MFT-1: Fundamentals

Recap

Plane stress:

Reference: Section 2.3: Mechanical Metallurgy by Dieter, 3rd EDITION

State of stress in 3D

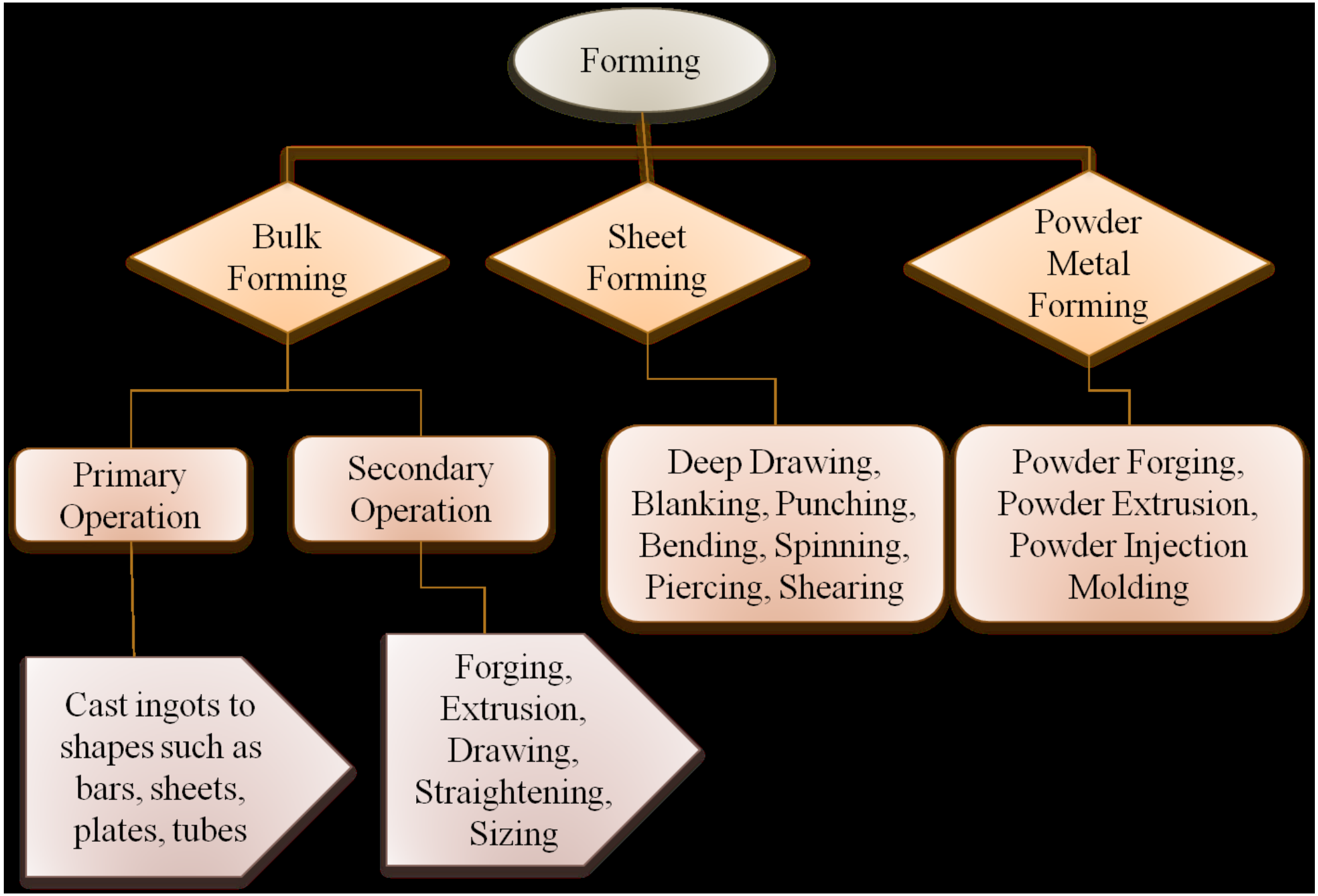
Reference: Section 2.5: Mechanical Metallurgy by Dieter, 3rd EDITION

Description of strain at a point

Reference: Section 2.8: Mechanical Metallurgy by Dieter, 3rd EDITION

Hydrostatic and deviator components of stress

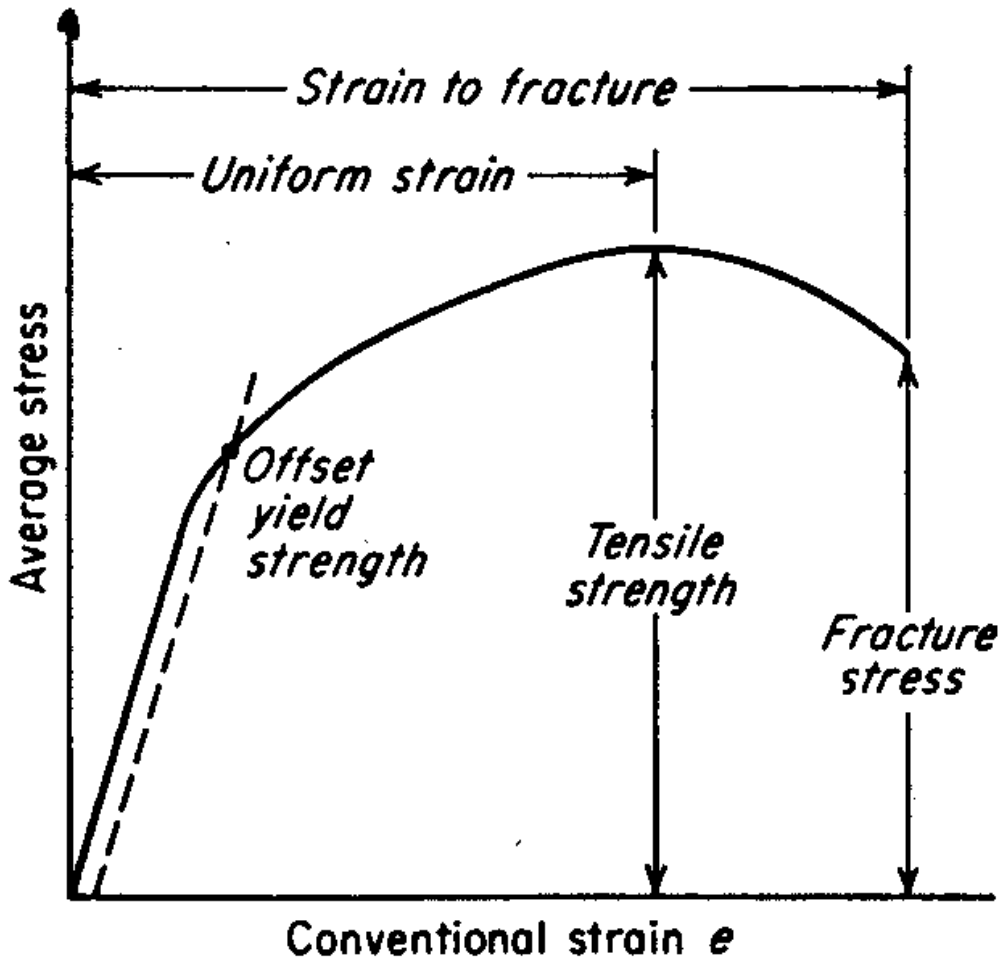
Reference: Section 2.10: Mechanical Metallurgy by Dieter, 3rd EDITION

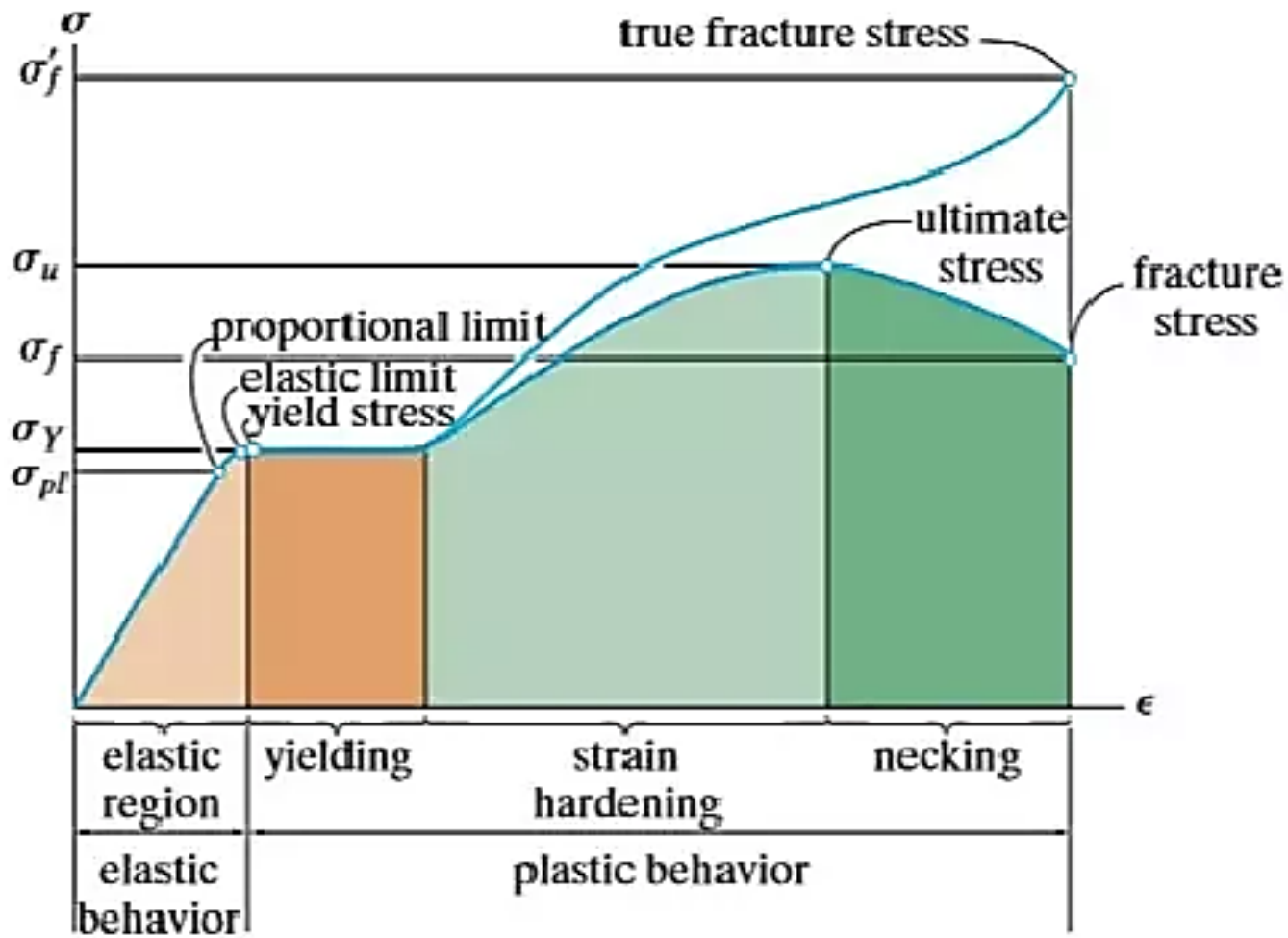

Forming
Bulk Forming
Sheet Forming
Powder Metal Forming
Primary Operation
Secondary Operation
Deep Drawing, Blanking, Punching, Bending, Spinning, Piercing, Shearing
Powder Forging, Powder Extrusion, Powder Injection Molding
Cast ingots to shapes such as bars, sheets, plates, tubes
Forging, Extrusion, Drawing, Straightening, Sizing

Based on the nature of deformation force applied on the material, during forming

Forming by compressive stress	Tensile and compressive stresses	Forming under Tensile stress	Bending and shearing stresses
•Open Die Forging •Closed Die Forging •Rolling •Coining •Extrusion	•Deep drawing •Spinning •Stripping •Wrinkle bulging	•Stretch forming •Stretching •Expanding	•Bending •Shearing •Punching •Blanking

Flow curve





Conventional and true stress-strain diagrams for ductile material (steel) (not to scale)

Topics covered

- Plane stress
- Plane strain
- Hydrostatic and deviator components of stress
- Flow curve

Recap: Elements of the theory of plasticity

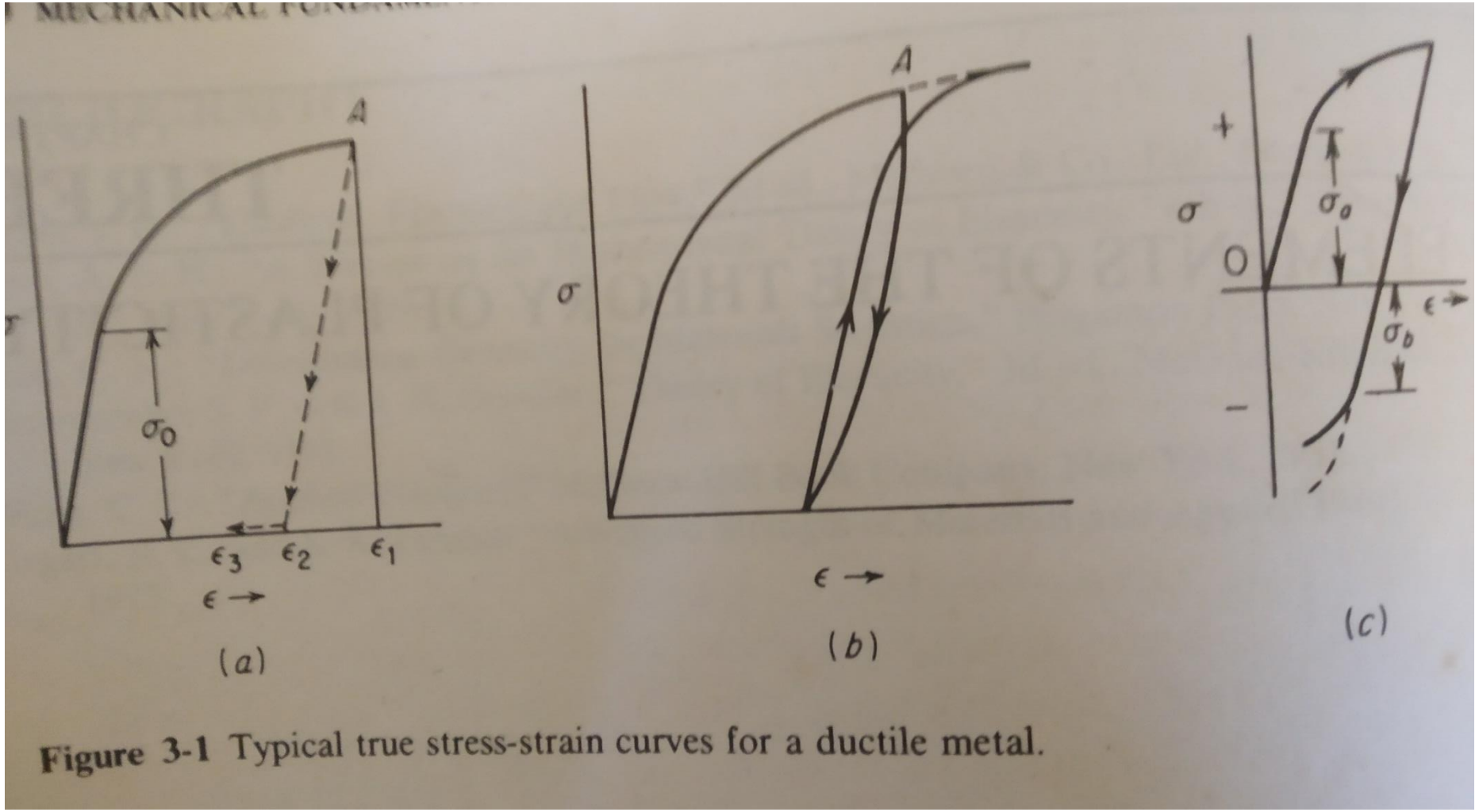


Figure 3-1 Typical true stress-strain curves for a ductile metal.

Reference: Section 3.2 and 3.3: Mechanical Metallurgy by Dieter, 3rd EDITION

Types of stress–strain curves

- Curves with associated stress–strain equations have the following characteristics:

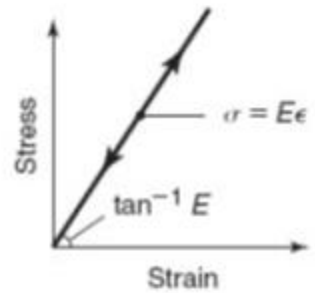
a. Perfectly elastic

b. Rigid and perfectly plastic

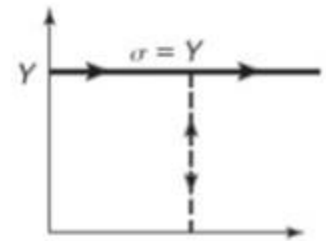
c. Elastic and perfectly plastic

d. Rid and linearly strain-hardening

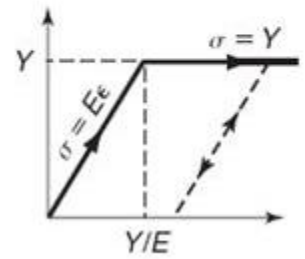
e. Elastic and linearly strain-hardening



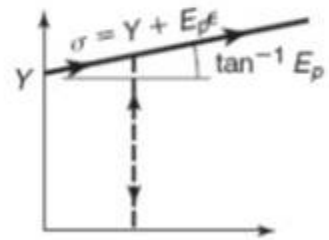
(a)



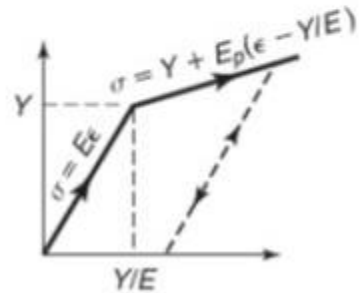
(b)



(c)

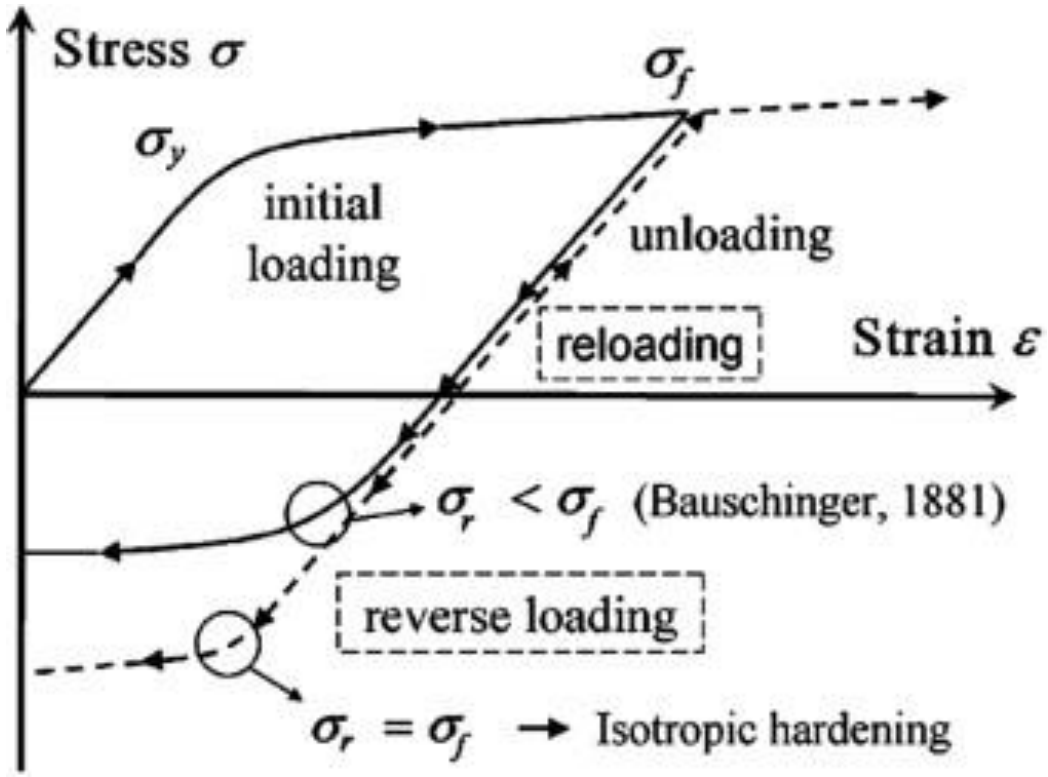


(d)



(e)

Bauschinger effect



- The stress σ_f is the forward flow stress, and σ_r at the start of reverse plastic flow is the reverse flow stress.
- If $\sigma_r = \sigma_f$, the material hardens isotropically.
- For many metals, however, the reverse flow stress is found to be lower than the forward flow stress. This anisotropic flow behavior was first reported by ***Bauschinger*** and is referred to as the ***Bauschinger effect***.
- The loss of strength due to the Bauschinger effect is of practical importance since the strength of a metal part may be impaired if the working stress acts in the reverse direction compared to the manufacturing stress

The physical origins are generally ascribed to either long-range effects, such as internal stresses due to dislocation interactions , dislocation pile-ups at grain boundaries or Orowan loops around strong precipitates, or to short range effects, such as the directionality of mobile dislocations in their resistance to motion or annihilation of the dislocations during reverse straining

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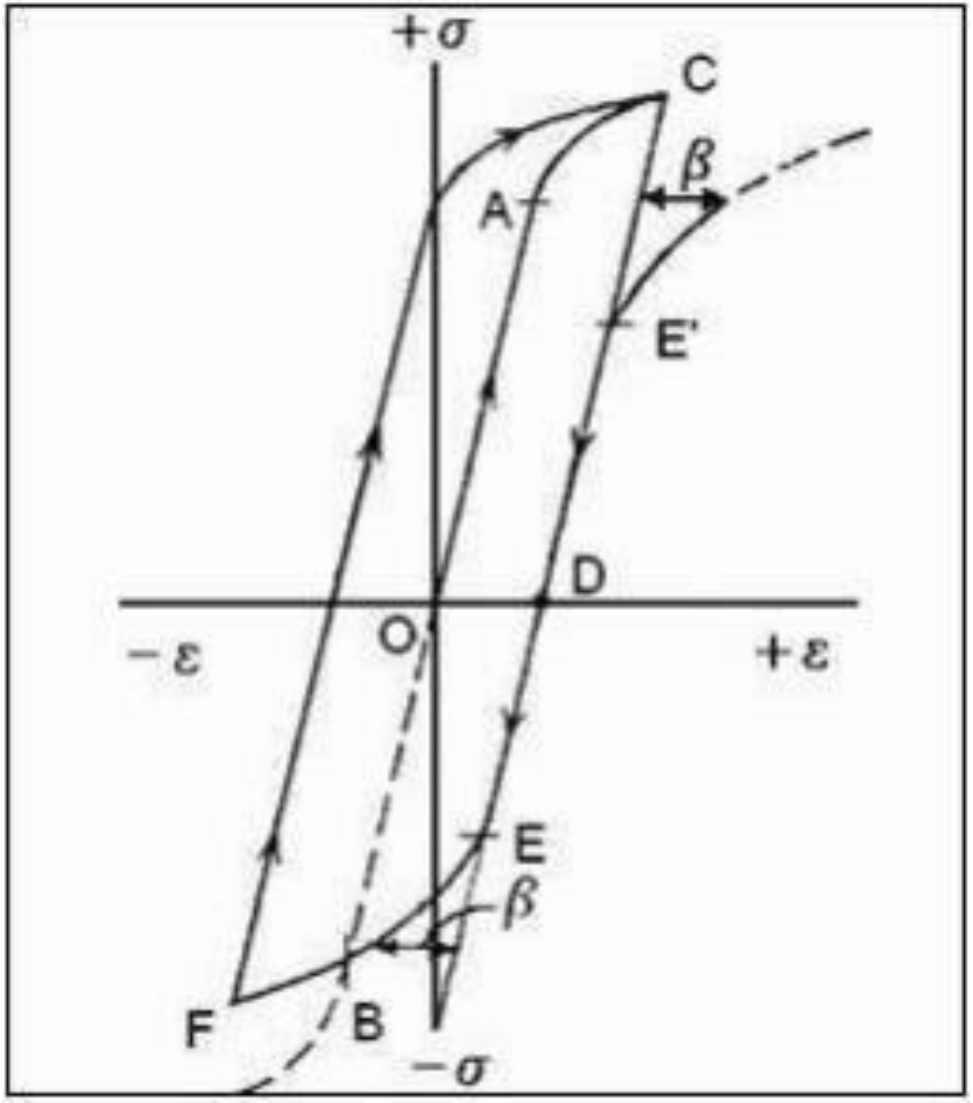

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