)

→ nucleus grows after radii $> r^*$

→ polycrystalline microstructure formed.

→



high ΔT : fine grain structure

low ΔT : coarse grain structure.

→ low toughness: high crack nucleation & easy crack propogation.

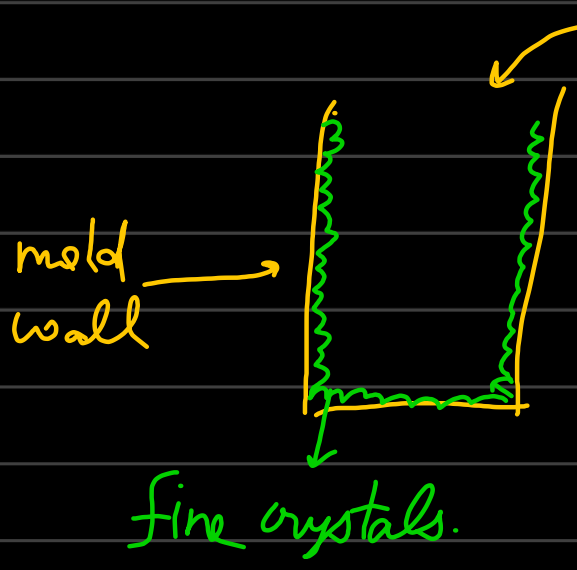
high toughness: low crack nucleation & difficult crack propogation

* fine grain microstructure: better strength & better toughness.
  - ↳ favourable for most applications.
  - ↳ bad for creep applications.
  - ↳ allow for grain movement aka creep.

Equiaxed microstructure: equal growth in all directions.

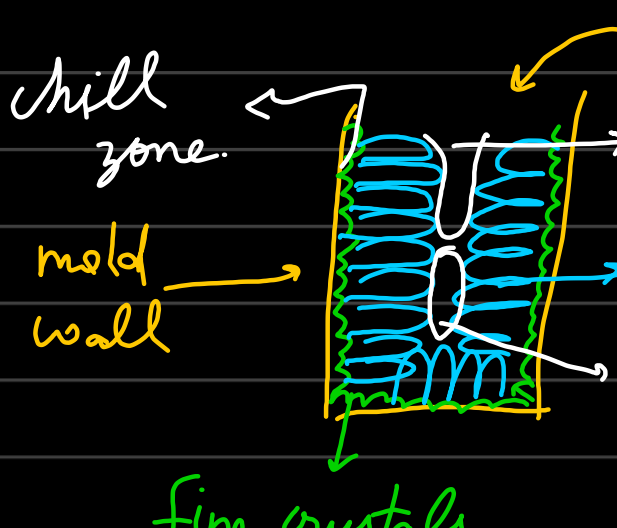
directionally solidifies: columnar grains
↳ high anisotropy.

Solidification Microstructure.



→ high probability for heterogenous nucleation
→ large ΔT at walls yield fine crystals at walls.

→ grow in direction in which heat extraction is fast.
→ kind of columnar crystals are formed.
↳ preferred growth.



pipe formation { vacant space due to shrinkage
columnar preferential growth.
impurities :(

* segregation as a problem in casting: in case of alloys.
↳ composition gradient.

→ equiaxed grain structure in centre of cast

↳ high heterogenous nucleation due to impurities.

→ This heterogenous microstructure will lead to collapse in properties.

↳ Use of secondary process to counter these heterogenous microstructure difficulties.