METALURGI FISIK

Rekristalisasi

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Proses pertumbuhan kristal baru yang bebas tegangan dan Equiaxed (Ukuran sama pada setiap sumbu)

Type Rekristalisasi :

1. Rekristalisasi Primer
2. Rekristalisasi Sekunder
3. Rekristalisasi Statik
4. Rekristalisasi dinamik

Continuous Casting & Integrated Mills & Minimills

- Continuous casting
  - Advantages
    - Highly automated
    - Reduces product cost
    - Companies are converting over to this type of casting

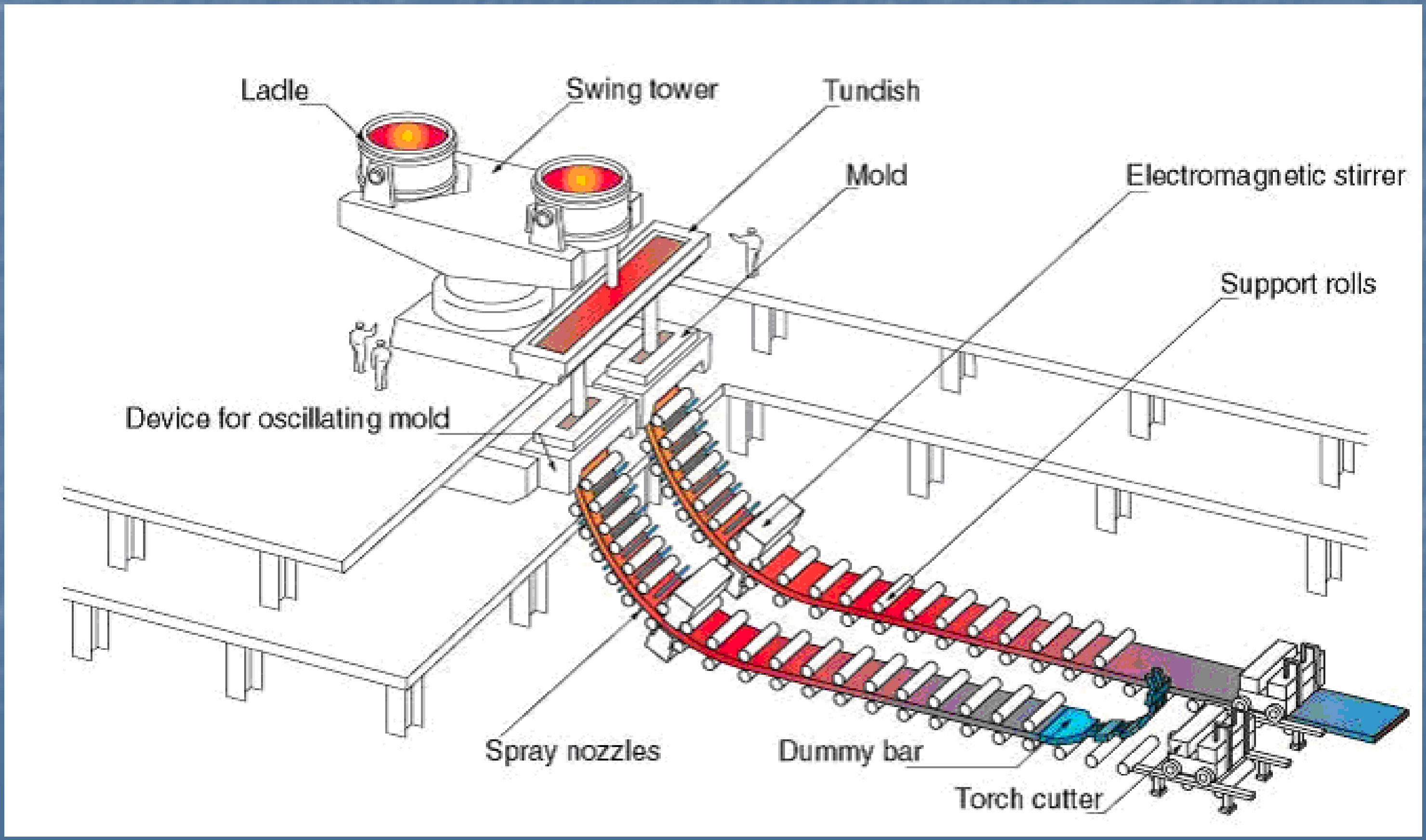
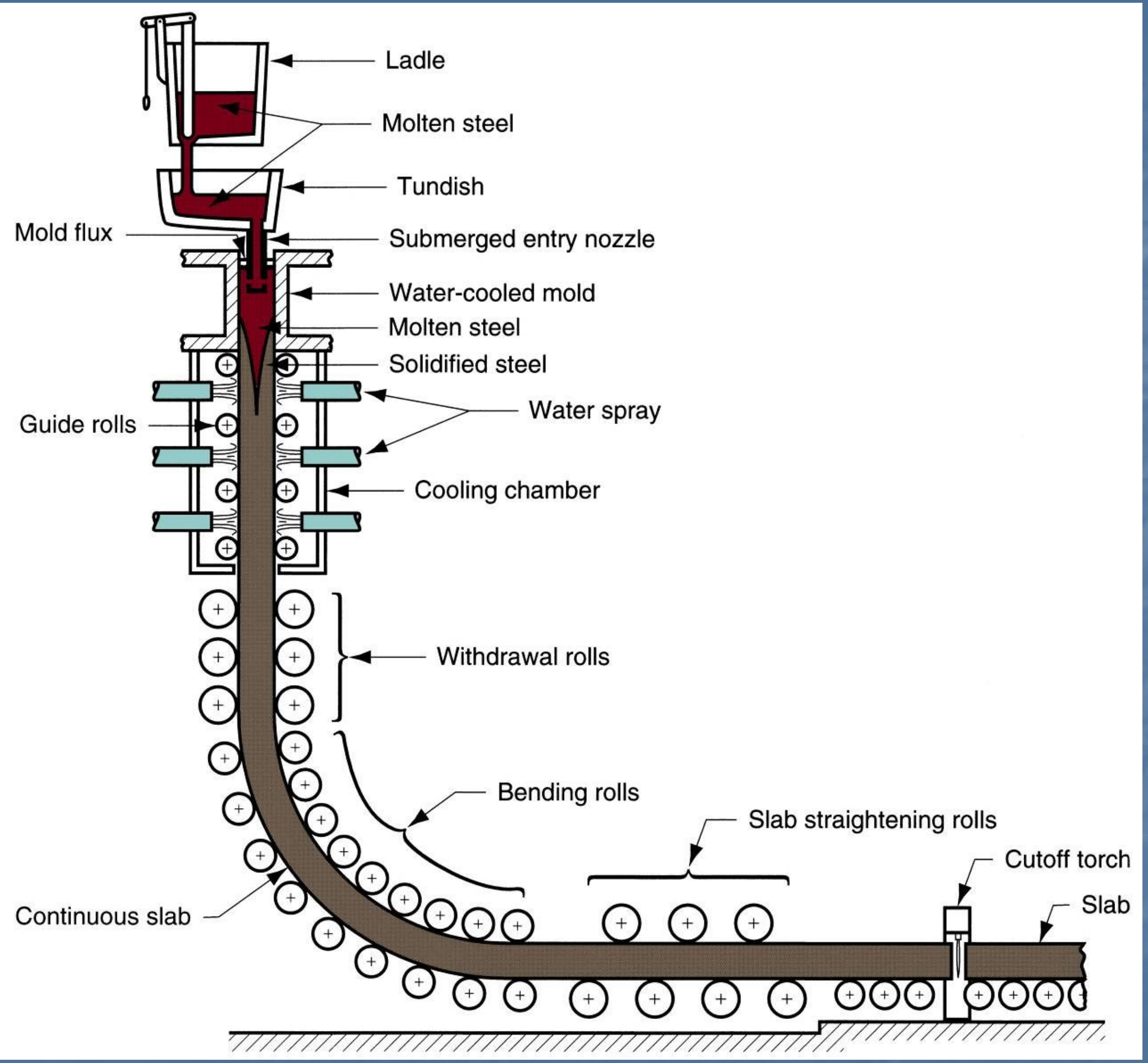
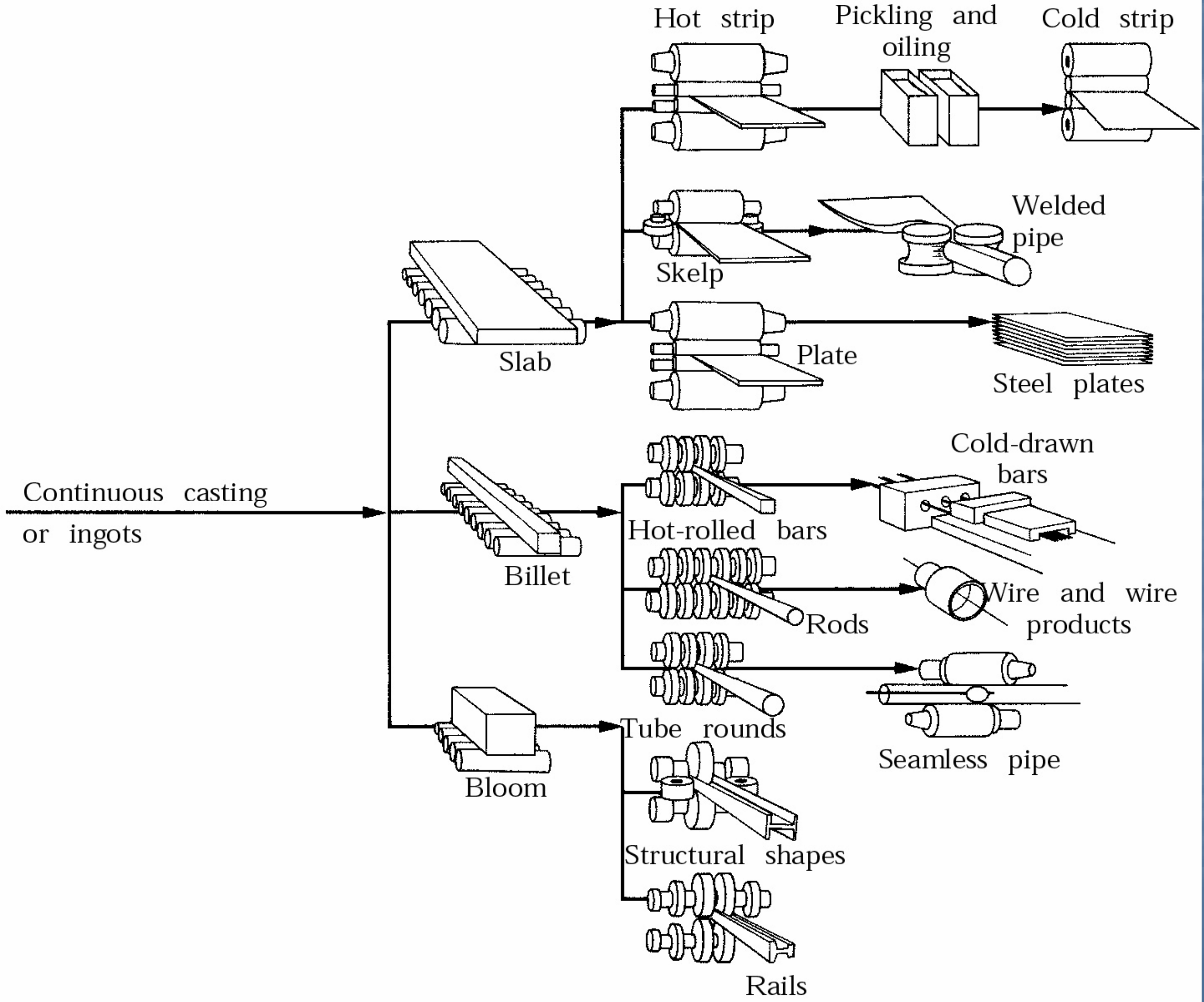


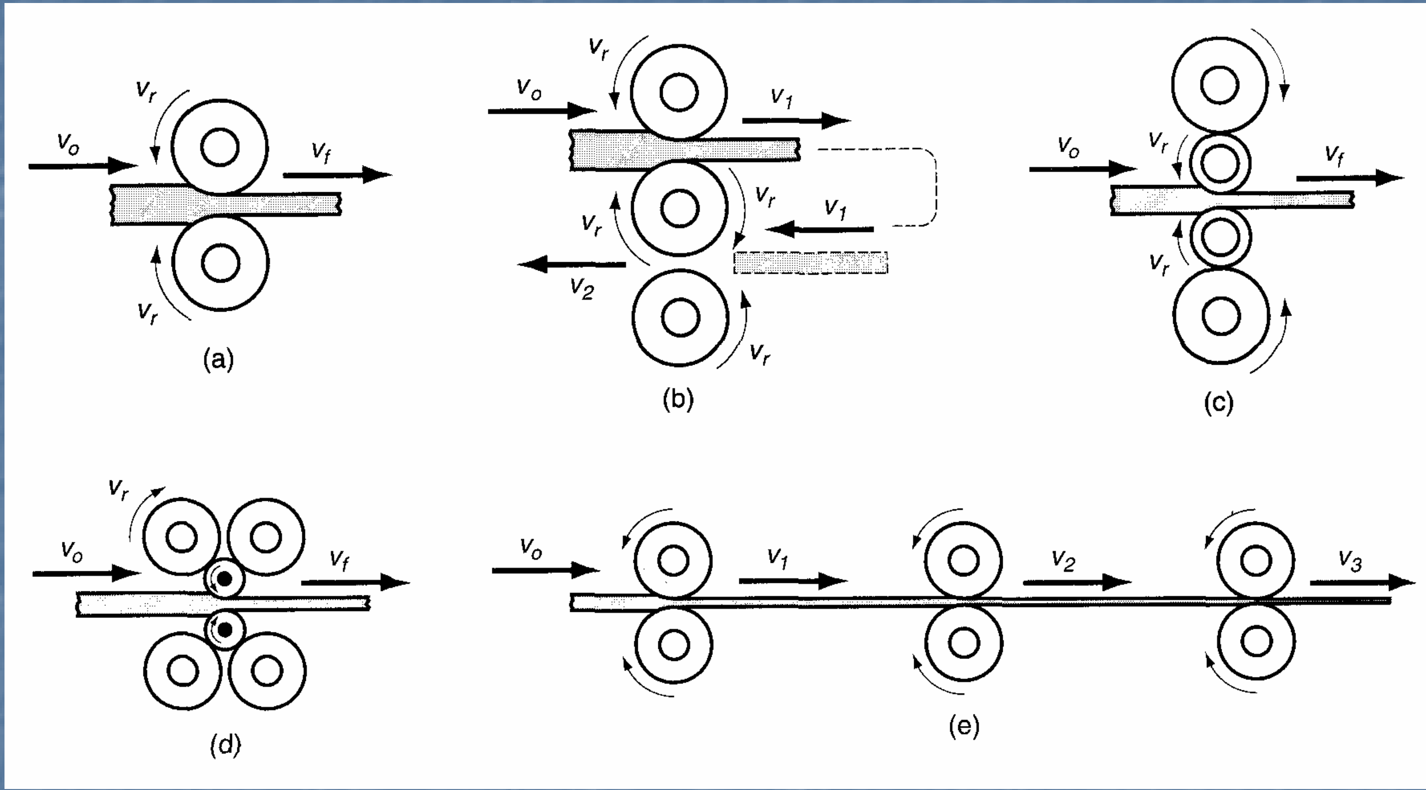
Figure 6.11 Continuous casting. Steel is poured into tundish and flows into a water-cooled continuous mold; it solidifies as it travels down in mold. Slab thickness is exaggerated for clarity.



Flat-Rolling Practice



Rolling Mill Configurations

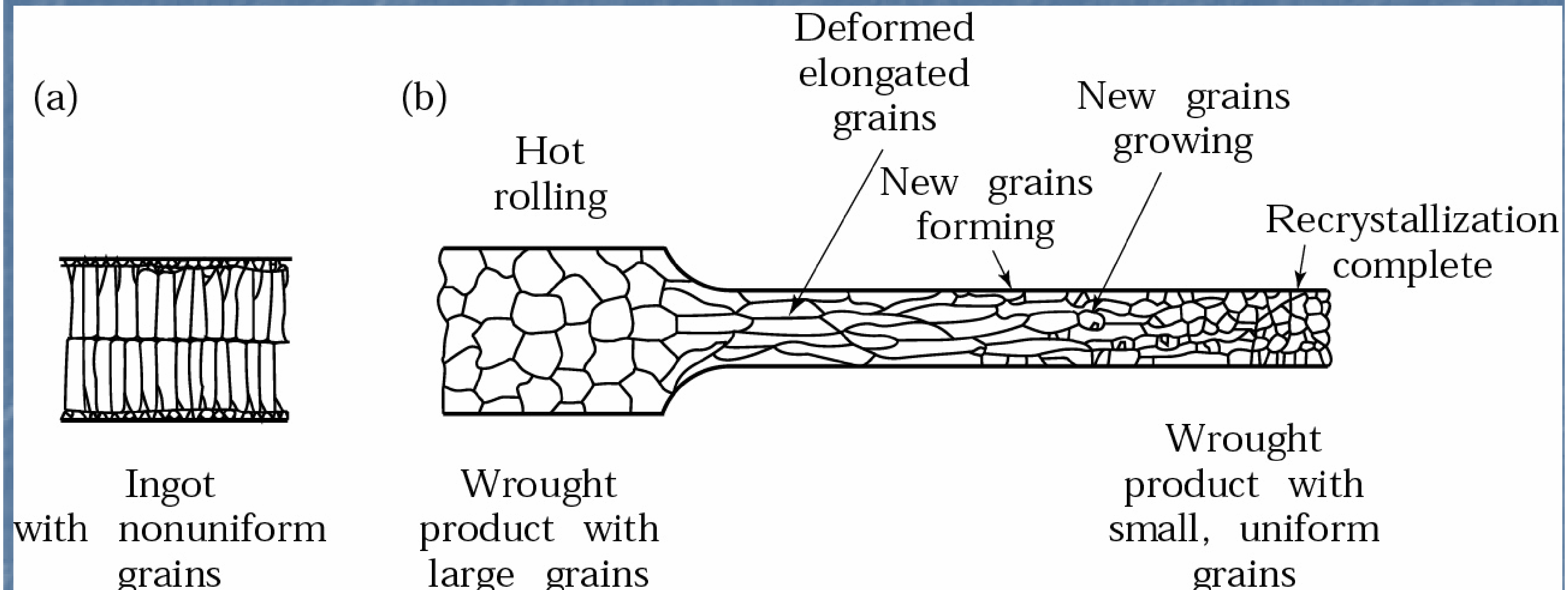


a) two high b) three high c) four high

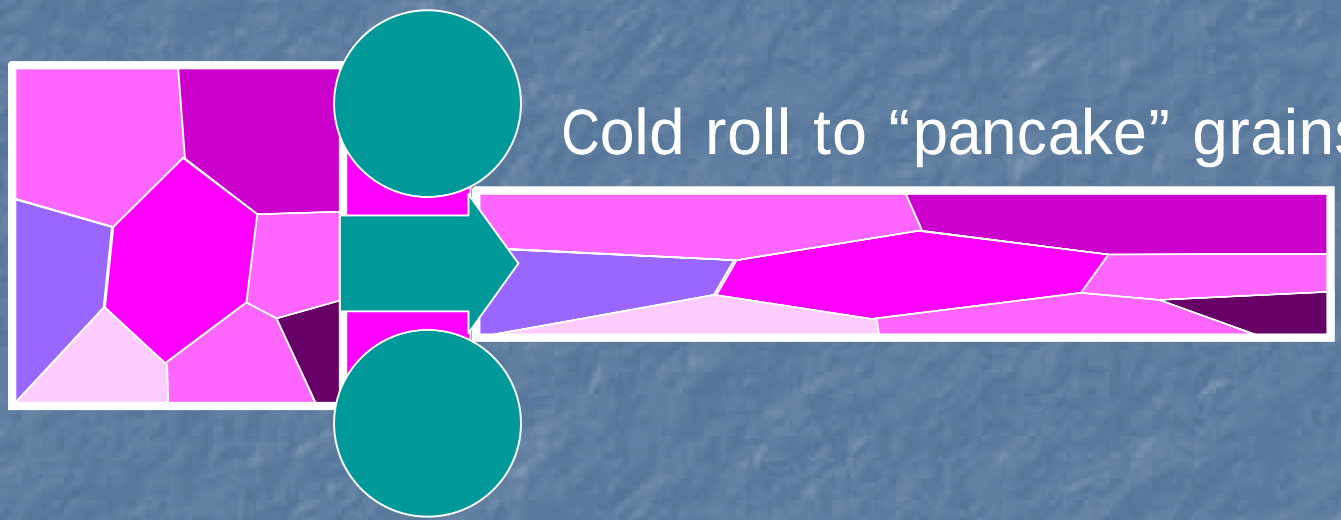
d) cluster mill e) tandem rolling mill

Rolled Sheet & Rail

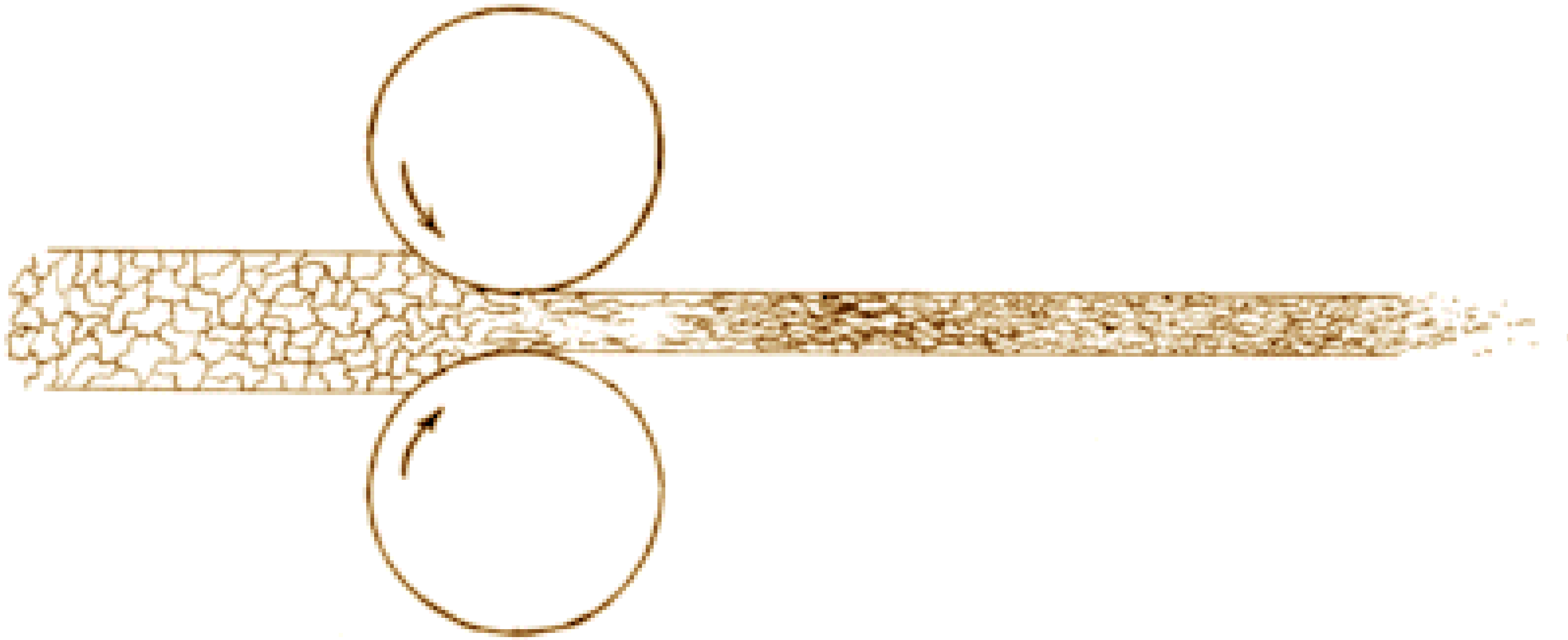
Flat-Rolling Practice



Cold Working

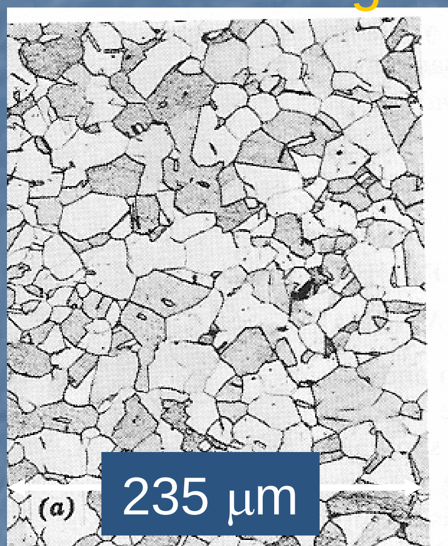


Increases hardness and strength at the expense of ductility.



ROLLING PROCESS

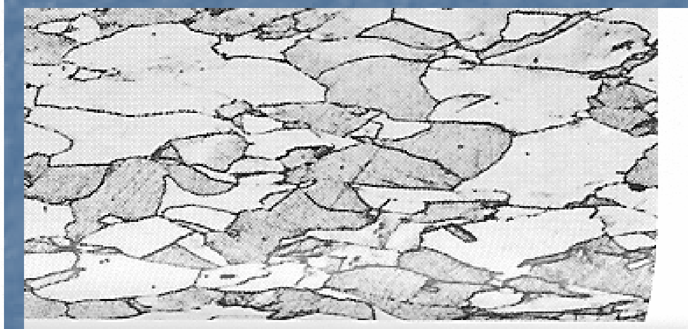
- before rolling



- isotropic

  since grains are approx. spherical & randomly oriented.

- after rolling



rolling direction

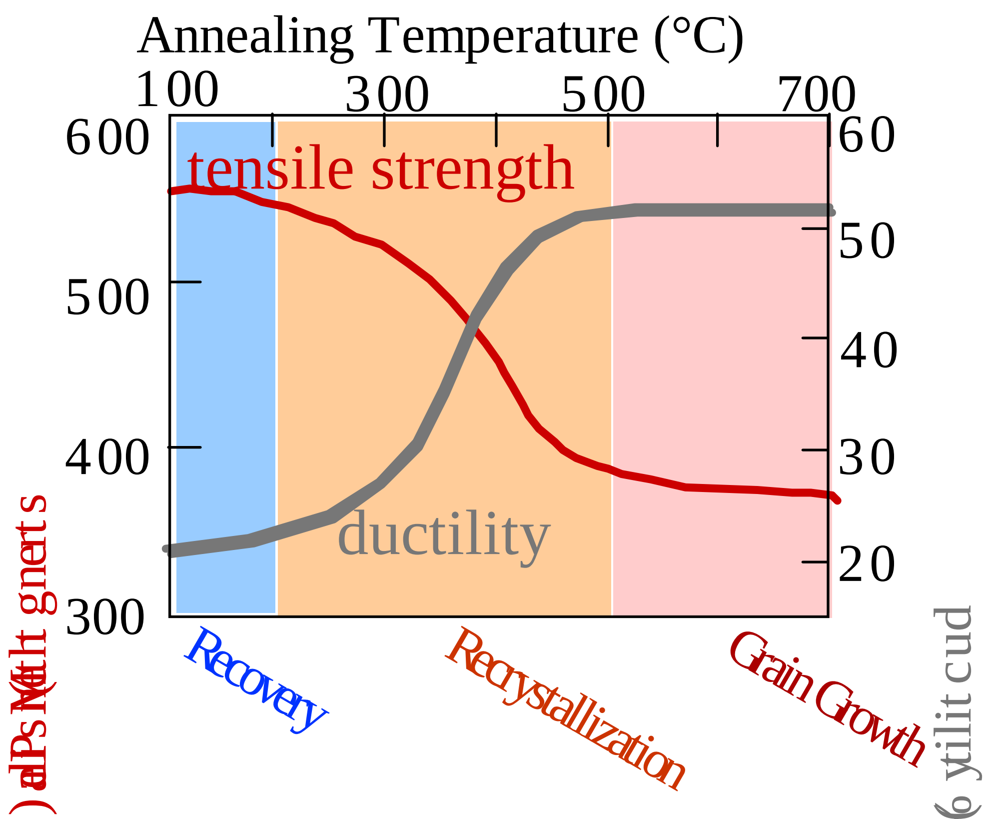
- anisotropic

  since rolling affects grain orientation and shape.

Adapted from Fig. 8.11, *Callister & Rethwisch 3e.* (Fig. 8.11 is from W.G. Moffatt, G.W. Pearsall, and J. Wulff, *The Structure and Properties of Materials*, Vol. I, *Structure*, p. 140, John Wiley and Sons, New York, 1964.)

EFFECT OF HEATING AFTER Cold Working

- 1 hour treatment at T_{anneal}...
  decreases TS and increases %EL.
- Effects of cold work are reversed!

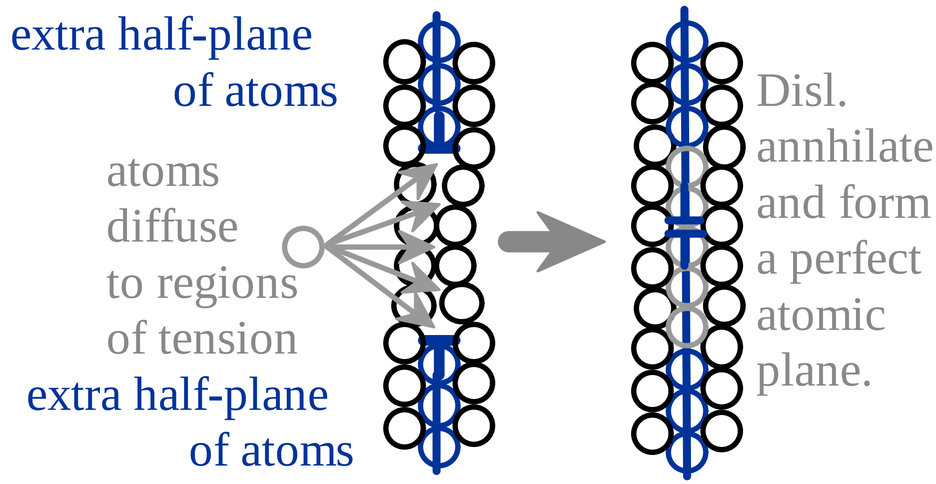


Adapted from Fig. 7.20, *Callister 6e.* (Fig. 7.20 is adapted from G. Sachs and K.R. van Horn, *Practical Metallurgy, Applied Metallurgy, and the Industrial Processing of Ferrous and Nonferrous Metals and Alloys*, American Society for Metals, 1940, p. 139.)

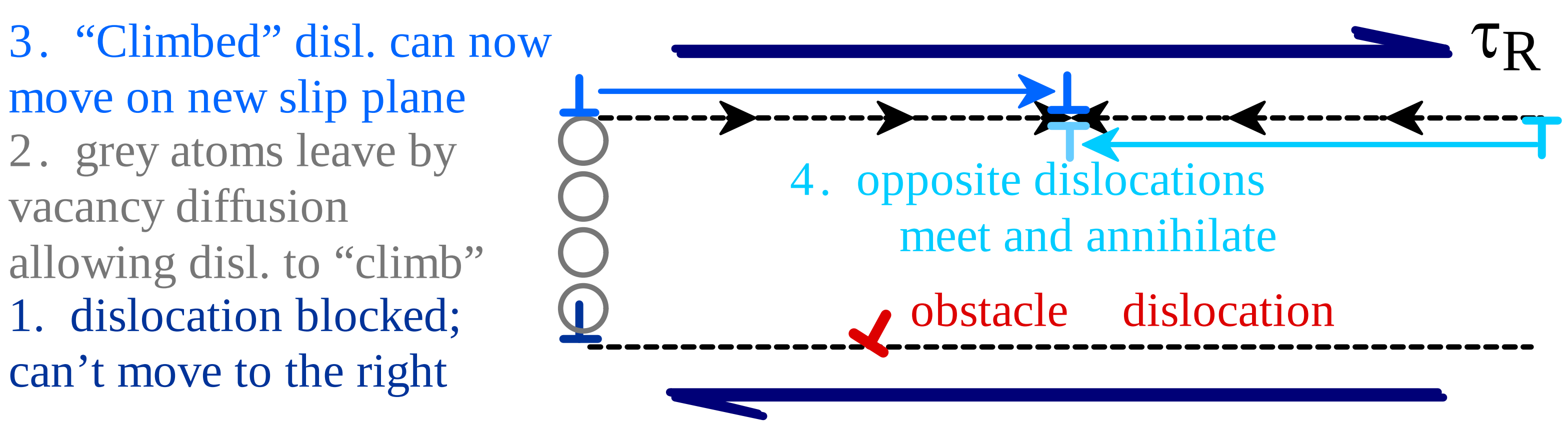
RECOVERY

Annihilation reduces dislocation density.

- Scenario 1

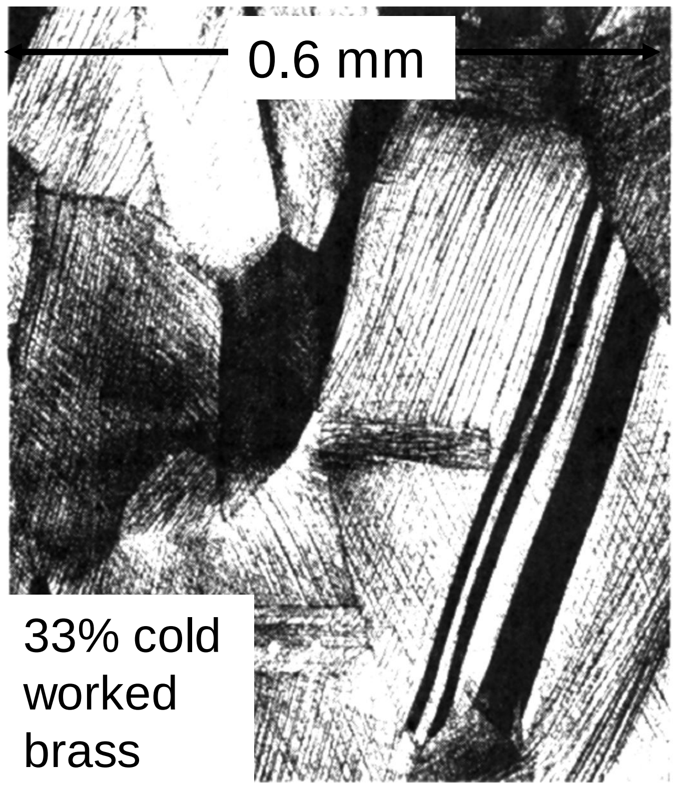


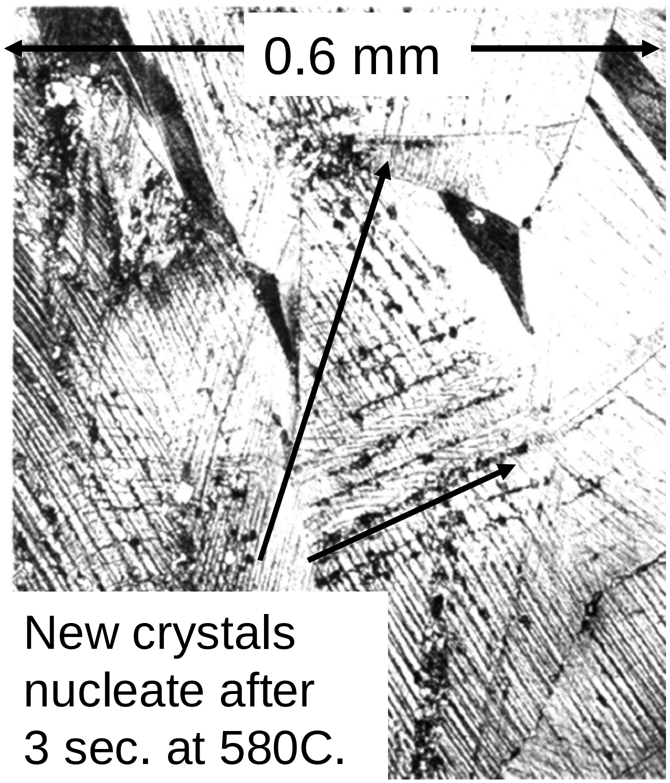
- Scenario 2



RECRYSTALLIZATION

- New crystals are formed that:
  --have a small disl. density
  --are small
  --consume cold-worked crystals.

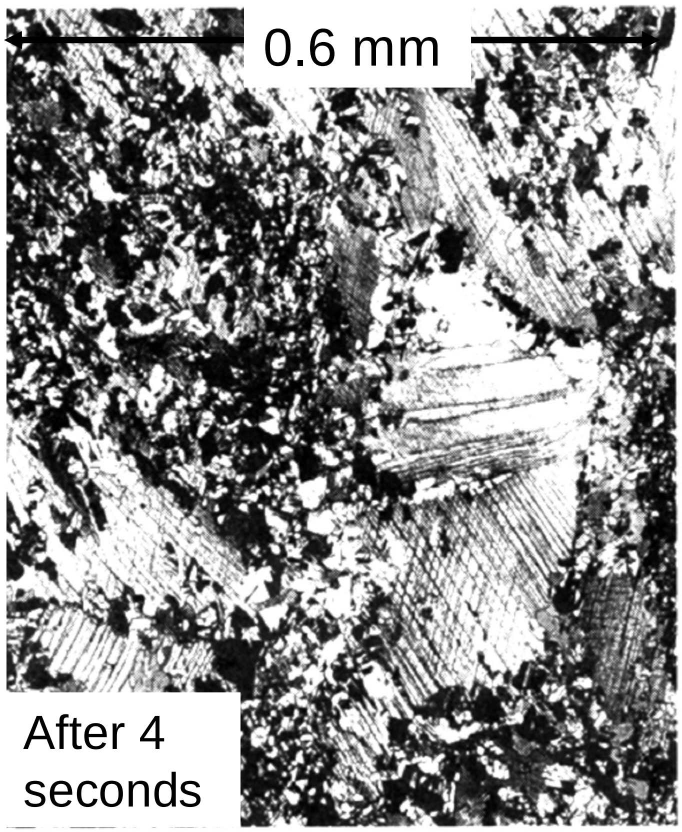


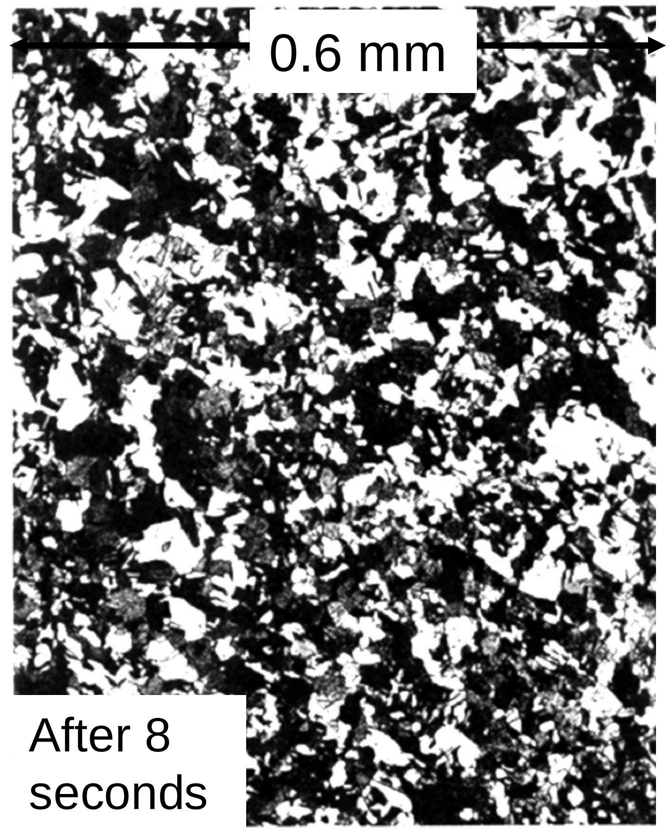


Adapted from Fig. 7.19 (a),(b), *Callister 6e.* (Fig. 7.19 (a),(b) are courtesy of J.E. Burke, General Electric Company.)

FURTHER RECRYSTALLIZATION

- All cold-worked crystals are consumed.

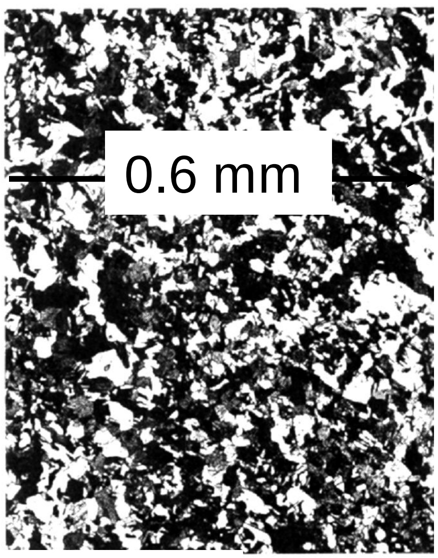




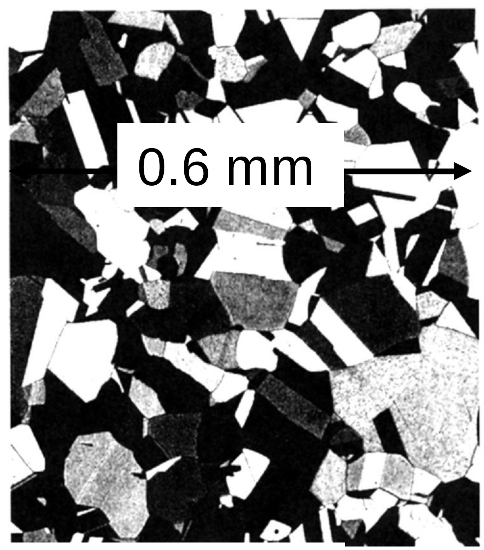
Adapted from Fig. 7.19 (c),(d), *Callister 6e.* (Fig. 7.19 (c),(d) are courtesy of J.E. Burke, General Electric Company.)

GRAIN GROWTH

- At longer times, larger grains consume smaller ones.
- Why? Grain boundary area (and therefore energy) is reduced.



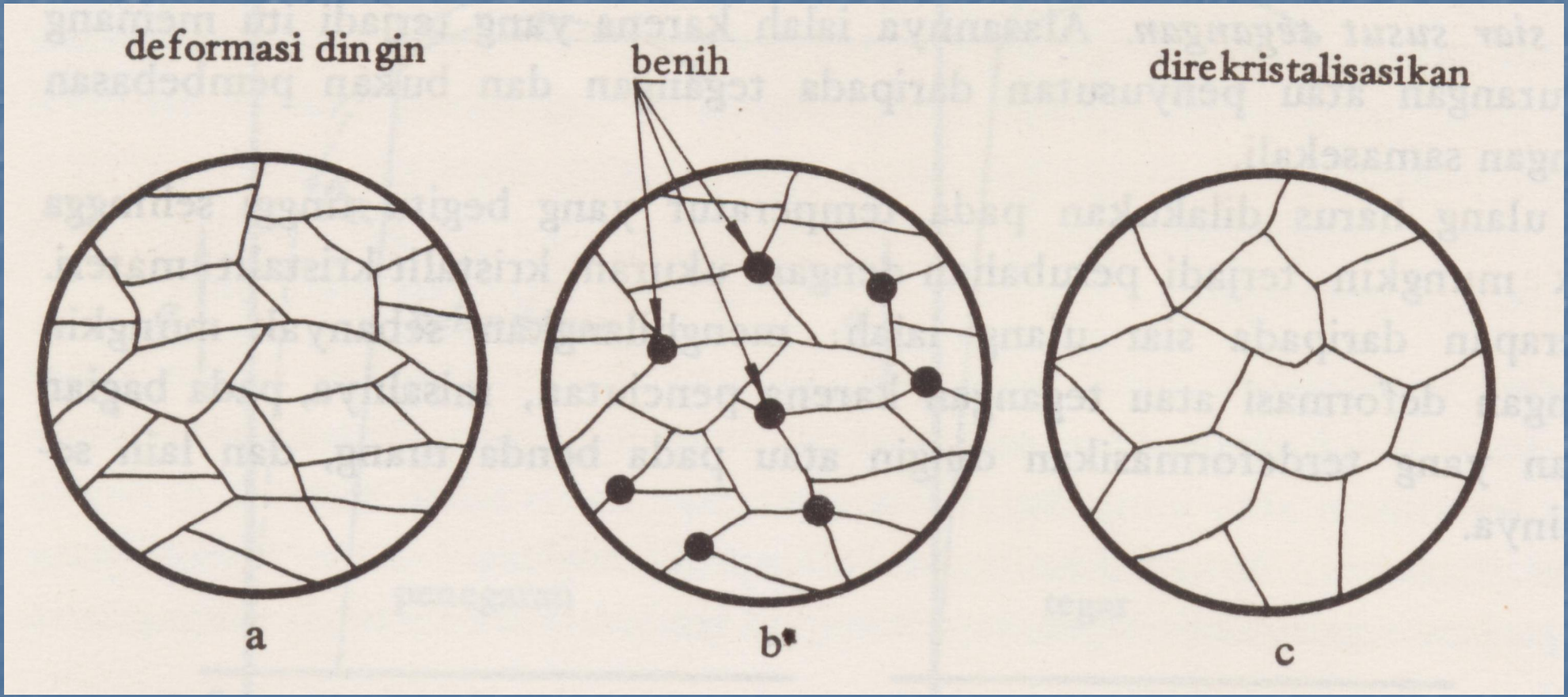
After 8 s, 580C



After 15 min, 580C

Adapted from Fig. 7.19 (d),(e), *Callister 6e.* (Fig. 7.19 (d),(e) are courtesy of J.E. Burke, General Electric Company.)

Perubahan Butir Dgn Rekristalisasi



Direct Extrusion

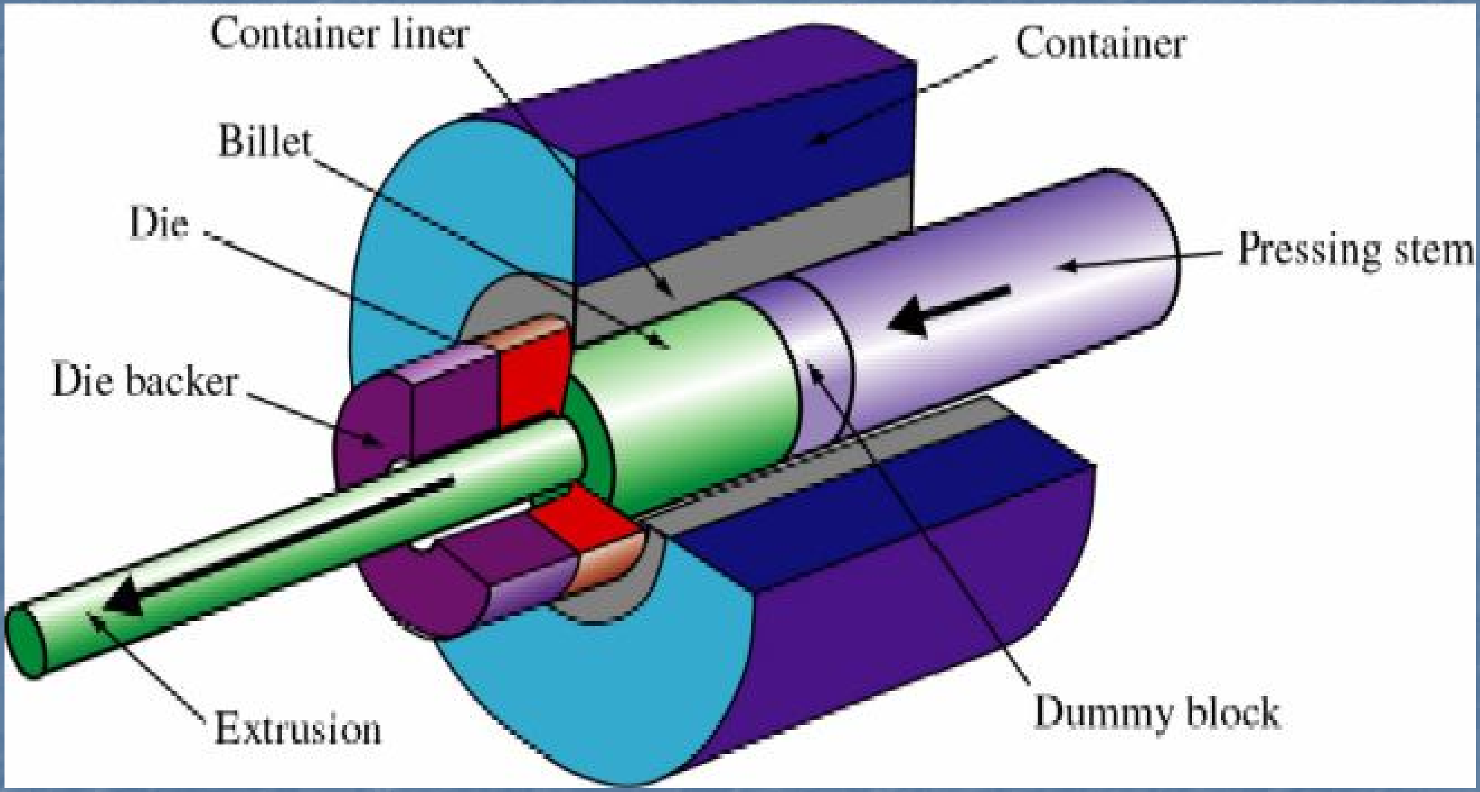


Fig : Schematic illustration of direct extrusion process.

Process Variables in Direct Extrusion

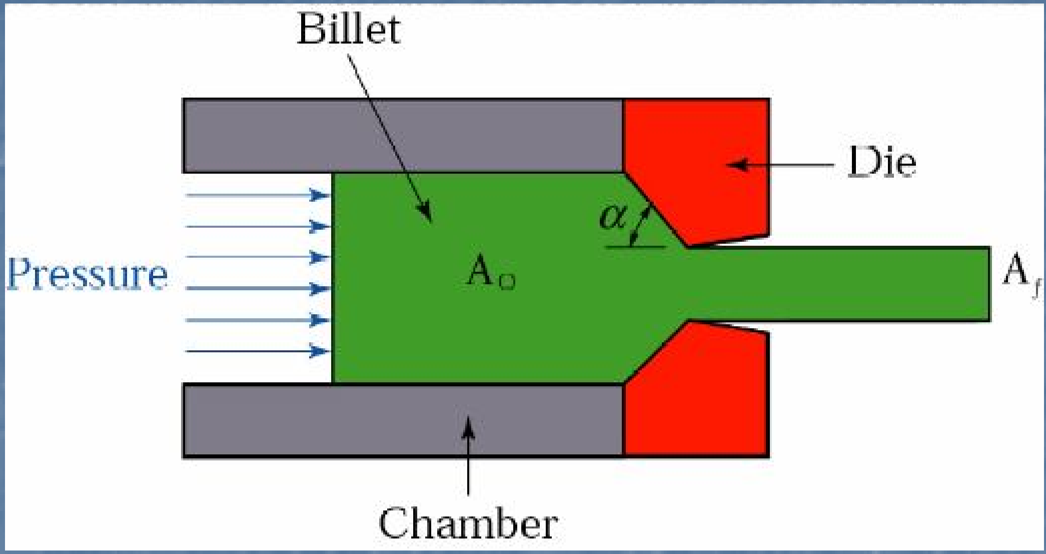


Fig : Process variables in direct extrusion. The die angle, reduction in cross-section, extrusion speed, billet temperature, and lubrication all affect the extrusion pressure.

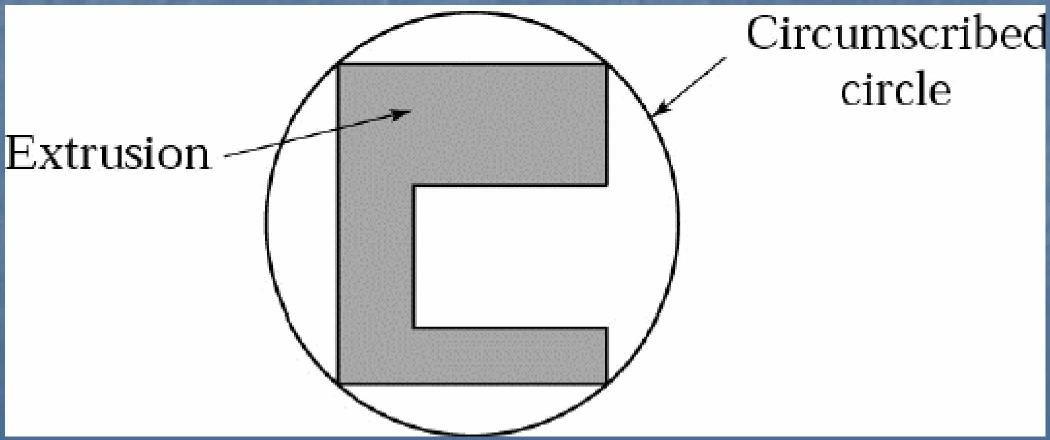


Fig : Method of determining the circumscribing-circle diameter (CCD) of an extruded cross-section.

Types of Metal flow in extruding with square dies.

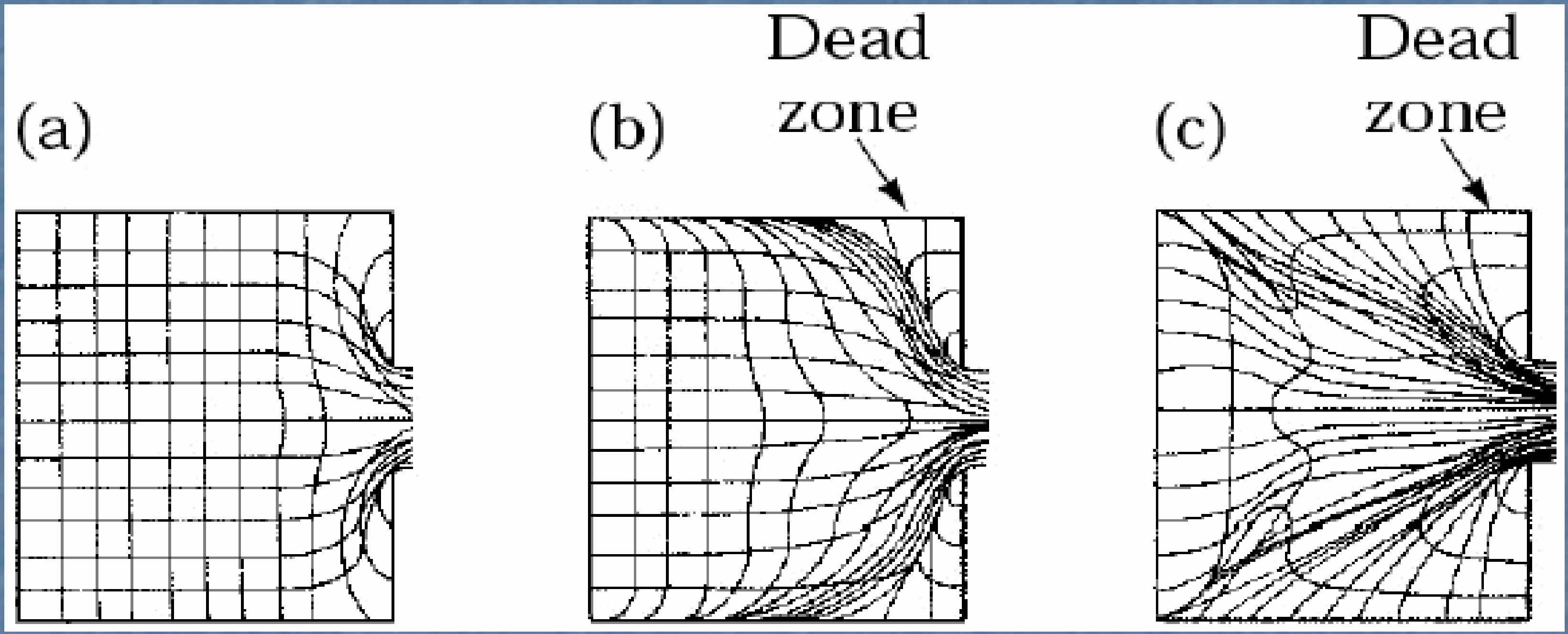
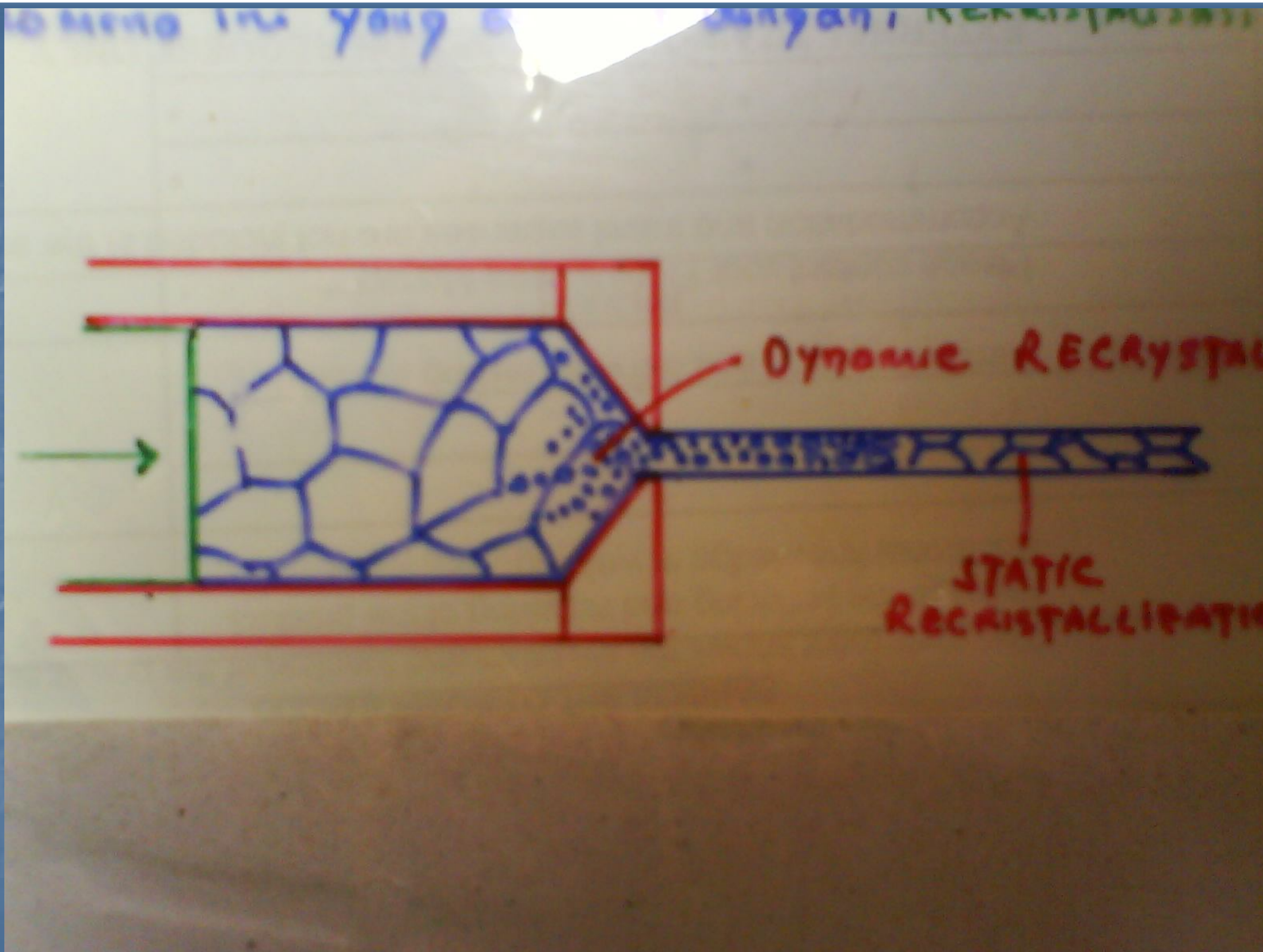
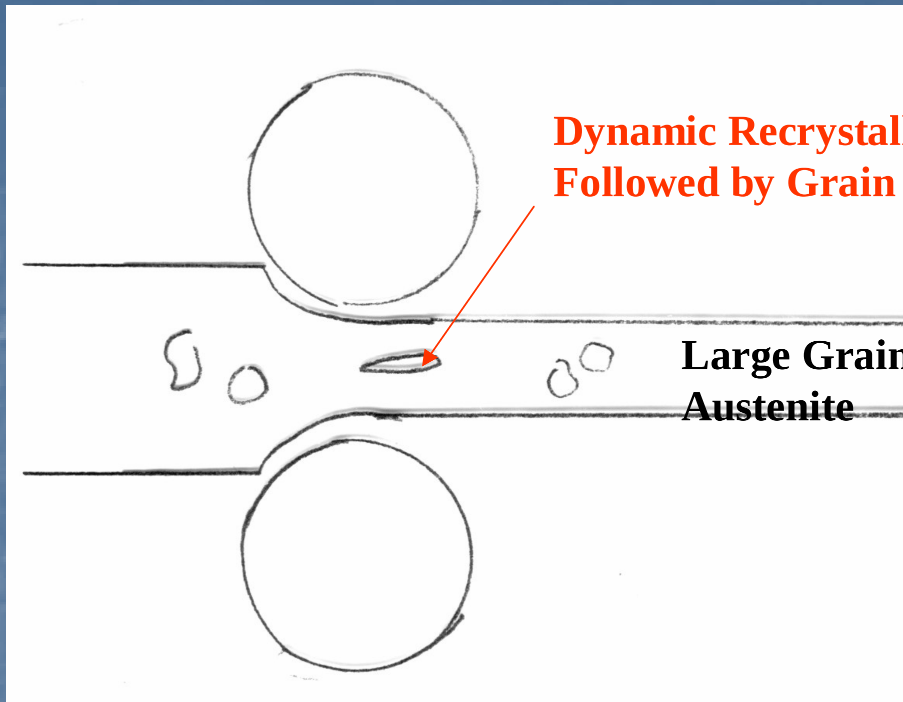
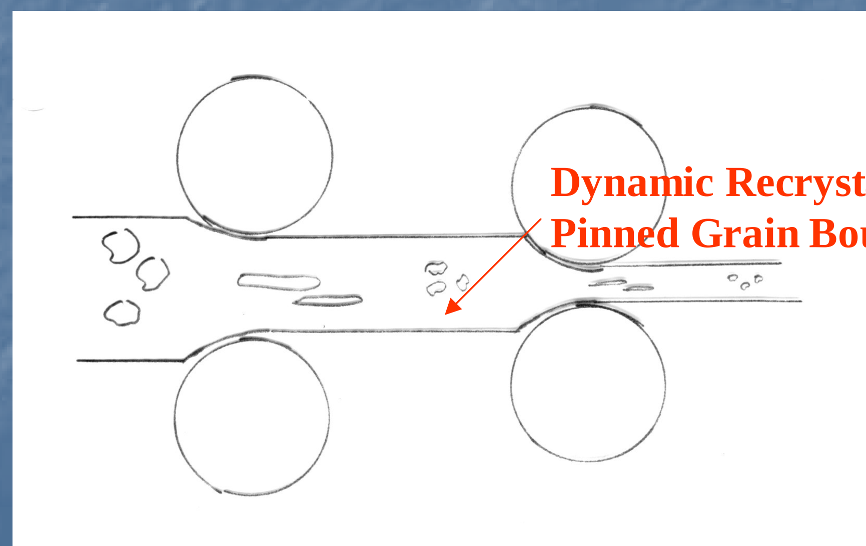
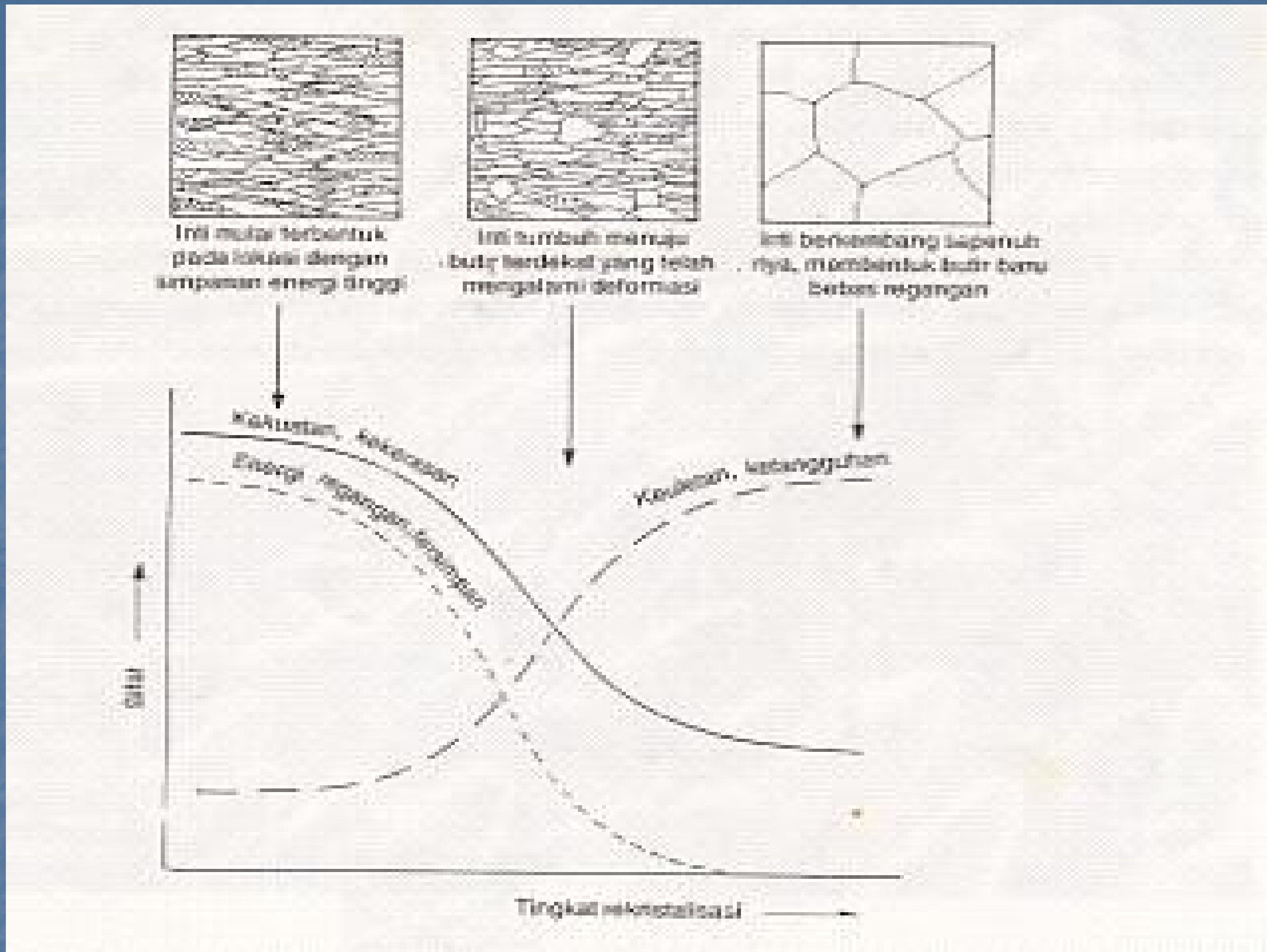


Fig : Types of metal flow in extruding with square dies. (a) Flow pattern obtained at low friction, or in indirect extrusion. (b) Pattern obtained with high friction at the billet-chamber interfaces, (c) Pattern obtained at high friction, or with cooling of the outer regions of the billet in the chamber. This type of pattern, observed in metals whose strength increases rapidly with decreasing temperature, leads to defect known as pipe, or extrusion defect.

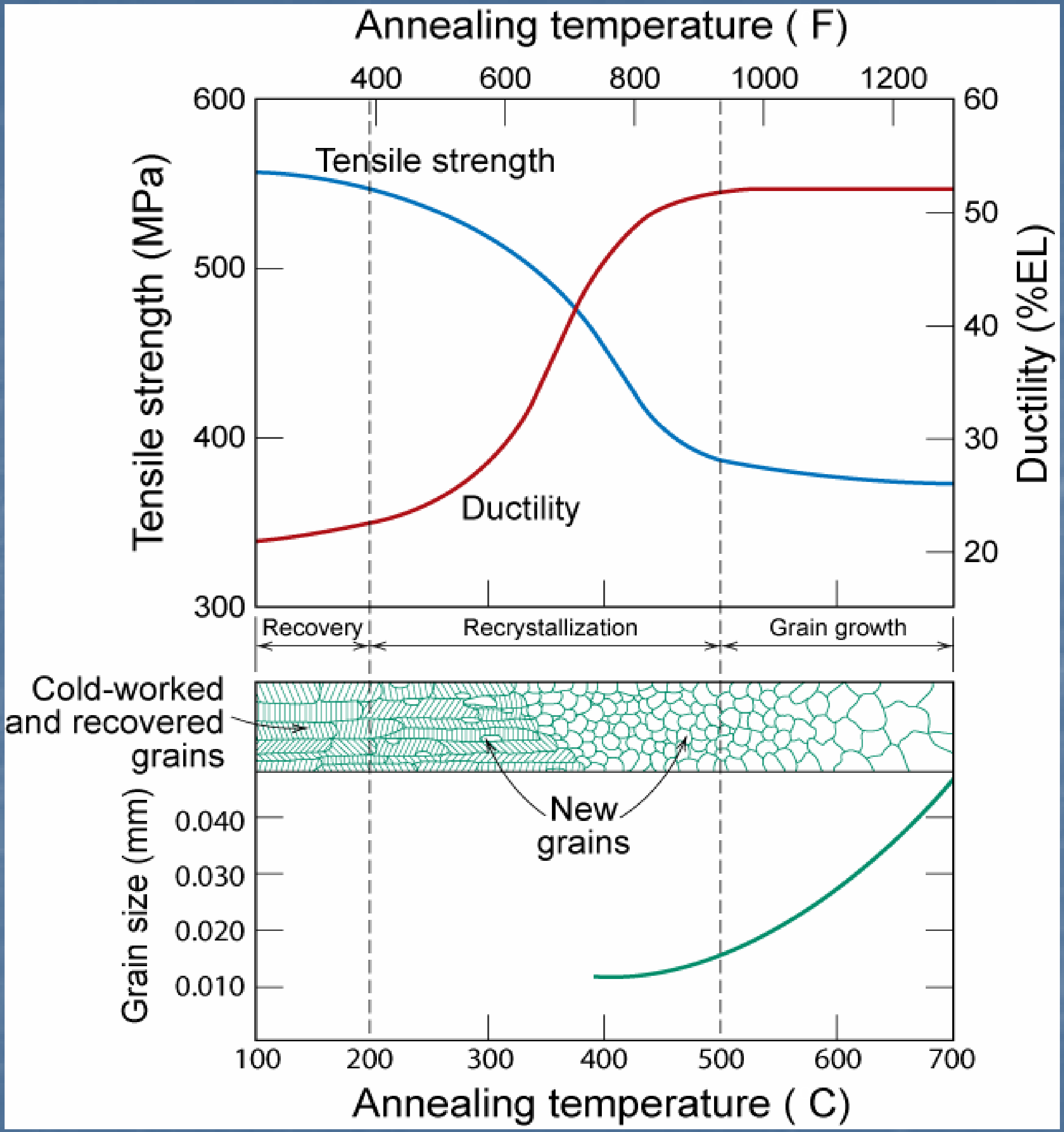

Dynamic RECRYSTAL
STATIC


Dynamic Recrystallization
Followed by Grain Growth
Large Grain Austenite
Transforms
Ferrite/Pearlite


Dynamic Recrystallization
Pinned Grain Boundaries

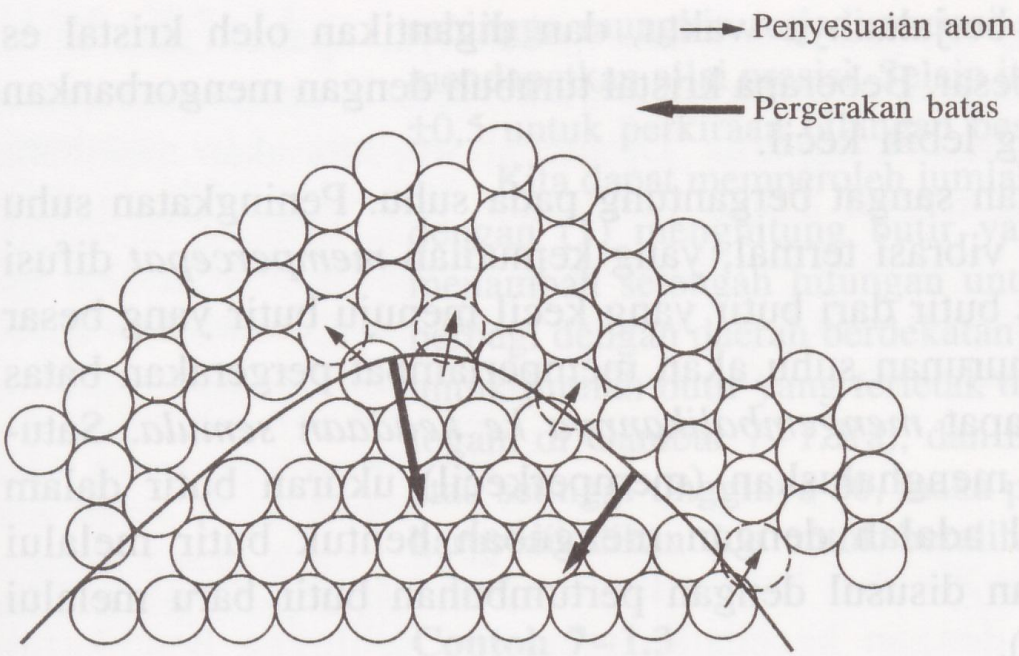


Perubahan struktur mikro dan sifat mekanik logam terdeformasi selama proses rekristalisasi



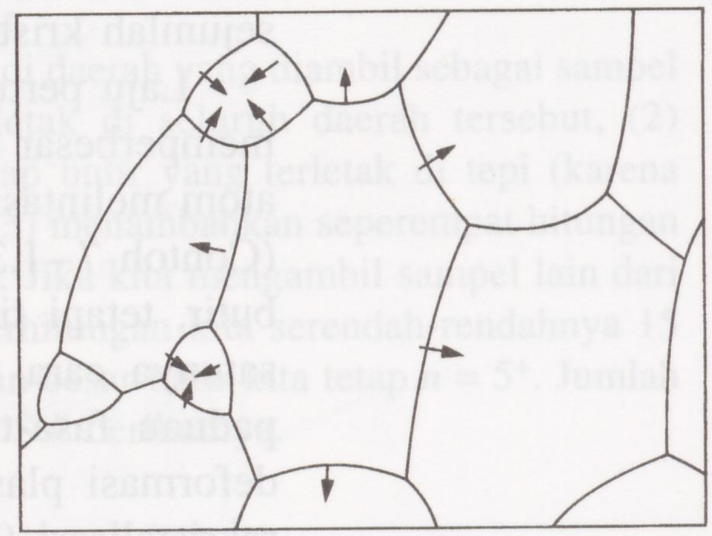
T_R = recrystallization temperature

Adapted from Fig. 8.22, *Callister & Rethwisch 3e.*



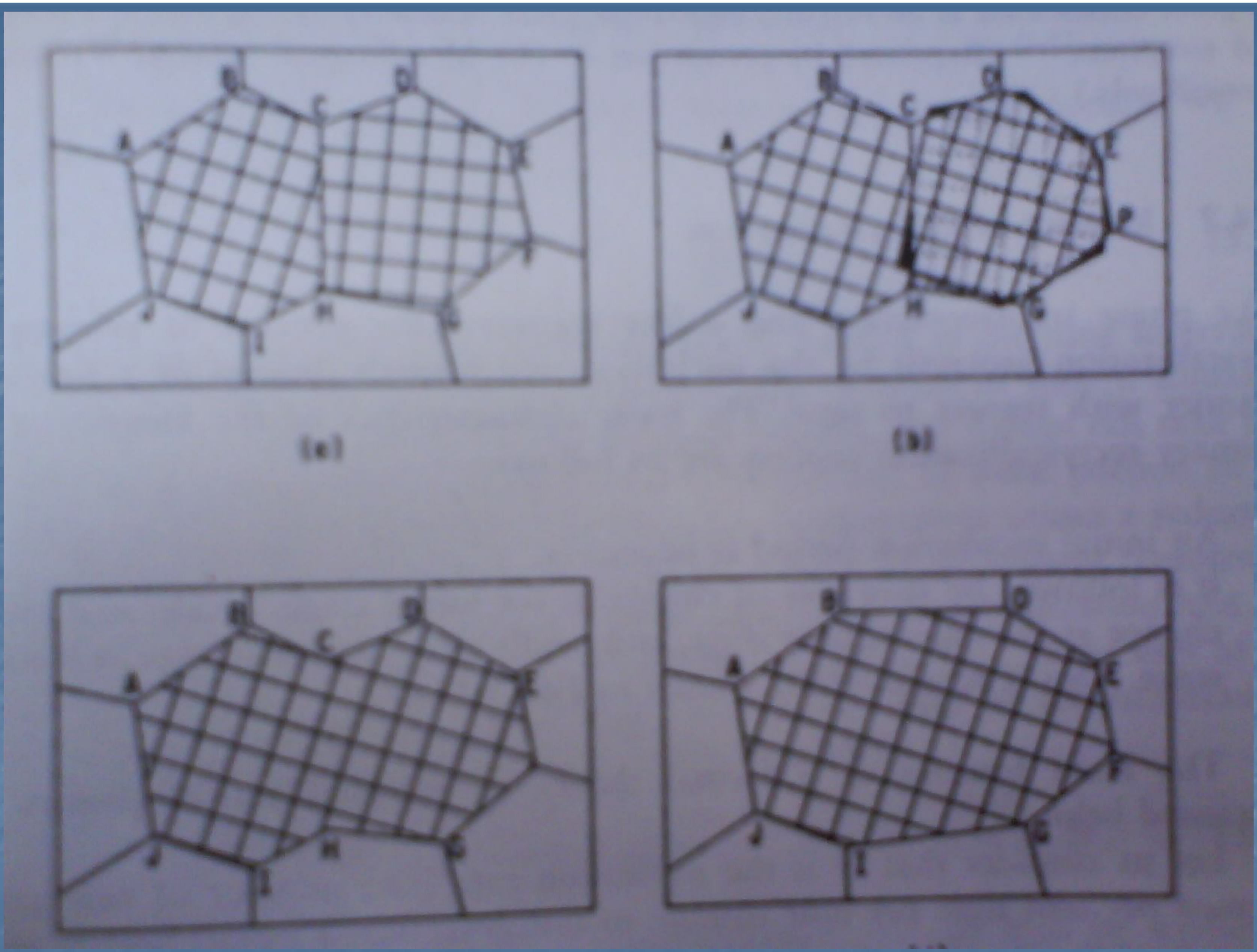
GAMBAR 7–1.7

Pergerakan Batas-Butir. Atom bergerak menuju butir dengan permukaan cekung, di mana mereka lebih stabil. Akibatnya, batas bergeser menuju pusat kelengkungan.



GAMBAR 7–1.8

Pertumbuhan Butir. Batas butir bergerak menuju pusat kelengkungan (tanda panah). Hasil akhirnya adalah lenyapnya butir kecil.


(a)
(b)